

Re-Connecting the Sea

**The Rochelongue metals assemblage, maritime connectivity
and cultural interactions in West Languedoc, France,
seventh to sixth centuries B.C.**

By

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SUMMARY

This thesis presents the first comprehensive study of the Rochelongue site (seventh–sixth century B.C.) since its discovery in 1964. This study includes a review of previous research and interpretations of the site and introduces a more systematic methodological approach to the investigation of the its metals assemblage. The aim of this thesis is to move beyond the site’s dating, characterisation and cultural ascription and instead examine its broader implication as an early contact zone where disparate cultural groups met and transacted. The Rochelongue site yielded an assemblage of mostly metallic objects of both local and foreign provenances, which allows for a thorough investigation into the connectivity in the western Mediterranean through the lens of regional and long-distance maritime trade networks. This research uses an interdisciplinary approach—geographic, material culture and network science—to assess the archaeological assemblage in order to make a more definitive and generalising interpretation of the site. Results from this multi-methods analysis reveal an inter-regional phenomenon in the Catalonia-Languedoc region that highlights the role of indigenous populations embedded in an increasingly long-distant trading context stimulated by contact via the sea with eastern maritime cultures. The Rochelongue shipwreck evidences a trans-Mediterranean network of varying intensities, which largely determine the levels of impact on the connected cultures from the Iberian Peninsula to Central Mediterranean.

RESUMEN

La presente tesis se puede considerar como el primer estudio comprensivo del llamado pecio de Rochelongue desde su descubrimiento en 1964. Para ello, se ha realizado una revisión bibliográfica, así como múltiples interpretaciones previas expuestas sobre el yacimiento subacuático de Rochelongue (s. VII–VI a.C.) siguiendo una metodología sistemática del conjunto de metales que componen el yacimiento. El objetivo general de esta investigación es promover la discusión más allá de la simple caracterización cronológica y cultural del conjunto, evaluando el yacimiento como una zona de contacto. El yacimiento de Rochelongue se compone en su mayoría por un grupo de metales de procedencia local y foránea, lo que supone una oportunidad excepcional de analizar la conectividad en el Mediterráneo Occidental desde la óptica de las redes de comercio marítima a escala tanto regional como de larga distancia. Este estudio utiliza una perspectiva interdisciplinar combinando el análisis sobre los materiales arqueológicos, datos geográficos, así como la información que se desprende del análisis de las redes sociales. Los resultados de los diferentes análisis han sido aplicados al conjunto arqueológico con el objetivo de exponer una interpretación más definitiva del yacimiento, así como una mayor comprensión de la implicación de este conjunto arqueológico con respecto a la conectividad marítima. Desde esta investigación se propone una visión innovadora a través de la conceptualización del yacimiento como “zona de contacto” en lugar de mantener una discusión más anclada en la definición de los restos como pecio frente a depósito ritual. En este sentido, el análisis de la información obtenida indica la presencia de un fenómeno interregional que afecta al área Cataluña-Languedoc. Este fenómeno se presenta definido por un protagonismo de los actores indígenas frente a los foráneos. Unas poblaciones locales cada vez más inmersas en circuitos de larga distancia motivados por el incremento de la conectividad marítima pero que parece seguir anclada a la conectividad y los encuentros de momentos previos a la presencia estable de actores foráneos en la región. Como conclusión, el pecio de Rochelongue es representativo de una red transmediterránea, que muestra un desplazamiento del metal desde la Península Ibérica al Languedoc (Sur de Francia), en vías de alimentar la demanda externa. Más concretamente, dicha demanda en términos de movilidad de metales y de personas, varía de intensidad y viene determinada por los diferentes niveles de impacto entre las culturas que se conectan desde la Península Ibérica al Mediterráneo central imbuidos por el contexto colonial del Hierro I.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed, Enrique Aragon

A handwritten signature in black ink, appearing to read 'Enrique Aragon', with a stylized, sweeping flourish extending to the right.

Date 31 January 2020

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CHAPTER 1. INTRODUCTION

1.1 Introduction

Over the course of the eighth to sixth centuries B.C., Phoenician maritime activity, commercialisation and settlement in the western Mediterranean reached its peak (Aubet 2001:257–341). The latter half of this period also witnessed the emergence of Greek and Etruscan sea trade in the central and western Mediterranean, with the latter particularly prevalent in the environs of the Tyrrhenian Sea and especially between Italy and the Languedoc region. Evidence from a number of sixth- and fifth-century B.C. shipwrecks, what Broodbank (2013:546) calls collectively the ‘first tangible horizon of wrecks’, supports this general picture of burgeoning maritime trade (Nantet 2010:97). These conditions promoted greater economic mobility, which contributed directly to a significant growth in mineral exploitation and metalworking in the region (Garcia and Sourisseau 2010:238; Garcia and Vital 2006:64; Ugolini 2010:32). Evidence of this is visible in the archaeological record, in both local and foreign material culture, and provides a window to the respective cultural practices and the processes impacting upon them (Bradley 1990; Dietrich 2014; Fontijn 2002; Huth 2017; Vives-Ferrándiz 2015:287).

The underwater site at Rochelongue was discovered in 1964 off Cap d’Agde (West Languedoc, France). The site was subject to annual archaeological investigations between 1964 and 1968, and again in 1970 (Gascó et al. 2014). Archaeological material at the site was scattered over an area measuring roughly 25 × 14 m at a depth of 6–8 m (Bouscaras and Hugues 1972). The recovered artefact assemblage has traditionally been described as comprising more than 800 kg of metal and at least 1,700 artefacts (Bouscaras 1964b:288; Hugues 1965:176; Jézégou 2012:6; Parker 1992:369).

The material assemblage recovered from the underwater site at Rochelongue is emblematic of this body of evidence. The diverse types and cultural origins represented by these objects have facilitated multiple characterisations of the site, all in keeping

with traditional views on the initial phase of colonial contact and their ramifications for archaeological interpretation.

1.2 Significance

The Rochelongue collection represents large accumulations of heavily fragmented metalwork and raw materials (Bradley 1990; Dietrich 2014; Fontijn 2002; Huth 2017). It comprises raw ore, bulk metals, scrap material and manufactured objects, including Atlantic, Mediterranean and local bronze works. The site therefore offers a unique opportunity to investigate long-distance trade and the movement of metals along the entire metallurgical *chaîne opératoire*. It is the first maritime assemblage in southern France that manifests foreign cultural influence from the eastern Mediterranean, with the implication of attendant culture contacts. The site also demonstrates vividly the importance of the region as the intersection of major land and sea trade routes that connected the British Isles and Atlantic seaboard to central Europe and the Mediterranean in the Late Bronze Age (LBA) and Early Iron Age (EIA) (Verger and Pernet 2013). Finally, being situated temporally during the highpoint of Phoenician commercialisation in the western Mediterranean and the flourish of Greek and Etruscan maritime activity in the region, the site offers a unique opportunity to study different colonial and economic strategies as they pertain to the procurement and supply of metals, metalworking and trade of metal wares and the recycling of scrap metals.

This thesis research takes advantage of this unique collection by studying it within a framework of maritime connectivity using a network analysis approach in order to elucidate culture contacts and the globalising dynamics of the Archaic period that helped shape Classical antiquity and, ultimately, Western culture. In doing so, it contributes significantly to the proper description and cataloguing of the Rochelongue assemblage, and further clarifies the confusion surrounding its historical and archaeological contexts and interpretations. This thesis also adds new information that assists in better interpreting the site. Locally, this work will be used by the curatorial

staff at the Museum of the Ephebe and Underwater Archaeology (*Musée de l'Ephèbe et d'archéologie sous-marine*), or Ephebe Museum, in Agde, to improve the collection's exhibition and presentation to the public.

To date, the Rochelongue artefacts and their archaeometallurgical characterisations remain understudied and poorly published. Similarly, the archaeometallurgy of lead, tin and copper in the western Mediterranean during this period, which is evidenced only by material from a few shipwreck sites (Lucas-Pellicer and Ramos 1993; Ramos 1993; Wang et al. 2016:41), is not well characterised. Chemical analyses for provenancing materials, in addition to standard typological studies, provide valuable new data that enable the meaningful interpretation of material assemblages with limited or no archaeological. This thesis is strategically placed to contribute significantly to methodological approaches using Social Network Analysis (SNA). While this has only recently been applied in archaeology, it has yet to be used for underwater sites, so its application is specifically significant for maritime archaeological studies.

Studies on the Rochelongue site have traditionally focused on the chronologies and cultural attributes of the remains, and especially on the question of what type of site it represents—shipwreck or ritual deposit (Barbot 2000; Gascó et al. 2014; Long 2004; Long et al. 2002a). As yet, there is no general consensus on the answers. This thesis introduces a new investigation of the Rochelongue metallic finds, using them as a case study to explore culture contacts within the pre-colonial context in southern France and western Mediterranean. Rather than focusing on site characterisation, this study approaches the site as a 'contact zone', which Dietler (2010:13) defines as a 'zone of direct, sustained encounter between indigenous people and alien colonist, where mutually misunderstood cultural differences were worked through in political and economic practice, pidgins and creole languages, and, often, violence'. This thesis applies multiple methods of analysis to address larger questions of culture contact and its socio-economic repercussions.

The following section discusses the primary and secondary research questions addressed in this thesis, as well as some of the supporting aims that will help establish the archaeological context and conditions of analysis.

1.3 Research Questions and Aims

1.3.1 Research Questions

The principal research question of this thesis is:

How can a research framework using multiple methods of analyses provide a better approach to theorising and interpreting evidence derived from the metal assemblage of the Rochelongue underwater archaeological site in order to create a clearer understanding of the dynamics of cultural interaction in the Western Mediterranean during the Archaic period?

In the process of formulating the research framework for this thesis project and applying it to the analysis of the Rochelongue assemblage, several other inquiries will be addressed in pursuit of answering the main research question above. These secondary questions are:

- How can an interpretation based on the concept of ‘contact zone’ allow us to locally contextualise the initial phase of colonial encounters in southern France?
- How does the Rochelongue metal assemblage compare with other metal hoards of the LBA–EIA found in terrestrial archaeological contexts?
- Do the characteristics of these assemblages reflect the social and cultural logic of indigenous societies and their institutions, cosmologies and structures; and, if so, how can their analysis contribute to a better understanding of these assemblages?

To fully address these questions, this thesis investigates the nature of the Rochelongue assemblage in order to establish whether it resulted from shipwrecking or some other processes, such as ceremonial or votive acts. This research also sets out to establish a more accurate dating of the assemblage and to characterise the individual items in the assemblage, including their material, likely provenance (especially of the raw materials), method of manufacture, use and meaning. This artefact study will provide a more complete context for the assemblage through the extraction of new data that can

help answer broader questions related to the dynamics of cultural interaction and its impact on the cultures involved.

1.3.2 Aims

In pursuit of answers to these questions, this thesis will address the following aims relating to archaeological context and provenance, and to the network analysis framework.

Archaeological context

- Critically review site records from the 1960s excavation to establish a detailed understanding of the existent data and a clear picture of the archaeological context;
- Establish a definitive catalogue of the Rochelongue collection and a more accurate identification and chronology of the individual constituent items;
- Discriminate between local objects and foreign imports using a standard typological approach;
- Identify the method of manufacture using metallurgical analytical techniques; and
- Use the historical and archaeological contexts, identification and provenance of the objects to ascertain their socio-economic function and meaning.

Provenance

- Undertake lead isotope analysis (LIA) of the objects and compare the resulting data with studies of similar materials from other sites to determine probable provenances of the raw metals or mineral ores used for the production of the Rochelongue manufactured objects;
- Determine the elemental composition of artefacts in the Rochelongue assemblage using energy dispersive x-ray fluorescence (ED-XRF) and inductively coupled plasma mass spectrometry (ICP-MS) in order to assess their elemental variability as another possible means of establishing provenance for the metal artefacts; and

- Combine the typological and chemical/ spectroscopic analyses to investigate possible types of interactions between local and foreign peoples.

Network Analysis

- Visualise the social relationships between local Languedoc populations and foreign peoples by using a network framework integrating the results of typological and metallurgical analyses;
- Use the assembled data to investigate maritime connectivity in the region; and
- Use the results of network analyses to expose evidence of cultural interaction.

In the following discussions, key analytical and theoretical concepts are briefly introduced. These will be important for contextualising and interpreting the results of the metal assemblage analyses and will be discussed in much greater detail in Chapter 4 (Theoretical Approach).

1.4 Understanding Mediterranean Societies

Defining an archaeological site as a contact zone means approaching the study of these places from multiple perspectives that encompass not only material or geographical considerations, as is traditional, but also social and cultural concerns. This thesis approaches maritime connectivity on a micro-regional basis in order to better understand how such domains cohabit and contribute to the ‘whole’—in this case, to the entirety of the Mediterranean region. Studying the Mediterranean from a local perspective is an essential step in addressing a broader interpretive context. In recent years, some scholars have approached connectivity in the Mediterranean from a Braudelian point of view where the Mediterranean Sea is viewed as a composite group of many smaller seas (Braudel 1972:17). From this, Horden and Purcell (2000) recreated Mediterranean spaces as interlaced sea routes that bring coasts and centres of distribution face to face and re-shape micro-regions through interaction and connection with each other. These micro-regions create ‘spheres of interaction’ that contain geographical, temporal and material scales characterised as: (1) coastscapes; (2) maritime small worlds; (3) regional or intra-cultural; and (4) inter-regional or inter-

cultural (Tartaron 2014). The Mediterranean appears, then, as a space both fragmented and interconnected by the opportunities the sea affords (Horden and Purcell 2000).

The sea has always been the medium for sustainable trans-Mediterranean relations—a common tool of mobility (Arnaud 2011:131). Maritime exchange has been both the object of and mechanism for profound transformations in societies and the foundation of all sorts of cultural traditions, resulting ultimately in a so-called pan-Mediterranean context (Arnaud 2011:132). The movement of people can thus be viewed as a structural phenomenon, one based on the sea and the reticulate system it made possible (Moatti 2012:41). Scholars do not attempt to understand the macro-structure and its attendant political and economic forces directly, but rather through evaluation of local experiences and situating local histories in relation to larger historical structures (Dietler 2010:10). This provides the clear observation that the cross-cultural trade that this thesis analyses in relation to pre-colonial Mediterranean France depended on the sea (Dietler 2010:149).

1.5 The Connected Past: Mobility, Migration and Connectivity

Prior to the 1980s, mobility was rarely used as a broad theoretical construct for studying Mediterranean immigration (colonisation), cultural encounters and their social ramifications (Finley 1973; van Dommelen 2012). Although research was indicating that the movement of populations in the Bronze Age was important and relevant to understanding processes, such as Greek expansion (Morel 1983), mobility was treated merely as long-distance movement rather than as a socially-structured phenomenon (Moatti 2012:40). In recent decades, however, the question of mobility of individuals in ancient societies has received greater attention. Osborne (1991), for example, has stressed the need to study its forms and causes, and warns that historians of antiquity should not underestimate the degree of mobility of ancient populations. He also emphasised the relative character of distance in the study of migratory phenomena. It

is important, therefore, to take into account how past populations conceived of space and not just distance in an absolute sense (Moatti 2012:41).

Claudia Moatti (2012) distinguishes four aspects of mobility when analysing migration as a phenomenon and as a process of population change. These can be summarised as follows:

1. Social. Mobility is a social process and, as a result, cannot be understood without taking into account its impact on the 'social reality' of the group in question. No matter the type of movement (regional micro-mobility, seasonal movements, chain migration, etc.), the social group and sub-groups (such as family unit) are impacted—materially, culturally and even generationally (Page Moch 2002:142).
2. Flow. Rather than approaching mobility from a linear perspective of movement from the point of departure to the point of arrival, Moatti introduces the idea of 'flows', a concept capable of communicating both movement and what De Wenden (2001:7) calls 'the mobile practices of space'. Other of Moatti's (2012) conceptualisations, such as 'circulatory space' and 'migratory field', are based on an understanding of space constituted by the displacement between the places of origin and reception; however, she preferred the term 'migratory circulation' to designate all forms of mobility induced by the migratory act—flows, both visible and invisible. Her concept is reflected in the term 'culture of mobility' introduced by previous authors (e.g., Clifford 1997), which designated all the values, behaviours and knowledge produced by and for the experience of movement (Moatti 2012:44). Mobility then, involves a certain *savoir-faire*—knowledge of routes, identification of navigation risk and so forth—that allows the migrant to seize opportunities.
3. Organisation/Structure. Cohen (1997) defines the concept of diaspora as characterised by an initially forced or voluntary dispersion, being distinct from the host society and having a continual social and spiritual connection with the origin (Lilley 2006:287–312). Based on this definition, Moatti (2012:46) argues

that diasporas need to be understood as the organisational capacity—from integration to structuring life in motion—of moving peoples, and can be categorised as cultural, imperial or commercial.

4. Lives in motion. Somewhat paradoxically, mobility (the act of moving people) requires some sort of structure—infrastructure or framework—and so researchers must refine how they think of sedentariness and mobility (Moatti 2012:46). Within the context of the present study, mobility can be understood as maritime transhumance (Gras 2012:21), which constantly disrupts the stability of local populations, or cabotage (about this term, see Arnaud 2005, 2011), which combines elements of sedentary life with phases of mobility (the journey from port to port). Moatti (2012:46) argues that the binary opposition of sedentariness (or permanence) and migration (transience) is problematic and cautions that, in fact, no society is purely sedentary.

Thus, mobility may be conceived as the mechanism that produces a degree of connectivity, which, using Horden and Purcell's (2000:123) approach, is the various ways in which 'micro-regions cohere, both internally and also one with another'. More broadly, connectivity is the mobility of people and goods, the means of travel and communication and any resultant social exchange (Knapp and Demesticha 2016:30).

From the perspective of western Mediterranean encounters, chain migration (chain mobility)—communities migrating one after another over an extended period of time and settling down together—is an important mechanism for the creation of patterns of connectivity that directly affect the region of settlement (van Dommelen 2012:404). Socially, material culture allows us to explore the relationship between mobility patterns and contact situations. Material culture, or materiality, can help us address the diversity and scale of mobility and connectivity between micro-regions in coastal Languedoc by examining imports (what was imported and from where), imitations (as indicators of value and meaning) and numbers of such (as indicators of intensity of interaction) (Vives-Ferrandiz 2015:279; Horden and Purcell 2000:123).

Connectivity and mobility also are pertinent to discussions concerning maritime contexts and have been used to create a theoretical framework for investigating past Mediterranean societies and the formation of identity through subsequent cultural interactions (Leidwanger 2013:302). Following this, maritime connectivity (via merchants, mariners and local traders) determines the level of relationship between different coastal or island communities, as well as the intensity of these connections (Knapp and Demesticha 2016:30). Furthermore, approaches based on networks apply new insights from network theory concerning the dynamic interactions between 'actors' as nodes or links, where connectivity and distance are measured by degrees of separation rather than physical distance (Malkin 2011:9).

1.6 Conclusions

This research examines the material culture of the Rochelongue site by providing key information to better understand traditional discussions about the site, such as its chronology, cultural attribution and nature. This thesis, however, focuses on the concept of 'contact zone' as a new approach that provides access to a much broader assessment of the material culture in terms of maritime cultural interaction. In order to address this objective, multiple methods have been proposed that cover not only the materiality of the assemblage, but also the geographical and social connectivity represented by its contents. The investigation traces maritime interactions using network analysis in order to understand socio-economic changes and processes in culture contact and colonial settings in western Languedoc, which occurred during the seventh and sixth centuries B.C. It abstracts the direct network around the Rochelongue site by analysing the distribution of metallic objects from the site assemblage in order to investigate maritime networks and connectivity with the western and broader Mediterranean Sea. These interactions have been reconstructed using geographical and contextual distributions via typological and archaeometallurgical studies. In a context where, for the first time in history, the entire Mediterranean was connected from east to west, the Rochelongue assemblage

represents the earliest evidence for maritime contact between local and foreign cultures in southern France. The research associated with this site also undoubtedly contributes to an improved understanding of Greek and Phoenician colonisation efforts in the western Mediterranean during the Early Iron Age.

CHAPTER 2. BACKGROUND: THE LATE BRONZE AND EARLY IRON AGE IN SOUTHERN FRANCE

2.1 Geographical Area of Study.

In this thesis, temporal and spatial terms are key to the interpretation of local archaeological contexts in relation to a broader Mediterranean network. Cultural encounters develop over time, and the characteristics that define the nature of the interaction change. In this sense, power relations and status can change rapidly due to the sporadic presence of foreign actors, up to the moment of more permanent colonial foundations (e.g., at Massalia or Emporion). It is important that the relevant actors (cultures) first be characterised and located within a macro context (in this case the Mediterranean Sea) to better understand them subsequently at the micro or local level (western Languedoc). The use of local realities, or the study of micro-regions, as an approach to understand Mediterranean movements makes it possible to consider archaeological data in an original way. In this way, by looking at the mobility of individuals, technologies or influences between sites, and by attempting to map this mobility, it is possible to understand certain social phenomena, such as the role of local actors.

As discussed in Chapter 1, the Mediterranean Sea cannot be considered a single unit of study, but rather must be seen as a complex of seas or regions. Accordingly, scholars traditionally have segregated the Mediterranean into three main regions or basins—eastern, central and western—based on its predominantly east-west geographical orientation (**Figure 2.1**). Additionally, in the scholarship of Greek and, especially, Phoenician expansion, the Mediterranean zone typically includes the near-Atlantic regions of the Iberian Peninsula and northwestern Africa, which is referred to as the Far West (Aubet 2001).

The geographical boundaries of the eastern Mediterranean encompass the Greek mainland, Aegean islands and coastal Anatolia (so-called East Greece), Cyprus, the Levant, Egypt and Mesopotamia, the latter due to its tremendous influence on the

cultures and geopolitics of the greater region (Broodbank 2013; Sherratt 1998; Tartaron 2014). Moving westward, the Central Mediterranean comprises the triangular area circumscribed by Sicily, Malta, the central coast of North Africa (including the Gulf of Sidra [*Syrtis Major*], the Gulf of Gabès [*Syrtis Minor*] and the Gulf of Tunisia) and the Tyrrhenian Sea (Botto 2013; Gonzalez 2014; López Castro et al. 2016). Occasionally, scholars use the appellation Western to designate all areas of the Mediterranean westward from Sardinia and Corsica (Niemeyer 2002; Sommer 2004). More precisely, though, this western adscription includes the southern coast of France, the Balearic Islands and the Mediterranean coast of the Iberian Peninsula. Finally, as already stated, many authors (e.g., Aubet 2001; Frankenstein 1979; Moscati 2001) use the Far West designation to refer to the near-Atlantic regions beyond the Strait of Gibraltar. Here, this includes the Strait itself, the Atlantic coasts of Spain, Portugal and Morocco, and oftentimes the Canary Islands as well (see Aubet 2001:257).



Figure 2.1. Geographical divisions typical in Archaic Mediterranean studies (from right to left): Eastern Mediterranean (dark orange); Central Mediterranean (light orange); Western Mediterranean (light blue); and Far West (dark blue).

This research is situated in the western coast of Languedoc in southern France, a cultural division of the region that describes a natural corridor extending west and

south in a broad arch from the Rhône River to the Roussillon territory (Figure 2.2; Gascó 2011). This stretch of coastal plain is bounded by the Cévennes and Montagne Noir ranges (Massif central) and traversed by a number of rivers, such as the Aude, Garonne and Hérault, which constitute an important means of connection with the immediate hinterlands, as well as between the Mediterranean and Atlantic ambits (Lemerrier 2012:132).

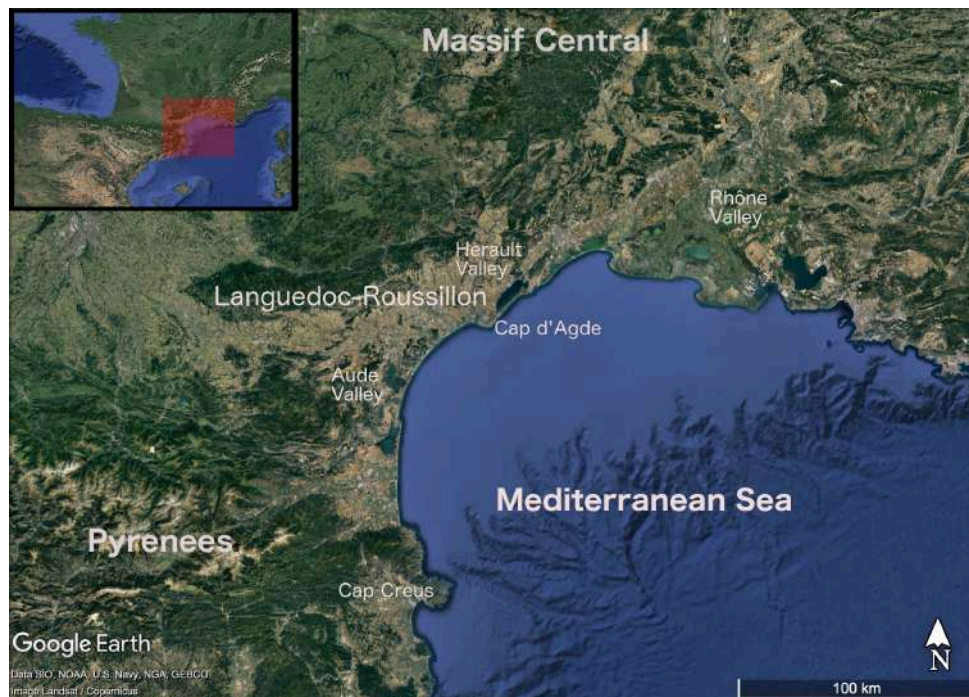


Figure 2.2. Regional map of southern France and northeastern Spain.

From a seascape perspective, the main maritime geographical reference for this research is the coastal region of the Gulf of Lion, where local populations create their identity, sense of place and history (Figure 2.3; Cooney 2004:323). In the LBA–EIA period, the Languedoc-Roussillon region constitutes a cultural focus particularly active in the western Mediterranean, where cross-cultural encounters are frequent, especially with Iberian cultures to the southwest and Alpine cultures to the north and east. This area stretches from Cap de Creus in the northeastern corner of the Iberian Peninsula, the so-called Ampurda, to the southwestern portion of Provence on the opposite side

of the gulf. In between, the area runs through the Roussillon, west Languedoc, east Languedoc and the Rhône Valley. West Languedoc culture differed significantly from that in east Languedoc and Provence due to an identical native substrate that coexisted on both sides of the Pyrenees, which also evolved in a parallel way under the strong influence of eastern Mediterranean groups (Rouillard 1991:200; Solier et al. 1976:212; Taffanel 1956). The seascape, then, is a key factor to understanding how southern France, via west Languedoc (as the first place of maritime contact), became an integral part of the pan-Mediterranean maritime trading network.



Figure 2.3. The Gulf of Lion and western Mediterranean Sea (ArcGIS™ map by author).

2.2 Chronology of the Late Bronze to Early Iron Age Transition (ninth–seventh centuries B.C.)

Traditionally, the chronology applied to the south of France (Figure 2.4) follows the European model, marking the transition from the Copper Age to the Bronze Age based on technical advances in metallurgy (Sørensen and Thomas 1989). The subsequent transition from the LBA to EIA is used in historiography to identify changes registered in

local socio-economic and cultural structures. These changes were the result of local developments, but of the increasing presence of seafaring foreigners—Phoenicians, Greeks and Etruscans—which accelerated the process (Gailledrat 2013:100).

According to the conventional chronological framework accepted by scholars, the Bronze Age extended from c. 3300–1200 B.C. in the Near East and from c. 1800–700 B.C. in Europe (Broodbank 2013; Kipfer 2000). This chronology was normalised based on the three-age theory: Stone, Bronze and Iron (Thomsen 1838). This division of industrial (changes in technology), as opposed to socio-economic, stages continues to be used in broad scopes (Heizer 1962:259); however, when the focus of study becomes more localised, the establishment of chronological sequences is based more on material culture attributes and the construction of typological sequences defining periods and cultures (Renfrew and Paul 2008:101). This research is focused on the Grand Bassin I–II, a period locally designated for west Languedoc that corresponds with the EIA for the northeast of the Iberian Peninsula, the Hallstatt C–D for central Europe, and the Archaic period for Phoenician and Greek colonial episodes across the Mediterranean (Figure 2.4).

From the perspective of archaeology of colonialism (Dietler 2010:39–67), the relative dating method is still closely linked to changes in technology (Ugolini 1993:27). In this case, though, the process of cultural interaction is based on the introduction of technical innovations (Dietler 2010:81–82), such as the generalisation of the use of iron or the introduction of wheel-made pottery (Ruiz and Molinos 1993:53). This approach has allowed researchers to create subdivisions in specific chronological phases and follow a potential geographical development of the colonial phenomena.

Furthermore, since the latter part of the 20th century, absolute chronologies based on radiocarbon and dendrochronological dating have become increasingly preferred (Aitken and Taylor 1997); this is true as well for southern France (Gascó 2001). For the period encompassing Phoenician and Greek colonisation, there are important elements that should be highlighted when comparing systems of relative and absolute chronological interpretation. The different Iron Age phases in the Mediterranean have been debated over the last decade (Botto 2004; Brandherm 2008; Docter et al. 2008).

This is not surprising, since any significant change in dates would affect the entire Mediterranean basin. The strength of Greek/Phoenician painted pottery typologies as the basis of a robust relative sequence, with rapid stylistic changes, presents a clear mismatch when compared with an absolute dating system (Botto 2004; Brandherm 2008; Docter et al. 2008).

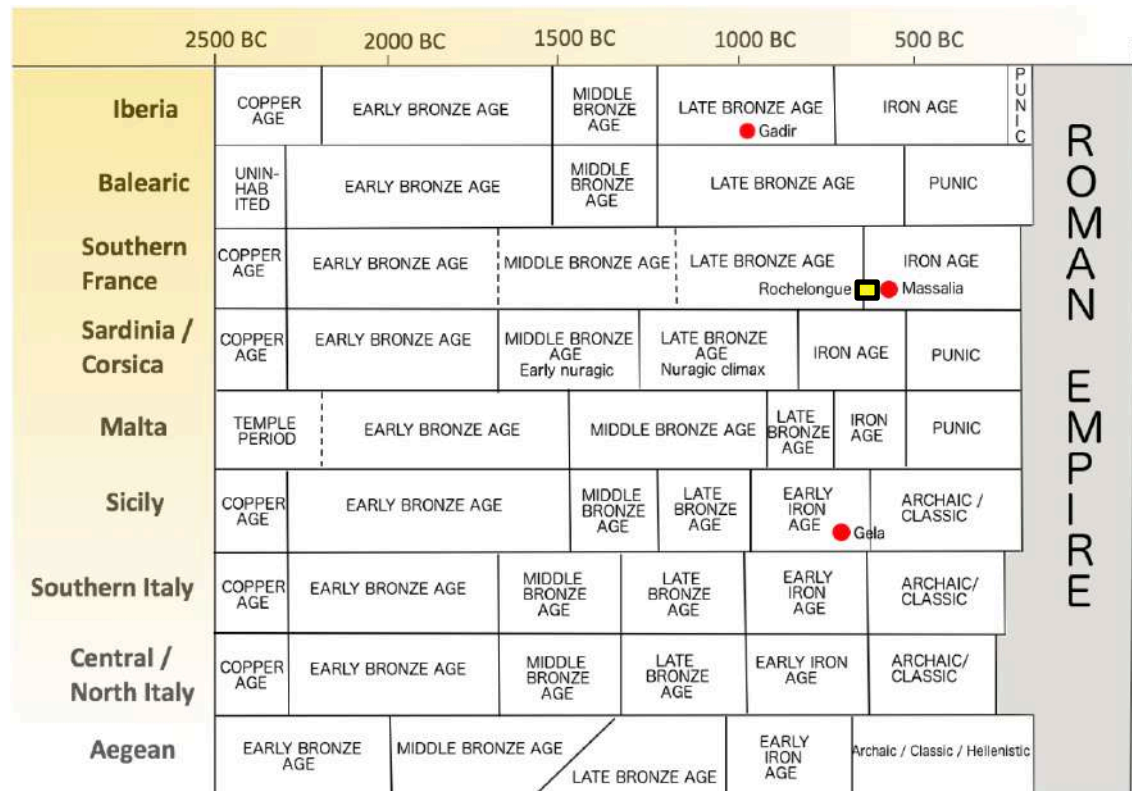


Figure 2.4. Regional Mediterranean chronologies. The founding dates of some relevant Phoenician and Greek western Mediterranean colonies are marked in red, while the established date of the Rochelongue underwater site is marked in yellow (after Broodbank 2013:14, Chronological Tables).

With respect to Greek colonisation, this certainly is the case for the period between the final stages of the Late Helladic IIIC (c. 1200–1050 B.C.) and the Archaic colonisation of Italy and Sicily (towards the end of the eighth century B.C.), for which there are few well-documented archaeological contexts. This can be related directly to events possessing absolute dates, such as stratigraphic layers containing Egyptian items bearing the names of pharaohs or other high-ranking officials whose reigns are well dated (Toffolo et al. 2013).

This situation can be extended to Phoenician colonisation, for which research traditionally has been divided between the eastern Mediterranean (the Levant and Cyprus) and the western Mediterranean (the Iberian Peninsula, Sardinia, Sicily, Italy and North Africa). Furthermore, Phoenician studies typically have taken on a regional approach, especially in the west (Morocco, central and southern Portugal, western and eastern Andalusia, Alicante, the Balearic Islands, Sardinia, Sicily, Malta and Tunisia). This has led to the creation of closed niches in the scholarship with a lack of awareness of the synchronicities observed in different regional trajectories and implications for the broader historical timeline of the Mediterranean (Martín 2005).

In the case of southern France, the colonial period is established by the arrival of the first Mediterranean imports (Domergue and Rico 2002; Guilaine and Verger 2008).¹ More specifically, the transition from the LBA to the EIA in west Languedoc is marked by the presence of Greek and Phoenician artefacts that appear first in the Grand Bassin I necropolis at Mailhac (Taffanel 1956; Taffanel and Taffanel 1962; Taffanel et al. 1998) and the necropolis of Peyrou at Agde (Nickels 1990; Nickels et al. 1989; Nickels et al. 1981) mixed with local productions dated to the seventh century B.C. (Gailledrat 2006; Ugolini 2018).² According to absolute chronology, the transition between the LBA and EIA is well represented in west Languedoc by recent research undertaken at the La Motte site in Agde (Moyat et al. 2010:79). Radiocarbon analysis of samples from a wooden pile yielded a date of 2620 ± 45 cal. B.P. (for details on calibration, see Moyat et al. 2010:79), putting the LBA-EIA transition at the end of the eighth century B.C. Thus, the chronological framework of this research lies between the LBA (c. 900–800 B.C.) and EIA (ca. 725–575 B.C.) (Guilaine 1972:357; Guilaine et al. 2017:351; Guilaine and Rancoule 1996:128). This period of transition generally is considered a turning point that marks the beginning of proto-history in southern France (Py 1993:29). The temporal range encompassed by this research is fairly large because of the relative

¹ Although older objects have been found, in particular, oxhide ingots at Sète (Cap d'Agde), these are not considered to result from direct cultural contact (see Guilaine and Verguer 2008). Similar ingots are known from 11th-century B.C. sites in the central Mediterranean, but are an eastern Mediterranean tradition (Domergue and Rico 2002).

² The Late Bronze Age (c. 1300–725 B.C.) in the south of France is subdivided into five stages: LBA, IIa, IIb, IIIa and IIIb, the latter including Mailhac I (Garcia and Vital 2005:63–80; Guilaine and Py 2000:415–432).

chronology traditionally attached to some artefacts in the Rochelongue assemblage. From this arise a number of questions relevant to the present research, namely: were all of the objects deposited at the same time; were the deposited objects still in a context of use; alternatively, were the deposited objects being recycled?

2.3 Local Actors

Defining indigenous ethnic groups in west Languedoc is difficult without resorting to written sources, which contain ethnographic information such as names, customs and territories occupied by local cultural groups.³ Archaeologically, it is clear that the communities of west Languedoc did not form a uniform conglomerate and that contact with Mediterranean cultures was having a decisive impact on their socio-economic structure (Bats 2007; Ugolini 2018). During the LBA–EIA period, the coastal region of southern France was home to three different cultural traditions: Grand Bassin I, Suspendien and Provençal (Figure 2.5). The indigenous culture associated with west Languedoc during this time was the result of local cultural changes associated with a determined territory and having its socio-economic structural origins in the Late Neolithic period (Gascó et al. 2014:128). This ethno-cultural mingling is the result of the establishment of tribal groups associated with specific territories. Grand Bassin refers to a group of in-situ burials that reached about 200 years of continuity with a chronology stretching from the seventh to the first quarter of the sixth century B.C. (Janin 2001; Lenorzer 2006; Taffanel 1956; Taffanel and Taffanel 1962). Excavations of these burials have yielded a rich collection of several thousand vases and hundreds of metal objects (Nickels et al. 1989; Taffanel and Taffanel 1962). The great majority are of local origin, but some pieces are more rare and could represent imports, such as the *skyphos*, or two-handled wine-cup. The origin of these pieces is debated, but normally is attributed to the Italo-Etruscan or Greek sphere of southern Italy (Mazière 2004; Verger and Pernet 2013).

³ Hecataeus of Miletus (fifth century B.C.), for example, identifies people of the west Languedoc region as Elysiques (*Ελισυχοι*) (see Gailledrat 1997:30–37).

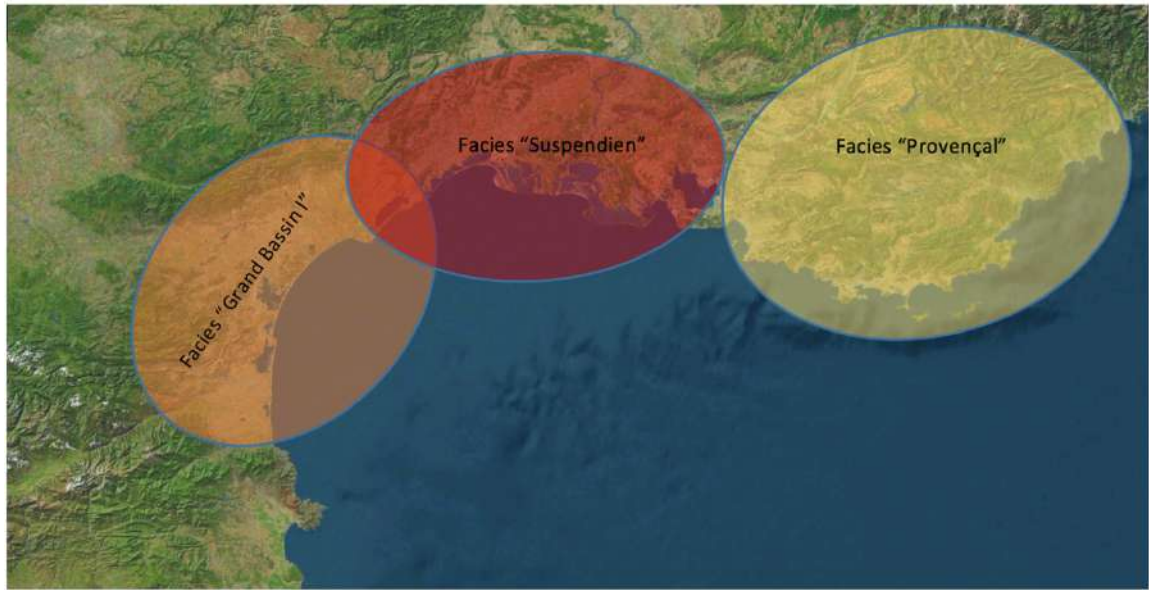


Figure 2.5. Cultural units of southern France (after Gailledrat 2013:99 fig. 1).

A majority of researchers believe the EIA is a ‘fracture’ from the previous period (Garcia and Sourisseau 2010; Garcia and Vital 2006; Garmy 1979; Gascó 2011, 2012). It is argued that the changes observed in various cultural aspects are significant enough to identify the EIA as a completely different episode from the previous LBA. There was an obvious change in technology, as local communities began to manage the complex process of manufacturing iron and improve the quality of tools and access to raw materials (Garcia and Vital 2006; Garmy 1979; Gascó 2011, 2012).

In addition, economic changes can be seen in the progressive incorporation of local communities into larger trading circuits through contact with Mediterranean cultures. The material culture shows rapid changes in decoration and production and changes in burial practices also are evident with significant diversification of typologies. During the LBA, populations attached to Mailhac I demonstrated a physical homogeneity and coherency, but regional cultural facies became more fragmented in the EIA. It is during this period that east and west Languedoc separate culturally into Suspendien and Grand Bassin, respectively (Ugolini 2018:230).

Finally, changing burial practices and the increasing presence of socially differentiating prestige goods in the archaeological record indicate that the social system of the area

also changed, from a tribal egalitarian social system during the LBA to a 'big man' society in the EIA (Garcia 2004:49). Despite the predominance of support for this picture of 'rupture' (e.g., Garcia and Vital 2006; Guilaine 1972), authors such as Eric Gailledrat (2013) argue instead for the view that this LBA-EIA period was transitional, in which local cultures were adapting to changing circumstances, notably increasing foreign contact. The former characterisation (as a fracture with the preceding period) is based on pre-established social models and assumptions about basic structures of Bronze Age societies, which results in a misunderstanding about the succeeding hierarchical systems and increased complexity of social structures.

Consequently, for this thesis, this period is considered one of transition rather than rupture, characterised by a good deal of continuity throughout. This discussion is not merely one of semantics, but is critical to understanding the encounters and development observed between the eighth and sixth centuries B.C., which could not have happened without a conducive social framework (Gailledrat 2013:108, 2014). This framework should be understood as the ability of local groups to organise or even guarantee the material conditions for exchange, to engage existing exchange networks and perhaps to mobilise productive forces that, before then, were oriented only to local needs (Gailledrat 2013:101).

2.3.1 Social, cultural and political landscape (LBA–EIA transition)

It is difficult to understand the LBA–EIA transition in terms of population and dispersion due to the scarcity of information. The socio-economical model traditionally applied to the LBA in southwestern France is one of agro-pastoral subsistence augmented with partial exploitation of coastal resources ((Garcia 2004; Py 1993). Settlements are dispersed and are occupied during short and variable episodes. This semi-nomadic model reveals a tribal characteristic that contrasts with an emerging new structure in the EIA, where greater social hierarchy develops with the appearance of 'big men' (Garcia 2004:49). On the other hand, the model is at odds with certain settlements of the LBA that show signs of proto-urbanisation (**Error! Reference source not found.**). Sites such as Ruscino, Carsac and Mailhac in Roussillon and west Languedoc, or

Sextantio, Roque-de-Viou and Le Marduel in east Languedoc, led Eric Gailledrat (2013:106) to argue that the semi-nomadic model of local societies is not functional. Gailledrat (2013:106), on the other hand, argues for consideration of some kind of previous social structure where the aristocracy already were present, only not as evident as in later periods.

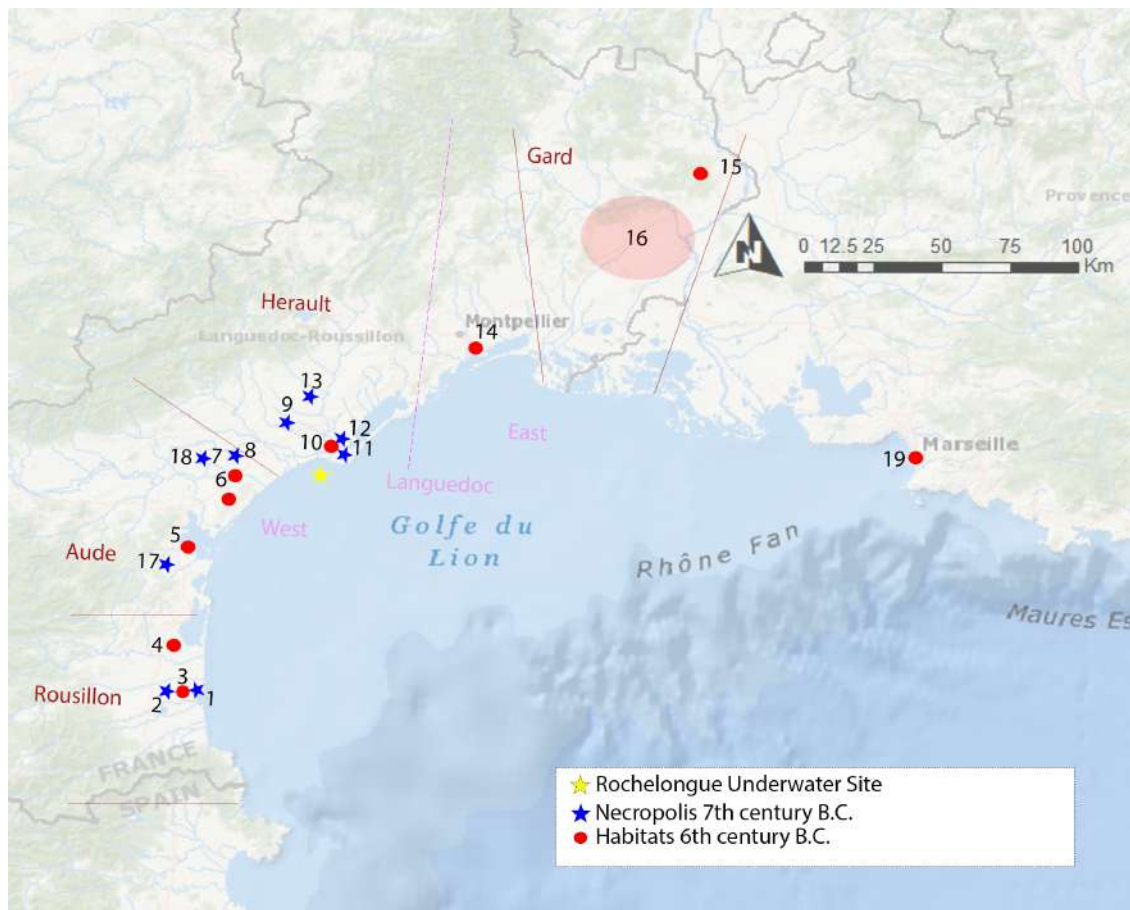


Figure 2.6. Map of coastal Languedoc-Roussillon showing sites and areas mentioned in the text and the division between east and west Languedoc (pink dashed line) (after Ugolini 2018:232 fig. 1): 1. Necropolis de Bellevue (Canet, Pyrénées-Orientales); 2. Necropolis de Négabous (Perpignan, Pyrénées-Orientales); 3. Ruscino (Château-Roussillon, Pyrénées-Orientales); 4. Le Port 2 (Salses-le-Château, Pyrénées-Orientales); 5. Pech Maho (Sigean, Aude); 6. Montlaurès (Narbonne, Aude); 7. Cayla II (Mailhac, Aude); 8. Necropolis du Grand Bassin I (Mailhac, Aude); 9. Necropolis de La Courondelle (Béziers, Hérault); 10. La Monédière (Bessan, Hérault); 11. Necropolis du Peyrou (Agde, Hérault); 12. Necropolis du Bousquet (Agde, Hérault); 13. Necropolis de La Cartoule (Servian, Hérault); 14. Lattes (Hérault); 15. Grotte Suspendue (Collias, Sainte-Anastasie, Gard); 16. Région nîmoise (Gard); 17. Necropolis de L'Agrédo (Roquefort-Corbières, Aude); 18. Grotte de Buffens (Caunes-Minervois, Aude).

In the specific case of the Hérault Basin, the formation of settlements is not well known, especially during the LBA. The short list of Bronze Age coastal habitation sites in

the area include La Motte, at the mouth of the Hérault River (Moyat et al. 2010), and La Fangade, by Lake Thau (Leroy et al. 2000), which were characterised by pile-dwellings. During the transition from the LBA to the EIA, there is a reported increase in the number of sites (Gailledrat 2014), most being located in the southern part of the Hérault basin (Ropiot 2007:150). In the seventh century B.C., the main development is the occupation of the lower coastal plain, although this is evidenced more by necropoleis than by actual habitation sites (**Error! Reference source not found.**). The two most important necropoleis were Peyrou, in Agde (Nickels et al. 1989), and Saint-Julien, in Pezenas (Giry 1965; Llinas and Robert 1971; Nickels 1990), and together they represent the stability of settlements in the Hérault Valley. Recent reconstructions of the paleo-landscape of this area are revealing that it was much more inundated than it is now (**Error! Reference source not found.**) (Benoît Devillers pers. comm. 2018). During the LBA-EIA, the present mouth of the Hérault River was a paleo-bay, which, along with the river, provided an ideal point of convergence for establishing commercial contacts. This is illustrated by the discovery of vases of Greek and Phoenician manufacture, the oldest of these types in France, as mentioned above (Gailledrat 2013, 2014; Ugolini 2018). Finally, the first half of the sixth century B.C. saw a significant increase in occupation sites with increased density, with a remarkable concentration of population in the low and middle course of the valley. At the end of the EIA, the so-called Oppida appears. These are permanent and sometimes fortified settlements that testify to the stability of some communities and their control of surrounding territory and secondary minor sites (Gailledrat 2013:106; Gascó 2011).

It is difficult to reconstruct the social organisation of the communities established in the Hérault/Agde territory during this time due to the relatively poor archaeological information available. Burials associated with habitats are homogeneous, suggesting a relatively equal social treatment of individuals at death (Janin 1992; Taffanel and Taffanel 1962). Nevertheless, there are some distinctive signs of social complexity, and two types of burials are recognised: circular tombs, representing the majority, and rectangular ones better furnished with artefacts. For male burials, riding equipment and the weapons are identified as symbol of power, whereas female graves of special

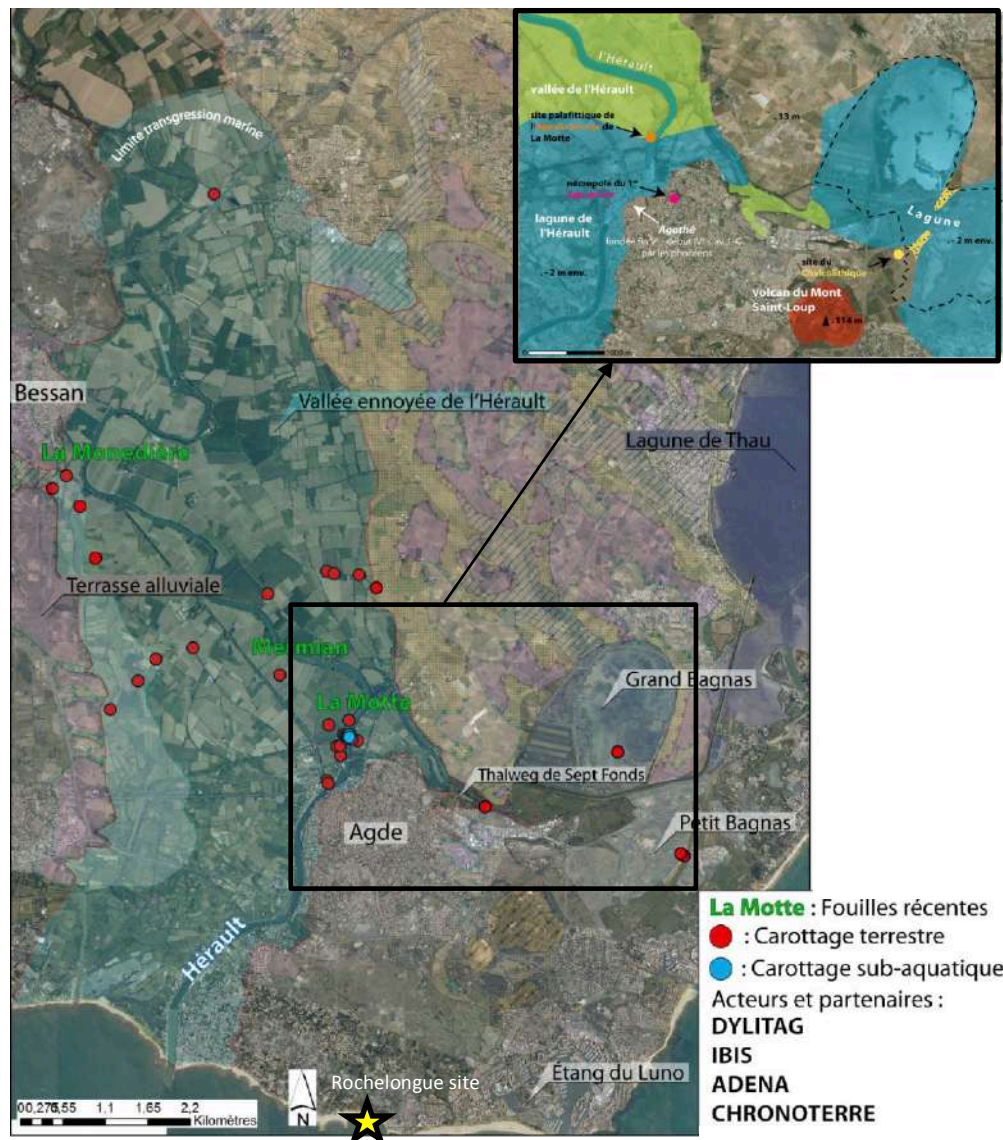


Figure 2.7. The Paleo-environment of Agde and the Hérault River basin, with insert showing the proposed reconstruction of the paleo-bay c. 800 B.C. (images courtesy of Benoît Devillers, Labex Archimède, CNRS ASM, Paul Valéry University, Montpellier).

status may result from the combination of different roles within the society (Lenorzer 2006). The group associated with these last burial typologies comprise a small local elite. Differences in the variations of funerary rituals reveal a west Languedoc divided into small tribal entities, which can be sub-divided into two large groups. One stretches from Carcassone to the middle valley of the river Orb, and the second is centred around the two necropolis of the Agde region at Peyrou and Bousquet (Verger and Pernet 2013). From the LBA to the EIA, the Languedoc territory experienced a social evolution from more egalitarian societies to the entrenchment of aristocracies. These

social elites benefited from the circulation of people and objects, which, throughout the Bronze Age, traditionally was linked to fluvial and terrestrial communication routes to the Atlantic, Iberian Peninsula and northern Italy, and which ultimately accelerated maritime trade with the broader Mediterranean world (Garcia 1993; Graells 2010; Graells and Sardà 2007; Verger and Pernet 2013:54).

Colonial trade and long-distance exchange relations were cemented at the end of the EIA, with local elites highly influenced by Phoenician, Greek and Etruscan cultural practices. Consequently, these local societies experienced transformations in social hierarchy and the system for controlling and managing material resources. Within the context of this research, this can be understood as the convergence of symbiotic interests of foreign groups in access to mineral and other natural resources and of local privileged groups in prestige goods that enhance and maintain their social distinction (Garcia 1993; Graells and Sarda 2005; Graells 2010; Verger and Pernet 2013:54). These associations, whereby locals adopt foreign customs that then co-exist with traditional practices, have a complex interpretation. Furthermore, the existence of previous local and long-distance trade circuits and the potential active role of local communities allow for discussion about the nature of these first encounters. Taking all of this into account, the phenomenon of 'Launacien' metal hoards is fundamental to identifying the scope of these contacts (Guilaine 1972; Guilaine et al. 2017).

2.3.2 Launac and the Launacien

The French engineer, geologist and anthropologist Paul Cazalis de Fondouce was the first to give the name Launacien to this local metallurgical tradition. In 1897, a group of farmers from Launac, at Fabrègues (Hérault), found a group of bronze objects buried in the ground. The landowner offered the pieces to the Archaeological Society of Montpellier. The entire collection was the subject of a publication in 1900 by de Fondouce, who described the discovery as a 'smelting hoard' (Cazalis de Fondouce 1900:171–172).

This assemblage from Launac included socketed axes, triangular scrapers, incised bracelets, and socketed hammers, extending from a long tradition. The affinities of the

axes with those of Atlantic workshops are manifested in their quadrangular form and decorative lines terminated by dots, sometimes surrounded by a circle. These forms are similar to the Armorican axes (northwestern France), which were manufactured until an advanced phase of the Hallstatt period (Guilaine 1972; Guilaine et al. 2017). The Launacien phenomenon is defined by a series of large deposits discovered in the region of Aude and Hérault (Guilaine et al. 2017:16–17). Among these deposits, the assemblage recovered from the Rochelongue underwater site, at a depth of 8 m, near Cap d'Agde, is one of the most representative.

The assemblage shows a much greater quantity of artefacts compared to those from terrestrial contexts (Figure 2.8). The Launac deposit, for instance, contains 678 artefacts, compared to Rochelongue's 4,640 (almost seven times as many). Furthermore, the Rochelongue site is significant because of its large number of copper ingots (Junghans et al. 1974), including 119 complete ingots, 239 partial ingots and 2,961 fragments of smelted copper.

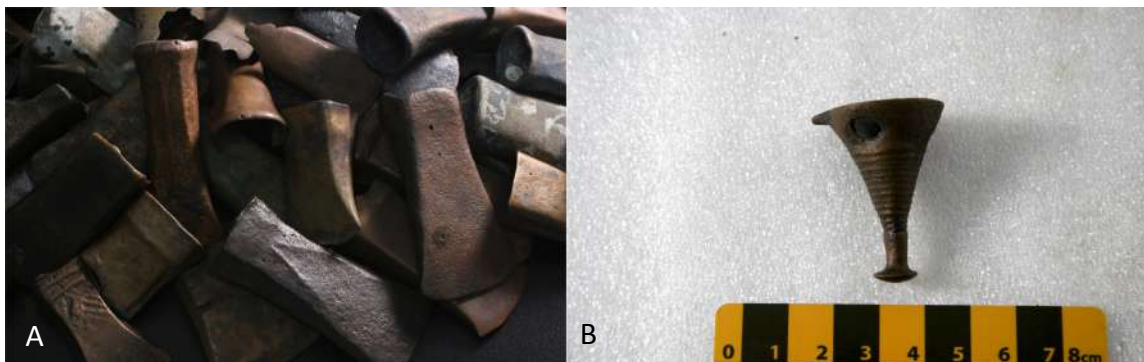


Figure 2.8. Artefacts from the Rochelongue site: A) socketed axes and B) a Launacien 'talon' (photographs by author).

The Launacien appellation applied to bronze hoards typically implied a recycling purpose linked to an indigenous culture of primarily continental inclination (Déchelette 1908; Guilaine 1972; Millotte 1963b; Sandars 1957; Taffanel 1956). With the discovery of the underwater site at Rochelongue in 1964, the origin of copper ingots in circulation and the destination of certain pieces found in this archaeological context were called

into question (Guilaine 1980). Subsequently, a wider Mediterranean perspective started to emerge (Verger 2005). The concentration of Launacien hoards in central and western Languedoc, between Mauguio and Corbières (Figure 2.9), should not negate the possible role played by these metal accumulations in the context of Mediterranean relations in the eighth and seventh centuries B.C. The idea of metal collections obtained by locals for trading with Etruscans was launched as a hypothesis without corresponding evidence (Long 2004; Long et al. 2002a). In parallel, the presence of Etruscan, Greek and Phoenician ceramics, whether original or imitation, in indigenous funerary and habitation contexts preceding the foundation of Massalia leaves open the questions of chronology and impact of contact between the newcomers and local populations (Guilaine et al. 2017).



Figure 2.9. Locations of Launacien metal hoards (map based on data from Guilaine et al. 2017).

According to Dominique Garcia (2002:41) the Launacien deposits represent ‘an original economic phenomenon that consisted of the development of indigenous metallurgic production for exchange purposes’. Currently, the term Launacien is used to identify

the general cultural context of bronze hoards found from this era and composed of local products and foreign elements of Continental, Atlantic or Mediterranean origin. During the Archaic period, the so-called Launacien peoples of the west Languedoc coast experienced increasing contact with Mediterranean cultures from the east and an influx of foreign products arriving by ship (Garcia and Vital 2006). According to historical accounts, Phocaeen Greeks established the colony of Massalia (Marseille) in 600 B.C., which greatly accelerated maritime trade and expanded cultural commingling across southern France and the surrounding regions (Dietler 2010:21). These developments were part of similar processes happening throughout the Mediterranean at this time, which helped usher in the first truly 'pan-Mediterranean' age and laid the foundation for the formation of western culture (Broodbank 2013:348).

2.4 The external actors

Phoenician and Greek colonisation in the western Mediterranean during the Archaic period (ninth–sixth century B.C.) and its consequences for local communities is an enormously varied phenomenon. During this historical episode, pre-existing trading structures experienced a transformation, passing from sporadic exchange contacts (*praxis*) to more specialised commerce (*emporía*) (Mele 1979). As a consequence, a cross-cultural interaction, from one side of the Mediterranean to the other, generated trading flows in a new 'globalised Mediterranean' environment that helped usher in the first truly pan-Mediterranean age during the Classical period (c. fifth–fourth century B.C.) (Malkin 2011:201). The archaeological record during this period indicates that the western expansion of eastern populations, historically associated with Phoenicians and Greeks, resulted in the creation of new trading networks that subsequently led to changes in the lives of local populations (Gras 2012:21; Malkin 2011:65).

With this context in mind, it was during the course of the seventh century B.C. that southern France began to receive Mediterranean imports of Etruscan (ceramics, bronze basins), Phoenician (amphorae) and Greek (Proto-Corinthian ceramics) wares. These

objects, from other cultural areas of the Mediterranean sphere, show the interest taken by foreign sailors in establishing contacts with the settled populations.

2.4.1 The metals motivation

The circulation of metals played an important role in proto-history, and led to the establishment of long distance trades routes. During the first millennium B.C., eastern colonisations encouraged the search for resources (Aubert 2001). Along these great routes arose small networks of local scope that facilitated the arrival of metal to the different territories (Earle et al. 2017). These contacts are shown by the incursion of certain foreign goods into local cultures, and also by the iconographic influences that occur between them (Kristiansen 1998). The exchange of particular goods also led to social inequalities whereby warrior-elites controlled such trade. These aristocratic warriors were sustained by the arrival of so-called prestige objects (Armada et al. 2018; Sanmartí 2014). With the emergence and intensification of long-distance trade, rituals emerged to legitimise commercial alliances. One such strategies used to establish and maintain large trading networks was inter-marriage (Kristiansen and Suchowska-Ducke 2015:373; Verger and Pernet 2013), reflected in the archaeological record by a large variety of metal objects that define culture and ethnicity (Verger and Pernet 2013:135–157).

The first half of the first millennium B.C. is characterised by the normalised use of copper ingots, but also for the introduction of innovative techniques in metallurgy, such as cupellation (Montero Ruiz and Renzi 2012). Cupellation is a metallurgical process that uses lead as a collector to extract silver, both from argentiferous galena and from other argentiferous minerals, such as jarosite and copper ores. This technique is particularly associated with Phoenicians, and evidence of cupellation often appears in archaeological contexts where Phoenician remains also are present (Hunt 2003; Renzi et al. 2012). Lead, then, constitutes an essential element in the recovery process and its exploitation has been revealed as key to understanding the relationship with emerging elites in the Iberian Peninsula (Murillo-Barroso et al. 2016).

Rivers and maritime routes play a pivotal role in the circulation of metals, as illustrated by shipwrecks such as Mazarrón 2 (Negueruela 2004) and Bajo de la Campana (Polzer 2014). We have clear evidence for the circulation of metals between the southeast and northeast of the Iberian Peninsula, connecting exploited mineral deposits in the interior, such as at Linares (Jaen), with coastal areas, such as Gador (Almeria) and Cartagena/Mazarrón (Murcia). Furthermore, copper from Linares also has been identified in the Catalonia region and at other Mediterranean sites (Montero Ruiz et al. 2012a). This intensification also is seen again in the central-Mediterranean in the first millennium B.C. A strong production and exchange of metallurgical goods is documented in Etruria from the ninth-eighth centuries B.C., with a relevant Phoenician influence evidenced by imports of Iberian lead from the second half of the eighth century B.C. (Benvenuti et al. 2015:106). The Greeks also developed a profound interest in metals. Authors such as Claude Rolley (1992:411–418, 1997:239–242) find metals to be the major motivation behind the founding of Greek colonies in the west. From the last third of the seventh century B.C., evidence from Classical authors and archaeology confirm this interest in metal resources (Domínguez Monedero 2013:23). Herodotus described long-distance voyages from Samos (Hdt., IV, 152) and Phocaea (Hdt., I, 163–165) to Tartessos (Huelva) in search of metal. Archaeologically, this is recognisable in the circulation of metals with a significant presence in areas of south of Italy and Sicily, where raw metals, ingots and manufactured objects frequently are found at sacred sites (Verger 2000; Verger 2003). In Bitalemi (Gela), a deposit of bronze ingots and artefacts, with pieces weighing up to 3.3 kg (Verger and Pernet 2013:256), is dated to the second quarter of the seventh century B.C. (Orsi 1906; Verger and Pernet 2013). These ingots have been put in relation with the Archaic wreck at the island of Giglio off the coast of Tuscany. The cargo of this shipwreck, which dates to the beginning of the sixth century B.C., includes nine lead and four copper ingots, a diverse group of Greek, Etruscan and Phoenician amphorae and sundry other items, such as a Corinthian helmet and nine flutes (Bound 1991; Cristofani 1996:21–48).

2.4.2 Phoenicians

A Biblical account (I Kings 5:25) states that during the reign of Hiram I of Tyre (ca. 970–936 B.C.), the Phoenicians initiated long-distance trade with the western Mediterranean (Botto 2013; Sherratt and Sherratt 1993:364). Trading stations like Sardinia provided them with access to indigenous coastal exchange circuits in the western Mediterranean and broader links through the Strait of Gibraltar to the Far West and its rich deposits of silver in southwestern Iberia and Atlantic tin sources (Gras 1995:126). While not the sole motive of Phoenician expansion, the search for metals was one of its main objectives, and this was only amplified by the need for precious metals, which formed the basis for commercial transactions in the eastern Mediterranean (Balmuth 1975:294; Martín Hernández 2013:18). It did not take long before Phoenician expansion extended over the entire central and western Mediterranean basins. The progressive westward expansion of the Phoenicians was based on minor settlements along the central Mediterranean coasts clustered in the triangle formed by western Sicily, southern Sardinia, and the Gulf of Tunisia, with its central node being Utica/Carthage. The western sphere was formed by the Balearic Islands, the southern coast of Spain and the Mediterranean and Atlantic coasts of Morocco, with Cadiz as its central node (Aubet 2001). Thus, although Socrates' expression 'living round our sea like ants or frogs round a pond' (in Plato, *Phaedo*, 109B) was in reference to the Greeks and frequently is cited by modern scholars to describe the Greek diaspora (van Dommelen 2012:394; for a recent review of this term, see Dufoix 2012), it is equally applicable to the widespread presence of Phoenician settlements on the shores around the Mediterranean Sea.

In the west, as in the east, Phoenicians settlements typically occupied the very edge of the seacoasts: a small coastal island (Motye, Mogador, Cadiz); the cove of a larger island (Sulcis); at the mouth of a river (Bithia, Toscanos, Morro de Mezquitilla, La Fontenta); at the tip of a peninsula (Tharros, Nora); or at the bottom of a gulf (Utica, Carthago, Cagliari, Palermo, Ibiza). Phoenicians always settled at the intersection of the land and the sea (Gras 1995:67).

Among historians and archaeologists, dating the initial Phoenician installation at this or that location continues to be debated. The archaeological interpretation, most often based on ceramic typologies, often is at odds with founding dates provided by literary sources (Gras 1995:69). Perhaps none is more contested than the founding date of Gadir (Cádiz), the first and most important Phoenician city in the Far West.

There are important studies, not just of Gadir, but also of sites in its hinterland, such as Doña Blanca (Mata 1991; Mata and Gomez Toscanos 2008; Mata and Pérez 1995). The recent discoveries in the city of Cadiz reveal an archaic settlement at the end of the ninth century B.C. that would correspond with the traditional Gadir (Gener Basallote et al. 2014). Doña Blanca, on the other hand, corresponds to a site resulting from the economic expansion that the Phoenician colony of Gadir experienced during the eighth century B.C. (Mata 2018).

Another important area to take into account when talking about eastern Mediterranean expansion to the west is Huelva on the Atlantic coast of the Iberian Peninsula. This area is traditionally linked to Tartessos (Blázquez 2002; Jurado 1989). The current documentation now allows us to locate, for the second half of the ninth century B.C., the presence of an oriental emporion in Huelva (Gailledrat 2014). Moreover, the discovery in these same ancient contexts of Cypriot, Sardinian, and Villanovan ceramics sheds a new light on the Phoenicia trade linking the south of the Peninsula and the Tyrian basin (González de Canales et al. 2004). At the same time an important Phoenician urban development during the early eighth and seventh centuries B.C., help illuminate interactions between local communities and newcomers.

A brief examination of the Phoenician colonisation process in Iberia shows that, after a so-called pre-colonial period (ninth century B.C.), the Phoenicians establish themselves all along the Andalusian coast—from the Atlantic in the west to the Mediterranean in the east—during the eighth and seventh centuries B.C. (on pre-colonisation in Phoenician expansion, see Celestino et al. 2008). The many surprisingly small sites identified in this region, such as Chorreras, Toscanos, or Abdera (Maass-Lindemann 1983; Niemeyer 1982; Suárez Márquez et al. 1989), have been interpreted as the

trading establishments of aristocratic families, factories for the production of specialised wares, and way stations for sailing ships designed to form a strategic network of settlements to control the trade routes in the western Mediterranean (Aubet 2001). Current data suggests that southern colonies located near the Strait of Gibraltar and Phoenician paleo-factories in Ibiza had their greatest contact with (and impact upon) the northeastern region of the Iberian Peninsula and its economic activity (Aubet 2001). The material record shows that indigenous and Phoenician colonial styles changed over time and that entirely new forms of material culture (ceramics, metal fabrications and other items) emerged as a result of the interactions of these different cultures. Some authors considered this a process of hybridisation (Vives-Ferrándiz 2008), while others view it as a phenomenon of consumption (Dietler 2010:53).

Research surrounding these important Phoenician settlements in southern Iberia have also included themes of cultural interaction. For example, investigations at Cerro del Villar (Aubet et al. 1999) and Morro de Mezquitilla (Schubart 1976, 1985), two sites on the Malaga coast, have helped clarify the production of western Phoenician pottery and its defining features. The decoration of these vases was limited to painted strips (in black and ochre) and a characteristic red slip. This pottery has very precise functions: it is used for eating (plates and kitchen vases) and also for drinking and pouring liquids (jugs) (Aubet et al. 1999). Together with these, the characteristic amphoras of type T.10.1.2.1 (Ramón Torres 1995) and oil lamps are the most common vessels associated with Phoenician production in the south of the Iberian Peninsula.

Along the Spanish Levante, where more of the raw material sources and production centres are located, sites of interest include the indigenous Peña Negra, with its Phoenician enclave and workshops, and the Phoenician colony at La Fonteta, the most important harbour along this coastline (González Prats 2011; Rouillard et al. 2007). During the Final Bronze Age, settlements in the Ebro Valley based their economy on recycling metals (Ramos 1993). From the EIA, important mineral resources were discovered in the region that may have attracted Phoenician interest and been accessed for commercialisation via the Ebro River (Rafel et al. 2010b). Another area of interest, the Alicante region of the east coast (Peña Negra and Crevillente), also had

mineral resources and exported both raw and worked metals, ostensibly via La Fonteta, at the mouth of the Segura River. Such exports may have flowed through a major transshipment port, such as Malaka (Málaga) or Gadir (Cádiz) in southern Andalusia.

The seventh and sixth centuries B.C. witnessed more frequent and intimate contacts between indigenous and Semitic populations in the Iberian northeast (Rubert Garcia and Alonso Garcia 2011), as consequently the relevant archaeological remains are more frequent than they are for the eighth century. There is, therefore, an ample range of artefacts to demonstrate this interaction, in settlements like Sant Jaume, Moleta del Remei, La Ferraduria and Aldovesta, in the Ebro River valley (northeastern Spain), among others.

There is considerable evidence (Bea et al. 2008; Rubert Garcia 2005; Rubert Garcia and Alonso Garcia 2011) to support the hypothesis that certain communities in touch with Mediterranean cultures experienced changes that allowed some individuals to enrich themselves (Sanmartí 2014). They were able to link commercially production areas and consumers in the northeast of Iberia as well as in Languedoc, France (Calvo et al. 2011; Guerrero Ayuso 2008b; Javaloyas et al. 2015; Vives-Ferrándiz 2015).

2.4.3 Greeks

The Greek diaspora

During the eighth century B.C., the so-called Greek diaspora started to re-shape the western Mediterranean, much as it had shaped the Aegean in previous centuries, extending the limits of the *oikoumene*—the known, inhabited or habitable Greek world.

The Greek diaspora typically is described as developing through a series of events that took place in one or other of the Greek city-states, starting with a crisis, usually either economic (drought, famine) or political (*stasis*), that precipitated the necessity for emigration (Jackman 2005:126). From the middle of the seventh century B.C., the metropoleis of Anatolian (or East) Greece, especially the Ionian cities, such as Miletus and Samos, intensify the population move westward (Verger and Pernet 2013:196).

Pithekoussai (Ischia), Tyrrhenian Sea and Sicily (Gela, Selinunte)

When referring to the first moments of Greek expansion to the west during the Early Archaic Period, it is traditional to refer to sites such as Cumas or Pithekoussai (or Pitheculsae), in the central Mediterranean, to understand the appearance of large numbers of Greek settlements scattered along the Mediterranean coastlines (van Dommelen 2012:394). The efforts of Euboeans, Corinthians and Megarians during the eighth and seventh centuries B.C., who established stops along the shipping routes, made it possible for others to create real commercial networks during the sixth century B.C., as was the case for the Phocaeans (Martinez-Sève 2012:394).

Pithekoussai, on the island of Ischia in the Gulf of Naples, followed probably just a few years later by Cumae, on the opposite mainland, represented the first steps in western colonisation taken by Greeks in the mid-eighth century B.C. (D'Acunto 2017:293). Archaeological remains on Ischia indicate that this settlement was far from a typical Greek colony (Esposito 2012). An intrusive Phoenician or Aegean origin often is assumed for the eighth century B.C. Material cultures for this period reveal that Pithekoussai was home to peoples from Campania (southern Italy), Etruria, Sardinia, the Aegean (primarily Euboea and Corinth) and Phoenicians from the western colonies (Broodbank 2013:512). Despite the number of imported pots and other goods, metals stand out as pre-eminent, especially iron from Elba, whose ores were so pure that they were worth shipping overseas for smelting (Broodbank 2013:512). A significant increase in the population is represented archaeologically by the large necropolis of Scarico Gosetti on the eastern slope of the acropolis of Monte di Vico. Also, metalworking activity is evidenced in the suburban area of Mazzola, indicating that that entire quarter was dedicated to such activity (Nizzo 2007).

Cumae, on the other hand, was founded on the northern shore of the Gulf of Naples, the perfect location from which to control maritime trade in this part of the Tyrrhenian Sea, and especially the channel between Ischia and the mainland (Stefaniuk and Morhange 2010). The remains of sanctuaries in the city's agora have allowed scholars to investigate cults connected with the motherland. Elaborate furnishings in graves associated with this site illustrate that leading colonists emphasised their links with the

Euboean metropolis (Cerchiai 1995:74–81). Conversely, it is clear from the earliest burials onward that the Cumaeen aristocracy also were open to connections with other communities in Campania and Etruria (D’Acunto 2017:309).

Together with metalworks, wine was important commodity for Pithekoussai and its hinterland. Exchange of wine with non-Greek communities in the Tyrrhenian region and central Mediterranean also transmitted agricultural and cultural models and points to the principal involvement of Euboeans in these trading relationships (Sourisseau 2011).

Some researchers have argued that these settlements reveal an early stage of encounters, or pre-colonisation, of the western Mediterranean (Gras 1995; for a review of the concept of pre-colonisation, see Lourdin-Casal and Roure 2006). This is linked strictly to Archaic trading. During the sixth century B.C., Archaic Greek commerce experienced an intensification that provided the mechanism for the transformation from so-called aristocratic *praxis*, a system based on piracy and hospitality, to *emporium*, a more specialised system developed by merchants (Esposito 2012; Gras 1995).

The seventh century B.C. is marked by a long period of Greek control of eastern Sicily, established in the context of competition between the main establishments at the heart of this regional expansion. Selinonte, founded at the end of the seventh century B.C., lies a mere 40 km from the Phoenician centre of Motya at the western end of the island. In the last two thirds of the seventh century B.C., Syracuse established a network of small centres that controlled the southeast corner of the island (Akrai, c. 663 B.C.; Kasmenai, c. 643 B.C. and Camarina, c. 598 B.C.). Gela, founded on the Sicily’s southern coast at the beginning of the seventh century B.C. by a mixed contingent from Rhodes and Crete, lies on the great trans-Mediterranean maritime route (Verger and Pernet 2013).

Euboeans in southern France?

The current state of investigation seems to show that the foundation of Massalia was preceded by a series of sporadic encounters that are difficult to characterise because of

the incomplete and sometimes confused state of available archaeological documentation. This pre-Massalian situation is more evident in western Languedoc and the Hérault valley, at Agde. Here, as mentioned above, imported objects dated to the second half of the seventh century B.C. were received from the Greek colonies of southern Italy or Sicily. A large iron knife, identical to the Greek butchery utensils of Sicily from the second half of seventh century B.C., was found in the necropolis of Peyrou at Agde (Nickels et al. 1989). Verger and Pernet (2013:32) have interpreted this object as evidence of hospitality, a ritual feasting practice well identified in the Greek world (Dietler 2010).

The few pieces of archaeological evidence of a Greek presence before Massalia's foundation seem to indicate the parallel establishment of two different networks: Phocaean-Etruscan in the east (Provence) and Greek Sicilian in the west. The latter is difficult to characterise, but recent research at Greek colonial sites, such as Gela and Selinonte (Verger and Pernet 2013; Guilaine et al. 2017, Gailledrat 2014), has uncovered material culture with a clear western Languedoc provenance (Verger 2008).

The Age of Emporia: Phocaeans in the West

Archaeologists and historians are in broad agreement that the approximate foundation date of Massalia (Marseille) by Phocaean Greeks was 600 B.C. (Bats 2012). This was followed closely by the Phocaean settlement of Empòrion (Ampurias, Sant Martí d'Empúries) in 575 B.C. and at Rhode (Roses, Girona) in the fifth century B.C. on the Gulf of Rosas in northern Catalonia (Aquilué et al. 1999; Dietler and López-Ruiz 2009).

The character of Massalia from its beginning was an open emporium (Bats 1998) and, as such, it acted as a transit point for goods and products moving east and west between northeastern Iberia and Italy. For the first half of the sixth century B.C., Etruscan amphora finds dominate the archaeological record of the city, testifying to the pivotal role that Etruscan trade played in the city's economy. Only by c. 540 B.C. does a picture of local Massalian amphora production emerge (Bats 2012). Over the course of the next few centuries, Massalia established a number of small coastal sub-colonies up and down the coast, such as Agathe Tyche (Agde) in 525 B.C.

Two important events that transpired between 540 and 530 B.C., the naval Battle of Alalia, between Greeks and the allied Etruscans and Carthaginians off the coast of Corsica, and the conquest of Ionia, including Phocaea, by the Persian king Cyrus II precipitated profound transformations in the balance of power and commercial dynamics in the western Mediterranean. Massalia, (as well as Empòrion and likely other colonies) experienced population growth from the influx of refugees and became the dominant influence of the entire region from Liguria to Iberia (Bats et al. 1992:287). These circumstances significantly changed the exchange networks developed during the seventh and the first half of the sixth centuries B.C. and brought the region into new spheres of connectivity.

2.4.4 Etruscans

The Etruscan culture was rooted in the Villanovan culture as an immediate predecessor (Bartoloni 2014). The culture experienced a flourishing period during the eleventh to tenth centuries B.C. as a result of the development of transalpine metallurgy, which is associated with heroic and warrior values representative of the aristocracy (Verger 2007:95).

Authors have argued that the Etruscans should be given greater consideration as one of the major maritime actors of the Iron Age in the western Mediterranean (Tiboni 2016). Their ability to maintain commercial and military networks has been mentioned along with their practice of piracy as key characteristics (Briquel 2000; Gras 1976, 1985:615–651). Their nautical capabilities have been bolstered above all by Classical literary sources, such as Herodotus (*Histories* I, 165–166), who claims that the Etruscans controlled maritime and commercial routes in the western Mediterranean, especially on both sides of the Italian Peninsula. Other ancient historians, such as Dionysius of Halicarnassus, (*Roman Antiquities* I, 11) and Livy (*History of Rome*, V, 33), write about the supremacy of the Etruscan navy. The Giglio (Cristofani 1997) and Grand Ribaud F (Pomey and Rival 2002) shipwrecks testify to Etruscan participation in the sea trade already in the sixth and fifth centuries B.C. Nevertheless, the nature of this participation still is under debate, as the type of shipbuilding evidenced in the remain

of these two ships is associated with the Greek tradition (Pomey 2006a). Despite the lack of a verifiable Etruscan shipwreck, or any true understanding of Etruscan shipbuilding practices, it is clear from their remains and privileged location along the Tyrrhenian coast that Etruria's port cities, such as Pyrgi, Gravisca and Regisvilla, constituted major facilities for outfitting and cargo lading merchant vessels.

The three main categories of Etruscan products, which demonstrate the dynamism of Etruscan trading, were *bucchero*, a distinctly black, burnished ceramic ware, transport amphorae and bronze wares. Etruscan products are prominent in two main regions abroad: the coastal regions of southern France and the Iberian Peninsula. The first imports of Etruscan amphorae to France arrive at the end of the seventh century B.C. These are linked to the wine trade and are limited to the coastal region of Languedoc. Related Etruscan material, such as *bucchero* pottery and metal bowls, frequently are found disconnected in indigenous habitation sites in the interior, which some authors argue is evidence for separate internal networks in the indigenous domain (Dedet and Py 2006:204).

The discovery of numerous Etruscan imports in the primitive levels of Massalia (Gantès 1992) has generated a debate about their adscription to a Etruscan presence prior to the foundation of the Phocaeen colony (Dedet and Py 2006) or if more precisely, would correspond to the first moments of this Greek settlement (Bats 1998). This discussion also involves consequences about the role of Phocaeans in the dispersion of Etruscan material from early stages along the French coast (Bats 1998:623). Contrary to this interpretation some authors suggest that the first group of Etruscan imports should be considered as an autonomous and independent initiative (Dedet and Py 2006:128–30).

What is certain is that from the beginning of the sixth century B.C. there is an increase in the number of shipwreckings along the southern coast of France, with examples such as Cap d'Antibes (Long et al. 2002b:25–31), l'Ecueil de Miet 3 in the Bay of Marseille (Long et al. 2002:32–36), Bon-Porté 1 near Saint-Tropez (Long et al. 2002:43–47), Pointe du Dattier at Cavalaire (Long et al. 2002:48–49) and Grand Ribaud F at Giens, the latter dated to the beginning of fifth century B.C. (Long et al. 2002b; Long et al. 2006:55–62). Etruscan cultural material finds, such as a bronze tripod and helmet

discovered at Cap d'Agde and Sète, respectively, suggest intense trade contacts during the sixth century B.C. (Feugère and Freises 1996). These contacts can be extended to the Hérault territory, where an Etruscan presence is evident in a settlement of great importance at Lattes, a port-city near Montpellier (Py 2009), and to the northeast of the Iberian Peninsula, where Etruscan finds are especially numerous in the environs of Empòrion (Aquilué et al. 2008). Etruscan imports begin to decline after the third quarter of the sixth century B.C., due mainly to increasing commercial control from Massalia and Emporion (Bats 1998; Dedet and Py 2006:139).

2.5 Conclusion

This chapter has introduced the historico-archaeological context of the present research, situated at the end of an expansive process of westward immigration from the eastern Mediterranean. This diaspora, highly motivated by the search for natural, and especially minero-metallic, resources, began with Phoenicians during the ninth century B.C. This expansion established the first colonies in the central Mediterranean and Far West, such as Utica and Gadir (Cádiz), respectively (Aubet 2001; Lopez Castro 2016; Niemeyer 2002; Sommer 2004). In the Greek case, such expansion begins during the eighth century B.C., with settlements at Pithekoussai (Ischia) and Cumae in Italy (Gras 1995). The formal encounter with southern France was initiated during the late seventh century B.C. by Etruscan city-states in central Italy, as evidenced by wine amphorae and other ceramics and small bronze basins (Dietler 2010:4). Other authors have argued earlier evidence for foreign contacts in southern France, especially characteristic wine-drinking cups from the incipient Greek colonies in Sicily (Verger 2000:389; Verger and Pernet 2013:312). A Phoenician influence also has been identified in some of the local pottery productions (Gailledrat 2004:165). These objects appear mainly in elite burials of the early seventh century B.C. (Janin 2001). The chronological span of this research ends in the second half of the sixth century B.C., when the Phocaean colony of Massalia (600 B.C.) begins to exert cultural and commercial dominance in western Languedoc and the whole of the Gulf of Lion.

CHAPTER 3. LITERATURE REVIEW: ROCHELONGUE AND THE LAUNACIEN

3.1 Introduction

This chapter provides a summary of the Rochelongue underwater site and a review of previous research and interpretations of the archaeological assemblage. It characterises the site in such a way as to support the aim of this thesis to consider the site's broader implications from the perspective of an early contact zone in the context of cultural and commercial interactions and maritime connectivity in the pre-colonial western Mediterranean. This approach allows us to move beyond prior debates, which have focussed solely on dating, characterising, and assigning cultural adscription. To this end, the region where the site is located needs to be viewed within its broader geographical and historical context in order to understand its important strategic position west Languedoc during the LBA and EIA was a link between Europe's Atlantic façade and the Mediterranean. This section of the French coast offers good natural harbourages, especially in the estuaries, which allowed communication with the interior and access to its mineral resources—not only those close by, such as at Montaigne Noir and Cabrières, but also those far distant, such as in Brittany. The region also sits strategically between Catalunya and Provence, with its ready access to northern Italy. These two intersections, combined with an accessible coast open to the Mediterranean, made this region a natural area for cross-cultural networking with a high range of cultural diversity (Gailledrat 2014; Gascó 2011; Graells 2013a; Guilaine and Rancoule 1996).



Figure 3.1. Panoramic view of Cap d'Agde, looking north: (1) Herault River mouth; (2) Saint-Loup Hill; and (3) Rochelongue reef (photograph by Javier Rodriguez).

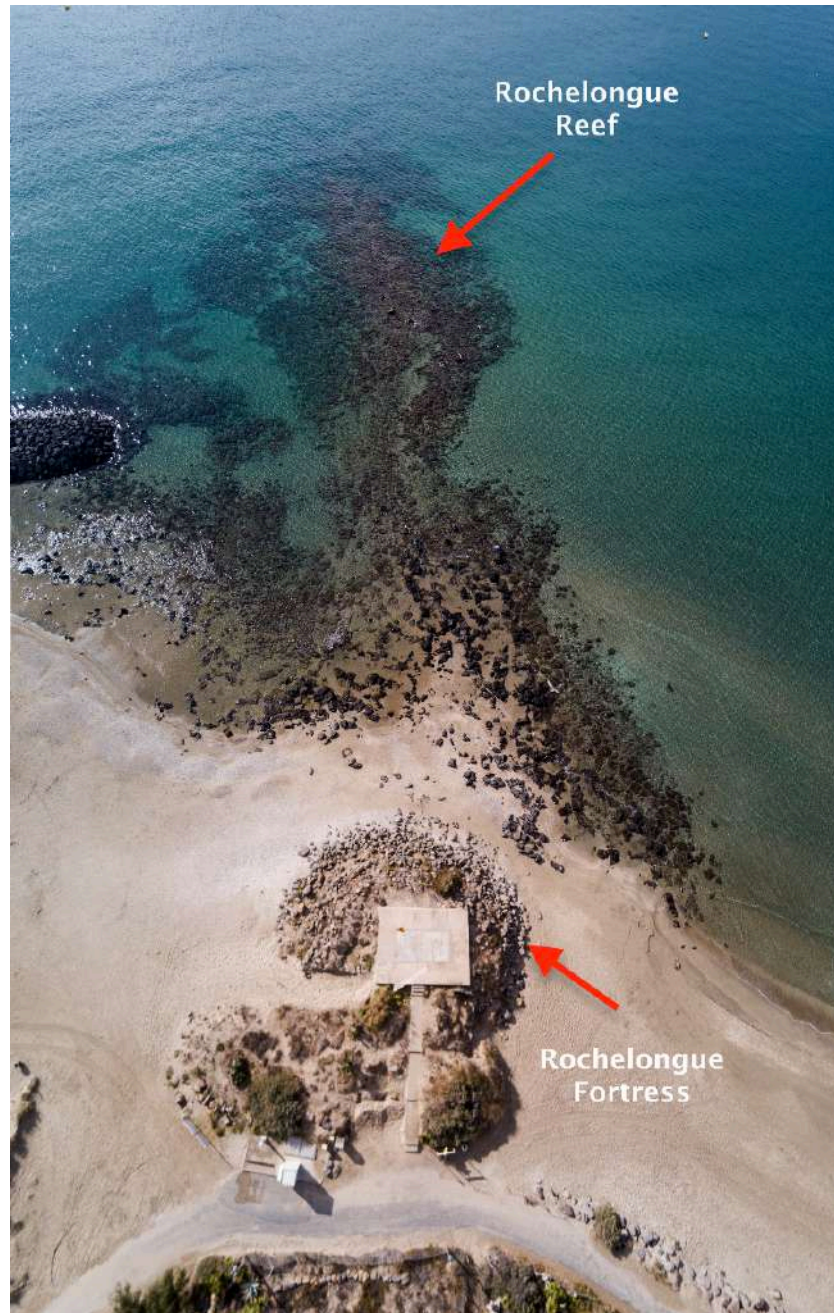


Figure 3.2. View of Rochelongue Reef and the modern fortress facing the beach (photograph by Javier Rodriguez).

The underwater archaeological site is located on the Rochelongue reef off Cap d'Agde, geologically formed by a basaltic outcrop and medium size blocks (Figure 3.1; Figure 3.2 and Figure 3.3). This basaltic geology is the result of a lava flow 740,000 years ago from the former Mount St. Loup volcano (Figure 3.1, feature 2). The reef runs southward and is surrounded by patches of *Posidonia* seagrass and sand. The reef extends into an area

known as ‘les mattes’ and then splits into two branches. One branch turns to the east, towards the islet of Brescou, taking the form of a line of rocks bordering a large area of sand. The second branch heads westward for some 2 km, in the direction of the mouth of the river Hérault, before giving way to sand. The reef is most visible from shore in two areas: off the so-called Pointe de Notre Dame, some 400 m from the mouth of the Hérault; and off the Pointe de Rochelongue, which directly faces the underwater site (Borja and Tourette 2011; Tourette 2006).

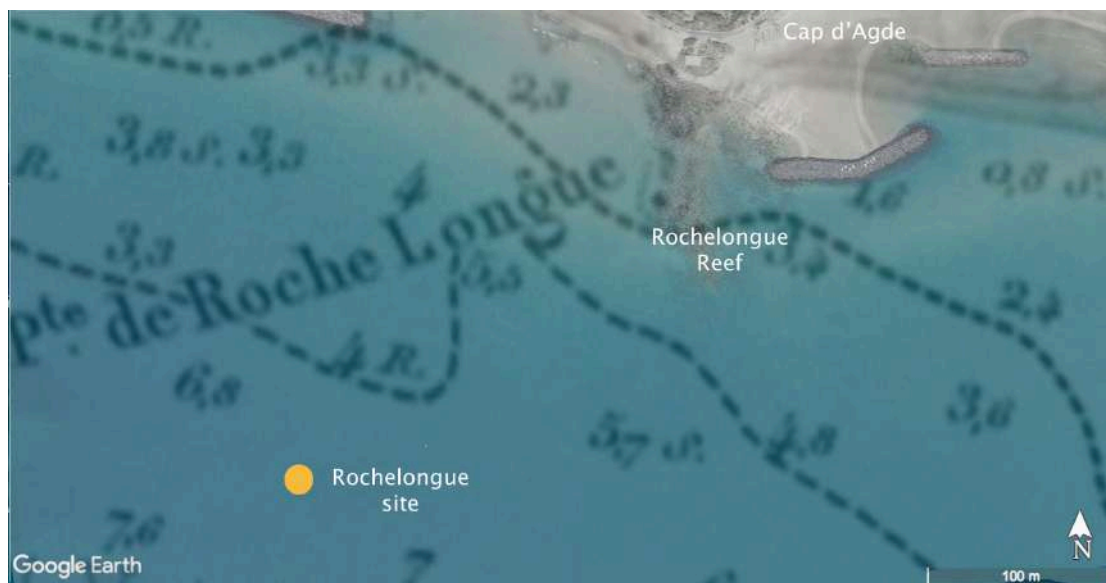


Figure 3.3. Estimated location of the Rochelongue underwater site, approximately 300 m southwest of Cap d'Agde.

Water depth can change abruptly along this shore due to the topography of the seabed, and especially the reef. In some areas, the reef juts up abruptly more than 1.5 m from the bottom, which makes the area dangerous for coastal navigation. Ships passing these shores also are at risk of inclement weather, as is attested in the historical record:

Agde (Hérault), 3 January. — During heavy south-easterly weather, with very bad seas, the Norwegian three-masted *Garibaldi*, with eleven crewmen, having lost its rudder and driven by the current, was lost at about one o'clock in the afternoon off the point of Rochelongue,

located two miles east of the mouth of the Herault (Société Centrale de Sauvetage des Naufragés 1888; translated from the original French by author).⁴

This stretch of coast is a virtual ships' graveyard, as testified by the numerous shipwrecks located between the Herault estuary and Île de Brescou (Figure 3.4). It is not surprising, then, that the Ephebe Museum in Cap d'Agde, dedicated to underwater archaeology, is the repository of a significant collection of artefacts with an underwater provenance, including the namesake Éphèbe (Adonis) bronze. In the immediate vicinity of the Rochelongue site, there are two known shipwrecks. The first one, dating to the early Roman Empire (first–second century A.D.), is represented by Dressel 20 and Dressel 2–4 amphorae, along with other objects, such as copper-alloy nails and a copper ingot (Tourette 2006). The second wreck is dated by a group of cannons to the 17th century (Borja and Tourette 2011; Tourette 2006).

3.2 The site

Studies of the Rochelongue site traditionally have focused on the chronologies and cultural attributes of the remains, as well as the question of what type of site it represents—shipwreck or ritual deposit (Barbot 2000; Gascó et al. 2014; Hugues 1965; Long 2004; Long et al. 2002a). As yet, there is no general consensus on these issues. This research introduces a new investigation into the Rochelongue metallic finds, using them as a case study to explore culture contacts within a pre-colonial context in southern France and the western Mediterranean. Rather than focusing on site characterisation, this study approaches the site—more precisely, the region in which it is located—as a contact zone, defined as a 'zone of direct, sustained encounter between indigenous people and alien colonists, where mutually misunderstood cultural differences were worked through in political and economic practice, pidgins and creole languages and, often, violence' (Dietler 2010:13). It applies a multi-methods analysis to

⁴ Agde (Hérault), 3 Janvier. — Par une grosse tempe de sud-est, mer très mauvaise, le trois-mâts norvégien *Garibaldi*, avec onze hommes d'équipage, ayant perdu son gouvernail et drosse par le courant, alla se perdre vers une heure de l'après-midi sur la pointe de la Rochelongue située à deux milles dans l'est de l'embouchure de l'Hérault.

address larger questions of culture contact and corresponding socio-economic repercussions.



Figure 3.4. Underwater sites in the vicinity of Cap d'Agde (map by C. Chary and M.-P. Jézégou, courtesy of DRASSM).

3.2.1 Rochelongue discovery and excavation

The underwater site at Rochelongue (Figure 3.5) was discovered in 1964 by André Bouscaras, a dedicated diver and shipwreck enthusiast responsible for locating many underwater sites (especially shipwrecks) in the waters of west Languedoc. The site was

subjected to a number of archaeological investigations between 1964 and 1968, and again in 1970 (Gascò 2014).

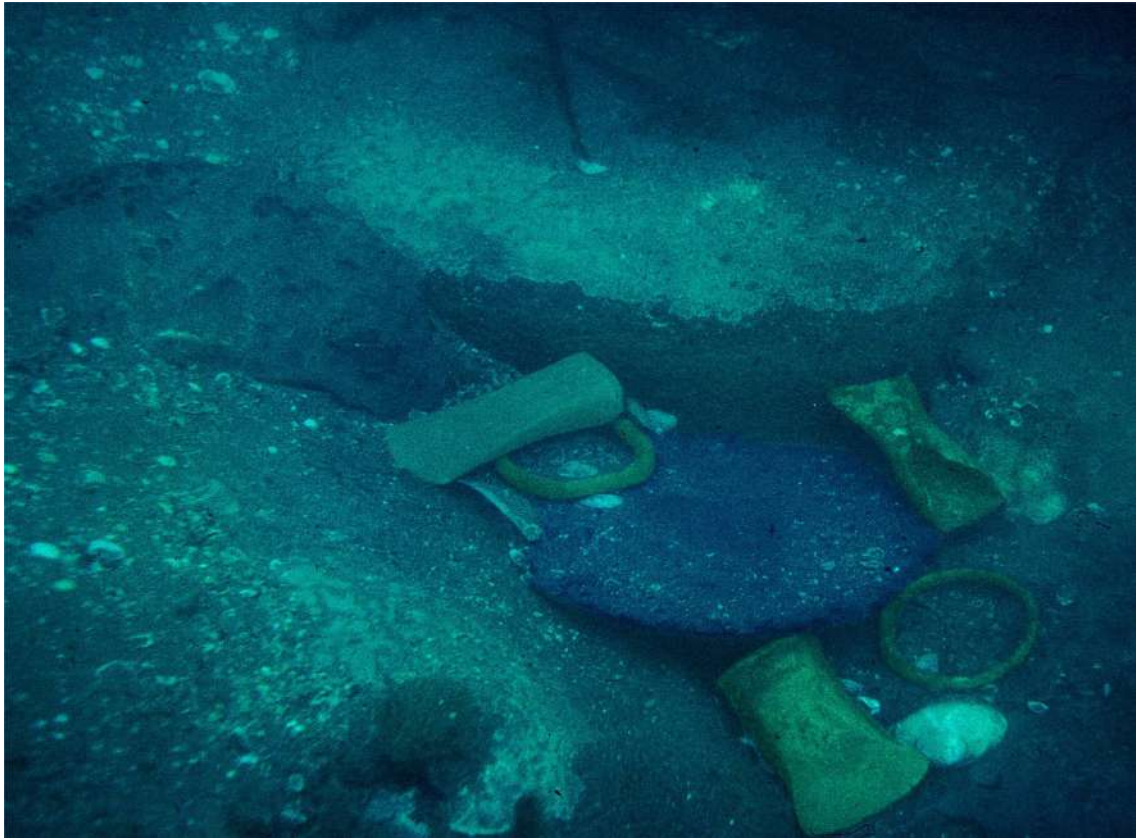


Figure 3.5. Metal artefacts—ingot, socket-axes and bracelets—on the seabed at the Rochelongue underwater site in 1964 (photograph by André Bouscaras, courtesy of the Bouscaras Collection, Archives of the Museum of the Ephebe and Underwater Archaeology).

In 1964, Bouscaras (1964b:5) announced the discovery of the site as follows:

How was this discovery made? Was it a matter of luck, as some say? A matter of luck—of chance—certainly, as is the case with many archaeological discoveries, but it also was a matter of work, of observation and the result of much research.

Each year, we systematically surveyed the rocky banks and their immediate environs in the research area assigned to us.

On three different occasions since the beginning of the summer, we surveyed the rocky bank near where the deposit was found. The first three times yielded no results ... the fourth took place in the afternoon of 21 July. That is when my eyes were drawn to two

grey-green objects amongst the stones. Having extricated them, I realized that they were a copper or bronze ingot and a socket axe (translated from the original French by author).⁵

Archaeological material at the site was dispersed over an area measuring roughly 25 × 14 m (this corresponds to the core area found in 1964) at a depth of 6–8 m (Bouscaras and Hugues 1972:175). The recovered assemblage has traditionally been described as comprising more than 800 kg of metal and at least 1,700 artefacts (Bouscaras 1964a:288; Hugues 1965:176; Jézégou 2012:17–18; Parker 1992:369). Particular objects in the assemblage have been identified as Etruscan, Greek, Phoenician or local and dated anywhere from the ninth to the sixth centuries B.C. (Barbot 2000; Bouscaras 1964a; Garcia 2002; Gascó et al. 2014; Hugues 1965; Parker 1992).

Unfortunately, the site coordinates (43°16'17" N, 03°28'44" E) preserved in the archives of the Department of Underwater and Undersea Archaeological Research (DRASSM) appear to be incorrect, and the precise location of the deposit now is unknown. Over the past few years, researchers have conducted underwater surveys in the area, but these have resulted only in the discovery of isolated finds of diverse chronology (Borja and Tourette 2011; Jézégou 2012; Leroy et al. 2000; Tourette 2006). As such, the only reference we have as to the location of the underwater site is from Bouscaras' (1964b:5) description at the moment of its discovery:

A large bank of rocks and seaweed (mostly *Posidonia*) stretches from in front of the two rocky points of Rochelongue, near Agde, to the west for more than two kilometres. An offshoot of the bank juts out to the north, the edges of which are composed of rocks and *Posidonia* and the central part forming a small bowl of sand. The first discovery was made southeast of this spur, about 500 meters from shore, where the depth varies between 6.50

⁵ Comment s'est effectuée la découverte? Question de chance, disent certains. Question de chance, de hasard, certainement, comme dans beaucoup de découvertes archéologiques, mais aussi question de travail, d'observation et fruit d'une longue recherche.

Chaque année, dans la zone de recherches qui nous est attribuée les bancs rocheux et leurs environs immédiats sont prospectés systématiquement.

Depuis le début de l'été, nous avons, à trois reprises différentes, prospecté le banc de roches près duquel se trouve le gisement dont nous allons parler. Le trois premières fois sans résultat...la quatrième celle du 21 juillet eu lieu dans l'après-midi. C'est ainsi que mon regard fut attiré par deux objets vert-de-grises coincés entre des pierres. Les ayant dégagés je m'aperçus qu'il s'agissait d'un culot de cuivre ou de bronze et d'une hache à douille.

m and 8 m. The seabed there is composed of a very uneven volcanic layer that slopes gently to the southeast towards Brescou. The objects rested directly upon this layer with no apparent stratigraphy; two rifle bullets from the last war were found mixed with the finds, indicating that the movements of the sea caused objects of high density to sink into the sand until they met a layer compacted enough to stop them (translated from the original French by author).⁶

During the 1964 and 1965 campaigns, excavations at Rochelongue focused on the central part of the site, in the sandy bowl formed by the reef (Bouscaras 1964b:6, 1965:81). Work in the subsequent three campaigns (1966–1967) expanded out to the periphery; first to the northwest, where a large accumulation of small objects was found, and then to the southeast and southwest, where a significant number of ingots were recovered. In 1969, the project was halted by infrastructure work in the port of Agde, during which time dredging activities negatively impacted water visibility at the site and made progression of the excavation impossible. Site work finally recommenced in 1970, when two trenches were excavated with the support of DRASSM and its scientific vessel *Archéonaute*. This intervention made clear the extent of the archaeological area to the southeast, as the work yielded only a single fragment from a copper ingot (Bouscaras 1970:2). Bouscaras (1970:3) noted in his report that ‘only the northwest area remains that potentially contains any artefacts’, concluding that ‘we will conduct a survey of this point during the next campaign, in 1971’. Unfortunately, that work never happened.

Bouscara’s excavation diaries were examined for data recorded during each excavation campaign from 1964 to 1970. The information partially was published in the *Bulletin de la Société Archéologique de Béziers* and synthesised in Bouscaras (1964a); Hugues

⁶ Face aux deux pointes rocheuses de Rochelongue, près d’Agde, commence un énorme banc de roches et d’algues (surtout posidonies), qui s’étend vers l’Ouest, sur plus de deux kilomètres. Partant, de ce banc, une avancée prend la direction du Nord. Les pourtours de cette pointe sont constitués de roches et de posidonies; la partie centrale faisant légèrement cuvette est formée de sable. C’est au Sud-Est de cet éperon et à environ 500 mètres du rivage que fut faite la première découverte. Les fonds varient en ce point entre 6 m. 50 et 8 m. Le sous-sol est composé d’une couche volcanique très peu accidentée qui s’enfonce lentement vers le Sud-Est en direction de Brescou. Les objets reposent directement sur cette couche sans stratigraphie apparente; deux balles de fusil de la dernière guerre ont été trouvées mêlées au mobilier, ce qui indique que, par suite des mouvements de la mer, les objets d’une densité élevée s’enfoncent dans le sable jusqu’au moment où ils rencontrent une couche compacte qui les arrête.

(1965) and Bouscaras and Hugues (1972). The information is tabulated below to provide a better overview of the overall excavation (Figure 3.6 and Figure 3.7). It also will help to better understand some of the interpretative conclusions about the deposit outlined later in this chapter.

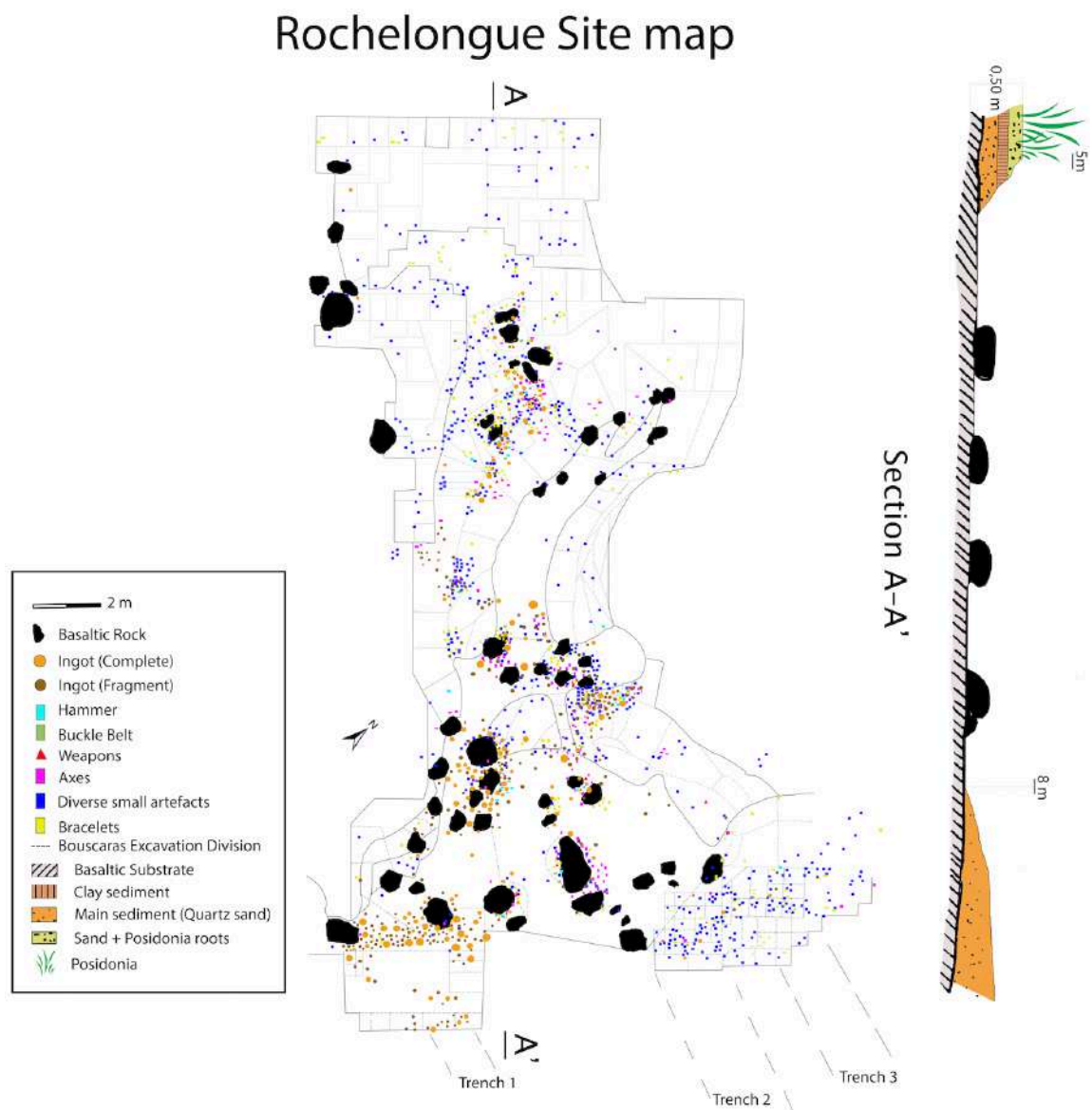


Figure 3.6. Site map of the Rochelongue underwater site (based on Bouscaras 1964a, 1964b, 1965, 1966, 1967, 1968, 1970).

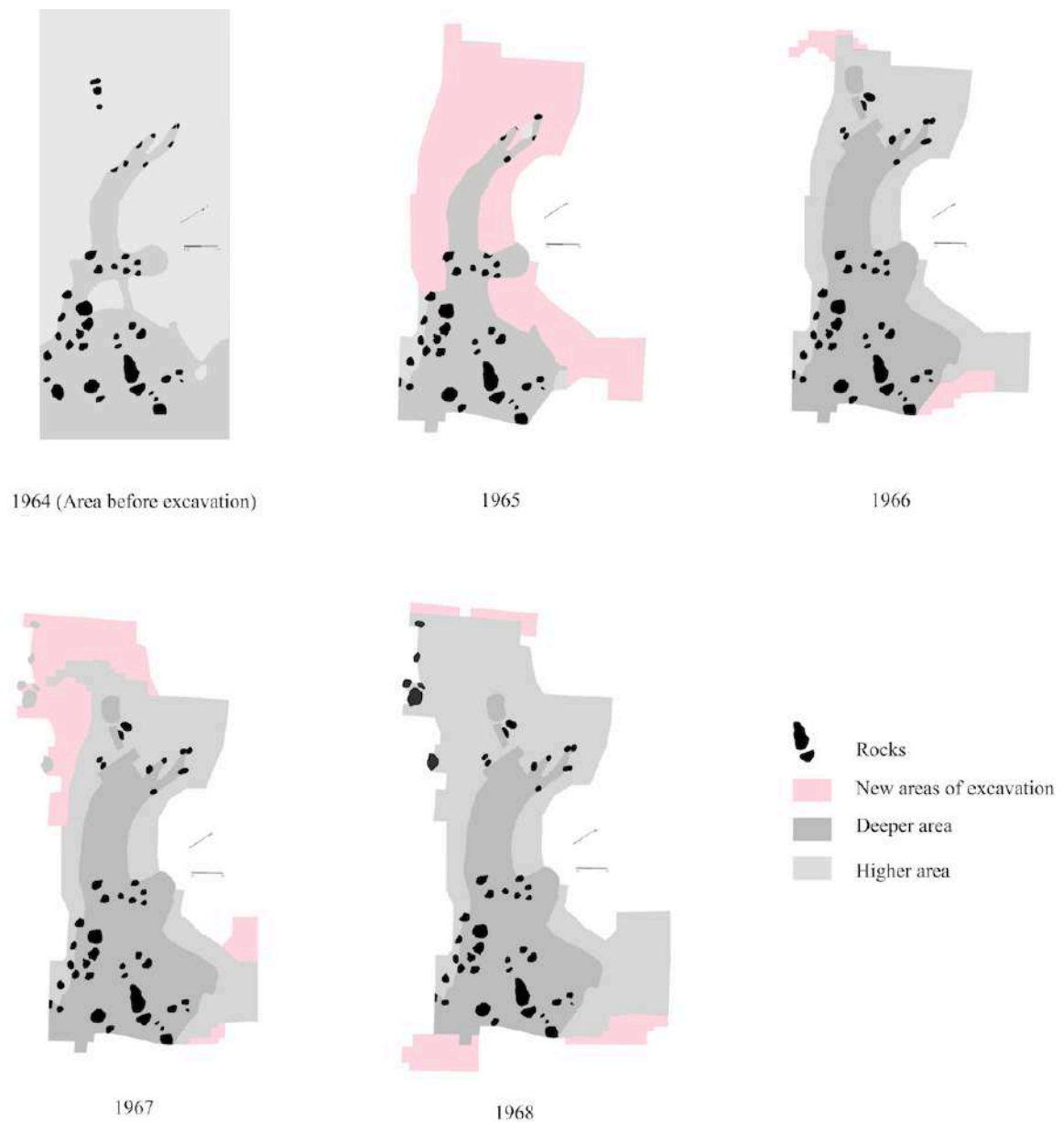


Figure 3.7. Diagrams of the Rochelongue underwater site showing the area excavated during each campaign, from 1964 to 1968 (based on Bouscaras' 1964–1970 annual Rochelongue reports, DRASSM archives).

Bouscaras (1964b):

- The dispersion of the artefacts is not random: beginning from a point located in the southeast, the artefacts are dispersed along the rocky reef and in the seagrass in a southeast-to-northwest direction, consistent with the direction of dominant storms.

- Moreover, objects are found very often grouped together. When one is found, there almost certainly will be others of the same series in the immediate vicinity, which would seem to indicate that the objects originally had been categorised and packed in containers—likely bags or baskets—that did not survive to the present.
- The interpretive hypothesis at this point of the excavation is that the site can be an in-situ foundry workshop or a wreck.
- Against the first option is Denizot's (1959:327–357) observation that there was 'a coastal sea level change dated at the end of the Middle Flandrians, which corresponds to about six millennia B.C. From that moment, the sea reached the current level and has not undergone any appreciable systematic change since.'
- The most likely hypothesis would seem to be that of a shipwreck: a ship, sailing along the coast, full of metal scrap for recycle and carrying with it not only a great quantity of new objects, but also the tools and raw material necessary for their manufacture—ingots, raw metal, casts, moulds, and metal scraps recovered from use.
- Despite the absence of any trace of the ship, it is not surprising that, in shallow water on a rocky bottom, no wood was preserved. Similarly, we never find wooden remains on any of the Greek and Roman wrecks located in the same area, but only pieces of equipment.
- If any such objects do exist on the site, they must be located in the southeastern sector, near the accumulation of ingots that we reported and under the deep layer of sediment that prevents us from continuing the survey in that direction.
- Metal analysis of the copper ingots was performed by Professor Junghans at Stuttgart.
- No ceramic material was found.
- The plano-convex copper ingots recovered have a maximum weight of 7 kg.

- No iron materials were found.
- Professors H. Gallet and M.C. Hugues conducted the material culture study of the assemblage (Hugues 1965).

Bouscaras (1965):

- Excavation of the southeast side of the site was impossible without mechanical tools, so the team decided to concentrate on the rocky areas.
- We opened a trench nearly 2 m wide in the northwest part of the site to verify the extent of the artefacts dispersion.
- We then continued the excavation by following from the same line as in the previous year, towards the west and the east.
- From this we were able to confirm that the materials were dispersed from a point in the southeastern part of the site in a northwesterly direction, due to the prevailing storms coming from the southeast.
- The work this year has provided new evidence: the copper ingots discovered in the northwest part of the site clearly were situated some 30 cm above the other objects; moreover, they are rather deteriorated. Some of them, such as AS 65 L 10 in particular, were covered with 2 cm of marine concretion, which indicates a prolonged exposure on the seabed without being covered by sand.
- The ingots, or ingot fragments, found in this part of the site clearly are situated above the objects and their surfaces are very deteriorated. They were uncovered beneath 20 cm of *Posidonia*, while the objects were located on the bedrock some 30 cm below. This would seem to indicate that the lighter objects were buried more quickly and trapped between the rocks.
- The difference in the states of preservation of the ingots is interesting, as these ingots are highly worn and have lost more than half of their weight in some cases, whilst the ingots found in the southeastern part of the site, in particular ingots AS 65 L 70–72, show no trace of abrasion.

- Another observation is that jewellery represents the largest part of the assemblage, whereas weapons and axes are much less abundant. Professor Albert France-Lanord, Director of the Iron History Museum (Musée de l'histoire du fer) in Nancy, had requested samples from these ingots in order to specify whether they are copper, or even native copper, rather than bronze. The ingots are in fact a very pure copper, at least 99% copper with traces of arsenic (0.01%), lead (0.01%), magnesium, iron (0.03%) and calcium.
- This boat was carrying very pure native copper, coming either from the Iberian Peninsula or north Africa. At that time, there still were surface deposits rich in native copper, which would have been exploited preferentially over copper ores that had to be dug.
- All of the socket-axes were quite new at the time of sinking; the deterioration they show was due to sand abrasion and not to use.
- As was noticed last year, some of the axes contain rolled copper sheet inside (AS 65 164 in axe 166 and AS 65 224 in axe 983).
- The discovery this year of larger fragment has permitted their identification as fragments of oenochoe (jug) handles. Some of these handles, especially AS 65 71 (Plate XIII, centre), still retain the part that connected them to the sheet of bronze.

Bouscaras (1966):

- It was apparent from the first dive on the wreck of the bronzes, on 24 April, that the site had changed considerably since 1965.
- If the central part already excavated always presents the same aspect, on the other hand, the south-eastern and north-western drop-offs are very sizable. Winter storms deposited an additional layer of sand and black mud, more than 50 cm thick, on top of the sand already covering the objects, meaning the sterile layer now is more than one meter thick.

- Some trenches along the north and south sides of the site confirmed the impression we had last year at the end of the campaign that we had reached the limit of artefact dispersion in those areas.
- The unknowns of the south-eastern and north-western drop-offs, of which we spoke in our 1965 report, were still unknown. Unfortunately, the accumulation of sand and mud inevitably slowed the excavation of these areas. After some very difficult work, we were only able to open up about 15 m² of that area during the excavation.
- Much like at the end of the previous campaign, the finds are mostly small objects, except for some fragments of metal and copper ingots found on the south-east side and some axes.
- As in previous years, buttons and pins are abundant, especially small flat buttons with a bulge.
- Among the non-metallic objects, and apart from coral beads, which have already been mentioned, of note is a fragment from the bottom of a wheel-made ceramic vase with pink fabric.⁷
- After three consecutive excavation campaigns, it appears that most of the cargo carried on the ship has been recovered. The north and south sides of the site appear to be exhausted, except perhaps for some lighter objects scattered farther afield, which would require excavation of a much larger area to recover.

Bouscaras (1967):

- The conclusions of previous years have been confirmed: the artefacts are dispersed towards the north-west from the main concentration of objects in the south-east of the site; greater wear of objects higher than objects falling north-west (the heavier they have put more time to park the distance, separating the south-east and north-west drop-offs and arrived towards the latter while the objects were already buried). finally, we are at the limit of the area of dispersion

⁷ There are no remains of these ceramics in the Museum.

of the objects. Only the falling northwest and southeast very sizable can still be to contain large quantities of objects.

- Spearhead no. 29, recognised by its shape, has the peculiarity of having retained wood from the shaft inside the socket.⁸
- A fragment of tin with decoration (no. 3), identical to no. 427 recovered in 1965, was discovered. Other new objects also include a fragment of copper sheet with stamped decoration. Comparative materials include copper-plate belts from Panges in the Cote d'Or (Déchelette 1908); however, the decoration of the Agde plates is absolutely different, even though it remains geometric. The entwined design that adorns the belts is reminiscent of oriental motifs.
- Many pieces of galena also have been found in this part of the site (northwest). The discovery of ore has been reported in previous years, but never in as much quantity as this year. Some pieces appear to have undergone a reduction in fire.
- Excavation has yielded other non-metallic objects, but none can be ascribed to the wreck of the bronzes with any certainty.

Bouscaras (1968):

- The Ministry of Culture's research vessel, *Archeonaute*, supported this year's excavation for several days, facilitating mechanical excavation of the site.
- This was significant, as this was the first time that the divers employed for this excavation, from the Underwater Research Group of the Beziers Archaeological Society, could use mechanical tools underwater.
- The results showed that the southeastern part of the site still contained finds, as we believed.
- We were able to verify an observation made in the previous years, that the rocky bottom, far from being regular, forms little pockets and basins that fill

⁸ There are no remains of this wood in the Museum and no report on any possible species identification.

with sediment. It is in these that we found the ingots, on top of a compact clay layer that forms a regular ground covered over with a metre of sediment.

- The ingots almost always were found with their flat face down and the convex side up.
- Before we end this report on the Rochelongue shipwreck, we must return to one of the objects discovered in 1967—the spear or javelin head (no. 29) with a fragment of the wooden shaft concreted to the inside of its socket. This object has been entrusted to the Laboratory of Marseilles for conservation and identification of the wood. It returned to us in early July... Mr Jean Bouis, conservator in charge of the restoration of the recovered objects, added the following note: 'Javelin spear in bronze. Stump of wood from the pole. Softwood, probably pine or fir.'
- During this campaign, an important group of diverse objects, not of the same chronology as the Rochelongue shipwreck, was located in the vicinity of the site. This indicates that there is a high probability that a number of artefacts accumulated in this zone as a result of wrecking or currents.

Bouscaras (1969):

- Dredging works for the planned tourist resort of Cap d'Agde resulted in the Rochelongue site being covered in a fluid layer of mud more than 50 cm thick. Any serious work on the wreck in these conditions was impossible, and so we decided not to excavate the site this year.

Bouscaras (1970):

- The Department of Underwater Archaeological Research asked Mr Paul Weydert, a laboratory assistant at the Centre for Geology at the University of Marseille-Luminy, to carry out an inspection of the site.⁹

⁹ Stratigraphic description and details from this report have been included in the reconstruction of the site map (Figure 3.6, Section A–A').

- From the established report and observations that we have been able to make on the seabed, it appears that the central part of the site, previously excavated, is again exposed. Very little sediment remains, and the bedrock is visible.
- During the 1970 field campaign, a trench was dug from the southeastern part of the site towards the un-excavated area with the aid of an airlift.
- However, under about 60 cm of sand, the mudflat creates a regular layer some 30 cm thick, below which sand again is encountered, then the 10- to 15-cm thick layer of red clay reported the previous year, with yet 10 cm more until the final bedrock.
- The trench reached a depth of 50 cm, was 2.5 m wide and ran 8 m towards the southeast.
- The only discovery was a fragment of copper ingot (AS 70 42) weighing 1.190 g.
- For an entire day, the divers from *Archaeonaute* and those of the Archaeological Association of Beziers took turns on the bottom to excavate a circular area measuring 6 m in diameter. So far, the same stratigraphy has been encountered: sand, modern remains, sand, compact red clay, sand and rock; but no archaeological material has been discovered.
- Based on this lack of finds, this area at least appears to be outside of the archaeological zone.
- The team opened a second section some 12 m to the north.
- The only find was a circular iron object (AS 70 43) encrusted with concretion and a pebble.
- It therefore seems that the entire southeastern part of the deposit is exhausted; the entire archaeological area was excavated in the previous years.
- Only the northwestern area remains with potential to contain artefacts. Indeed, this zone is an extension of the wreck dispersion, following the direction of

predominant storms and currents, from the southeast to the northwest. We will search this area during the next campaign, in 1971.

3.3 The assemblage

The metal artefacts from Rochelongue can be sorted into three categories: 1) raw or semi-processed materials, such as iron in mineral form (Hematite), plano-convex copper ingots, and tin and lead sheets; 2) manufacturing wastes, such as slag and unsuccessful mould castings; and 3) manufactured objects, including personal adornments, weapons, tools and an assortment of other objects (Bérard-Azzouz and Feugère 1997:70; Garcia 2002; Verger and Pernet 2013:208) (Figure 3.8).

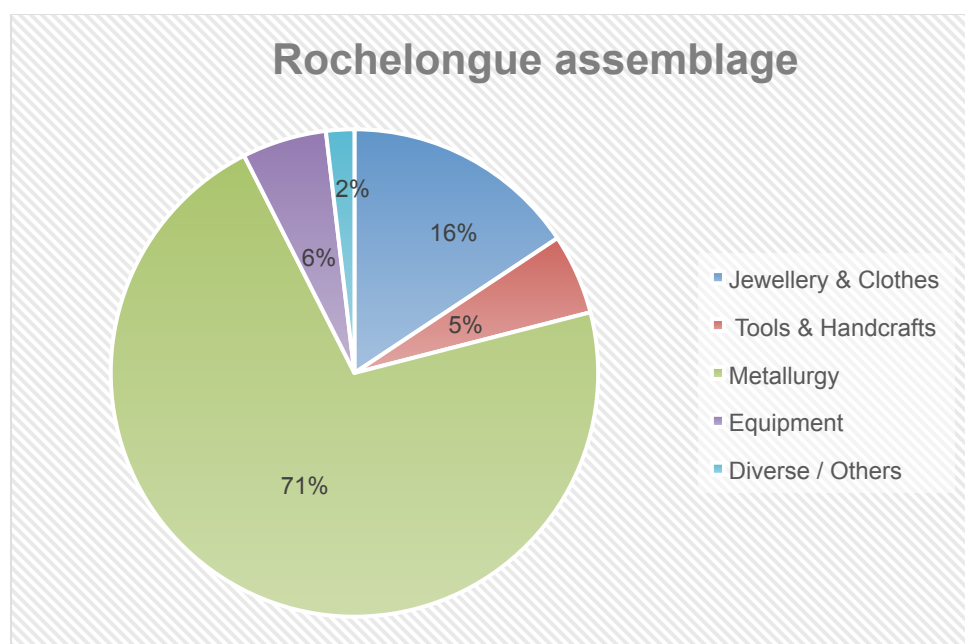


Figure 3.8. Object categories in the Rochelongue assemblage.

The Rochelongue ingots have been used as evidence to justify an early Greek presence in west Languedoc, as some of them bear a 'Y' stamp or anthropomorphic symbols similar to examples found in Greece (García 2002:38–41). The Giglio shipwreck, excavated in the northern Tyrrhenian Sea and dated to the beginning of the sixth

century B.C., yielded ingots with similar markings, but has been interpreted as both an Etruscan (Bound and Vallintine 1983:119) and Greek (Polzer 2011:365) vessel.

Others have used these markings to link the site to the eastern Mediterranean (Barbot 2000:36), where similarly stamped ingots have been found off the coast of Haifa, Israel (Galili et al. 2013:10). In any case, both of the latter sites are situated within the broader Mediterranean Greek milieu, and so do not necessarily contradict a Greek characterisation.

The manufactured objects are currently thought to have broad geographical origins. Some of the weapons, for example, are believed to be associated with the Atlantic bronze metalworking tradition (Guilaine 1972:359) on the Atlantic bronze trade and metalworking tradition, see Nordez (2017), while others are presumably linked to the Iberian Peninsula (Verger 2000:388). The bracelets, on the other hand, clearly are connected to central European cultural traditions based on their typology and likely originated in eastern France (Verger 2000:388). The fibulae present in the assemblage have been instrumental in dating the site due to the wide distribution of this object type and its well-established chronological typology (cf. Arnal et al. 1970; Carrasco Rus et al. 2016; Duval et al. 1974; González Prats 2010; Graells 2010, 2014b). Currently, the dates estimated for the Rochelongue examples range from the second half of the seventh century to the first half of the sixth century B.C. (Arnal et al. 1970:58; Duval 1974:22–41). This group exemplifies how the object diversity in this assemblage affects interpretation of the geographical origins and chronology of the site. For example, similar double-spring fibulae have been found in Phoenician contexts of the seventh and sixth centuries B.C., while some believe that the triangle-bow fibula originated in Cyprus between the tenth and ninth centuries B.C. (Rafel et al. 2008:244; but against this, see Carrasco et al. 2016, who argue for a local origin). Conversely, examples of the *navicella*-type fibulae typical are associated with northern Italy (Duval et al. 1974; Verger and Pernet 2013:208).

Adding to the complexity of interpretation is the prolonged use of some artefact types, which extends over much of the first half of the first millennium B.C., and perhaps even earlier, as the chronologies of some of the weapons and socketed axes, for example,

begin at least in the LBA. Some authors ascribe symbolic meaning to these anachronistic objects and interpret their function as votive or for marking transitional zones, such as borders, route intersections, watercourses or other locations strategic to communities in contact with one another (Huth 2017; Javaloyas et al. 2015:68). Others link such objects of longevity—for example the socketed axes, often interpreted as ingot axes—to a pre-monetary system of exchange (Bats 2011:99; de Laet and Dani 1994:910 who refer to them as ‘axe-coinage’). Garcia (2013:208) associated the Rochelongue assemblage with other terrestrial metal hoards that he believed represented a homogenous group, or phenomenon. The eponymic hoard of Launac, found inside a pot in a closed context, is dated to the second half of the seventh century B.C. (Garcia 2013:208; Graells and Lorrio 2017:104–105; Guilaine et al. 2017:13–25). Recent work on belt buckles from various archaeological sites on the Iberian Peninsula have reinforced this dating; the ‘Fleury’ type, for example, represented in the Rochelongue assemblage, has been dated there between 625 and 575 B.C. (Graells and Alvarado Lorrio 2017:100, fig. 52).

3.3.1 Rochelongue underwater site: local or foreign?

Speculative characterisation of the Rochelongue site has resulted in different interpretations, which has only added to the general confusion about its artefact assemblage. Because of its early dating, some authors consider the site to be an Etruscan shipwreck and associate it with other presumed Etruscan wrecks found along the French Mediterranean coast, such as at Antibes, Esteou dou Miet, Cassidaigne, and Grand Ribaud, even though some of these sites are up to a century later in date. These shipwrecks yielded a significant number of Etruscan artefacts or complete Etruscan cargoes, including wine or other products transported in Etruscan amphorae, and are located in waters where Etruscan sea-traders would likely have been sailing during the sixth century B.C. (Long 2002:129; Barbot 2000:35–36). Ignoring the fact that a ship’s cargo is not always a good indicator of the cultural affiliation of the vessel and its crew (Bass et al. 1989:152–153; Bass et al. 1967:165; Bass and van Doorninck Jr 1979:131; Gibbins 1989:5; and for a broader methodological discussion of assigning shipwreck affiliation, see Harpster 2013), there are no such ceramics or other Etruscan material

culture in the Rochelongue assemblage to makes such an interpretation appropriate or likely. Only two small fragments of pottery were mentioned in the archaeological reports that motivated some claims of thrown pottery amongst the Rochelongue finds (Garcia 2013:208). There is nothing, however, in the Rochelongue collection at the Ephebe Museum that might substantiate this claim. Regardless, the presence of Etruscan material, indicative of Etruscan contact with the region, would not be surprising, as such evidence has been found in terrestrial bronze hoards linked to the Launacien phenomenon of the seventh–sixth centuries B.C. (Guilaine et al. 2017:242).

Other authors infer that the Rochelongue site is of Phoenician origin (e.g. Abdelhamid 2015:4; Kaufman 2014:14) since the copper ingots in the assemblage are similar to those found on the Mazarrón 2 (Negueruela 2004:227) and Bajo de la Campana (Polzer 2014:230) shipwrecks. Both sites were found in Phoenician colonial contexts off the southeastern coast of Spain and have been dated to the late seventh century B.C. Such an argument rests on rather tenuous evidence, though, and primarily reflects the historically attested and generally accepted notion that the early metals trade in the western Mediterranean—in particular, the Iberian Peninsula—was dominated by Phoenician traders (Aubert 2001:355; Broodbank 2013:546). Such conjecture needs to be tested with archaeometric analyses of the metal ingots, which the present research aims to do. There also is secondary evidence for Phoenician contact, namely Phoenician stylistic influences observed in some local pottery production. This can be seen in amphora shapes that imitate, for example, to the *Cruz del negro* type, as well as in the use of red slip on some ceramics (Gailledrat 2006:165). This, of course, does not preclude the possibility of indirect associations as the responsible intervening agency.

Nowadays, the Rochelongue site is more likely to be described by scholars as a Launacien deposit, closely linked to the local LBA IIIb (ca. 900–800 B.C.) to EIA (ca. 725–575 B.C.) cultural horizon (Guilaine 1972:357; Guilaine et al. 2017:351; Guilaine and Rancoule 1996:128). According to Dominique García (2002:41), this designation of Launacien recognises ‘an original economic phenomenon that consisted of the development of indigenous metallurgic production for exchange purpose’. Currently, the term Launacien is used to identify the general cultural context that was responsible

for the bronze hoards of this time in the area of west Languedoc, composed of locally manufactured products and foreign elements of continental, Atlantic, or Mediterranean origin (Guilaine et al. 2017:14).

3.3.2 Rochelongue underwater site: shipwreck or votive deposit?

Three hypotheses have been advanced to explain the presence of this assemblage of metallurgical objects in the waters off the west coast of the Languedoc. The most common hypothesis in the literature, since the moment of discovery, is that it represents a shipwreck; more precisely, the cargo of a sunken vessel that was carrying raw and scrap metals. The second hypothesis attributes the assemblage to a smelting site located in an area affected by sea level change. The third hypothesis considers the assemblage to be the result of ritual deposition and links it to the broader terrestrial phenomenon of Launacien metal hoards, as well as funerary and mythological Indo-European ritual traditions documented along the continent's Atlantic facade and British Isles. This last hypothesis has been reinforced by the appearance of Launacien objects in votive deposits in Greek sanctuaries in Sicily and Corinth (Verger 2000; Verger and Pernet 2013).

All of these hypotheses have suffered from poor recording and reporting of the original excavation and lack of thorough evaluations to produce firm and consistent data. Publications that discuss the cultural ascription or nature of the Rochelongue site are summarised in Table 3.1. The current study seeks to remedy these shortcomings by subjecting the site and its documentation to comprehensive review and the material assemblage to rigorous analysis. Only then can each hypothesis be evaluated on its merits and deficiencies and a legitimate assessment of the site type be made.

The biggest evidentiary hurdle that this hypothesis fails to overcome is the glaring absence of any wooden hull remains (even any trace of such), rope, rigging elements or other equipment typically associated with water craft that would provide definitive evidence of a boat or ship. The museum collection includes only some iron and copper alloy nails that have any possible nautical association, their inclusion in the assemblage can be questioned due to the presence of artefacts from different periods in the same

area of Rochelongue site. The complete assemblage amounts to a total weight of approximately 1.3 tons, a rather low tonnage in comparison to that of known Mediterranean wrecks of the seventh and sixth centuries B.C., which range from 2–4 tons up to 30 tons. If indeed the site is that of a shipwreck, then the vessel type we most likely are dealing with is a small riverine boat with limited coastal capability, rather than a true sea-going ship.

Table 3.1. Summary of publications that reference the cultural ascription and nature of the Rochelongue underwater site.

Publication	Cultural Affiliation	Site Type
Bouscaras 1964a, 1964b	None	Shipwreck or metal hoard?
Bouscaras 1965	A ship from Spain or North Africa (origin of copper ingots)	A shipwreck with ingots from Spain or North Africa, together with scrap metal for recycling
Huges 1965	None	Remains of a traveling metal workshop on a ship
De Santerre	None	Remains of a traveling metal workshop on a ship
Tchernia 1969	None	Site?
Arnal et al. 1970	None	Shipwreck or hoard?
Gras 1985	Etruscan	Shipwreck returning with a metal cargo exchanged for wine
Bouloumie 1985	Etruscan	Shipwreck returning with a metal cargo exchanged for wine
Bouscaras 1986	None	Shipwreck. A traveling bronze workshop transacting with coastal populations to exchange metal scrap or rejected objects for new objects manufactured in situ
Bouscaras 1991	None	Shipwreck? Metal hoard? Deposit?
Parker 1992	None	A small vessel carrying an itinerant coppersmith
Bérard-Azzouz 1997	Launacien	Shipwreck (indigenous exchanges with the Mediterranean coast)
Jézégou 1997	Launacien	?
Garcia 2002	Launacien (assemblage)	(Foreign/Greek?) Shipwreck
Ayuso 2004	None	Shipwreck of a vessel engaged in the nautical route linking the south coast of France with the Balearic Islands

Luc Long 2005	Etruscan	Shipwreck (some ingots bear same Y stamp or marks as examples on Giglio shipwreck linked to eastern Mediterranean cultures)
Samson 2006	Local	Votive deposit
Abdelhamid 2007	Phoenician	Shipwreck
Cesari 2010	Etruscan?	Remains of a traveling workshop on a ship
Garcia and Sourisseau 2010	(Foreign/Greek?) Shipwreck	(Foreign/Greek?) Shipwreck
Gascò 2014	Launacien	Votive deposit
Jézégou 2012	None	Who is trading with whom? Are locals exchanging old and broken objects and so the cargo is departing? Or are there foreigners who bring waste materials to recast and so the remains reflect an import?
Garcia 2013	Launacien (assemblage)	(Foreign/Greek?) Shipwreck
Verger and Pernet 2013	Launacien (assemblage)	(Foreign/Greek?) Shipwreck
Guilaine et al. 2017	Launacien (assemblage)	(Foreign) Shipwreck

Submerged smelting site. Andre Bouscaras, himself, was the first to suggest that the site might represent a smelting or metalworking workshop in an area of the shoreline that now is inundated (Bouscaras 1964a; 1964b). This hypothesis relies on similar evidence as the previous; namely, copper ingots, tools and fragmentary copper bits, damaged bronze objects and waste products linked to recycling operations. It also falls in line with many recent discoveries and re-evaluations of mainland sites in Europe that now are submerged due to sea level rise. Nevertheless, this interpretation was rejected almost immediately by Bouscaras himself, who, consulting studies of the paleo-coast of the time, confirmed that the sea level in this region had not varied enough in the last 6,000 years to support such an assertion (Ambert 2001:53). More recent sea level studies for the Languedoc coast have confirmed these results and show a completely different coastal morphology, with a paleo-bay at the mouth of the river Hérault (Benoît Devillers pers. comm. 2018). Even then, the Rochelongue site still would have been submerged at a depth of 4–6 m (Gascò 2014:233; Ambert 2001:53).

Votive deposit. The interpretation of the Rochelongue material as a votive offering has been argued mainly by Gascó (2012), who has explained in depth the supplicatory nature of the deposit. Although many scholars still are reluctant to accept this type of reading, at present it constitutes one of the principal alternatives to the shipwreck interpretation. The main arguments of this hypothesis are that: (1) the weapons, harness and personal adornments represent prestige objects showing aristocratic and heroic social status (Graells 2007; Graells et al. 2010) and (2) the presence of foundry tools and waste material are representative of the high social position metal smiths seem to have enjoyed in proto-history (Fregni 2014:30). Certainly, during the LBA–EIA, the manufacture of such objects was the result of specialised knowledge and techniques skilfully applied, and their ownership the prerogative of social elites.

The fragmentation or intentional deformation of a good part of the metallic objects could be the result of ritualistic or symbolic destruction meant to prevent the items' reuse. Riverine and coastal deposits of similar material—especially weapons—in similar condition have been found in the Iberian Peninsula and British Isles. Jagged edges, cutting and folding can be considered evidence of ritualistic disablement and an indicator of the votive nature of these deposits. Nevertheless, the reasons for the deformation of these materials continue to elicit multiple explanatory hypotheses, essentially between reasons profane and those of a more sacred, or at least ritualistic, nature (Brandherm 2008:8). Among the former is the proposal that such deformation is the result of bending, cutting or crushing scrap objects or materials for recycle to reduced their size and volume for transport. Among the interesting explanations of ritual destruction is one based on the Dionysian character of such damage (Nebelsick 2000) and another on the euphoric feasting behaviour of some Celtic populations following victorious combat. The latter included sacrifices, banquets and the redistribution of captured wealth, all dedicated to the Celtic war deity in gratitude for help given (Cesar, BG, 6.17.2–3).

Some obvious questions arise upon subscribing to the votive hypothesis: How and when did the deposition of all these objects happened? Does the assemblage represent one or several deposition episodes? How and why was the location selected? Were the

objects thrown from a boat, or was the deposit the result of a wrecking (capsizing/swamping) event; alternatively, was the deposition made from a wooden platform or structure from shore? Was the deposit location marked in some way to ensure that subsequent deposition events would occur at the same spot? A deposition over time does not clash with some of the objects that have prevailed since the MBA or LBA; nor does it seem to be discordant with other previous deposits in the vicinity, such as at Luno lagoon (Verger and Pernet 2013:43) or the pile dwelling settlements of La Motte (Moyat et al. 2010).

The distance from the site to the paleo-coast, even taking into account the 2 m rise in sea-level change, still would have been about 500 m, making the possibility that the material was deposited ritually (i.e., thrown) into the sea from land unlikely. All this reinforces the votive nature of such pieces and the sacred character of the space where they were deposited. In this sense it is interesting to consider the recent proposal of Samson (2006), formulated from an analysis of findings in the English Channel and North Sea. The author argues that, in areas of maritime interaction of particular intensity, the sea needed to be 'incorporated into Bronze Age cosmology in similar ways to other zones in the landscape', where the deliberate deposition of metal artefacts provides an alternative interpretation to underwater archaeological contexts other than shipwrecks (Samson 2006:317).

In light of such considerations, one objective of this study has been to record any technical details or indicators of ritual or religious function in the Rochelongue assemblage. Evidence of such was sought in the in-situ disposition of the materials, their appearance and condition, their typology and their archaeological context that might provide indication of intentionality or of sacred or prescribed motivations.

Relevant to this and the shipwreck hypothesis is Gascó's (2014:235) argument that Rochelongue could not have been a coastal transshipment point, since no associated port facilities or related elements have been located during the various excavation campaigns, or indeed the more recent surveys in 2006 and 2011 (Tourrette 2006; Borja and Tourrette 2011). This contention, however, fails to consider the nature of

indigenous water transport and practices of the time and the surrounding coastal and fluvial landscape in the context of a contact zone.

Local societies of the LBA–EIA typically were embedded in riverine environments, as attested by the eighth-century B.C. settlement at La Motte (Agde), situated on the edge of a palaeo-bay near the mouth of the Herault River, but now submerged under the river (Moyat et al. 2010; Verger et al. 2007:162–163) (Figure 3.9). Similarly, it is not coincidental that a large number of metal deposits appear in close relation to watercourses (Dedet and Marchand 2015; Ropiot 2007:144), especially given the notion in European Bronze Age cosmology of rivers as boundaries between different spheres or worlds (Huth 2017:277). In light of this, such communities almost certainly would have used watercraft for transport and trading along the network of rivers (and possibly the adjoining coastlines), utilising natural features within this environment for harbourages. Thus, the near ‘invisibility’ of prehistoric and proto-historic harbours (anthropogenic structures) in the archaeological record is easily explained.

In her study of Late Bronze Age harbours in the Aegean, for which there are scant remains, Loizou (2016:123) argued that they must be viewed in the context of the dynamic seascape and considered as active cultural landscapes with socio-political implications. An analogous reading can be applied to the Rochelongue site as a contact zone; namely, a dynamic geographic and social space. The surrounding topography is full of natural markers: the rocky platform of Pointe Rochelongue, the Herault estuary to the west and the promontory of Cap d’Agde to the east; Mont Saint-Loup and the small islet of Brescou lying just off the coast (Grimal 2018). All of these features would have served as navigational landmarks for riverine, coastal as well as terrestrial travel, and the estuary additionally would have offered shelter and points of debarkation for boats or ships.

3.3.3 Material distribution on the site

The original distribution of material across the seabed might provide additional insight into the nature of the site. Although a final site map was never completed and published, Bouscaras did locate a large number of objects on a site plan, which gives a

good idea of the artefacts' dispersion. Presumably, the more diminutive objects, such as pins, fibulae, and buckles, were susceptible to displacement by currents and storms, whereas objects of greater mass, such as ingots, which weigh up to 8 kg a piece, were likely located where they were originally deposited or came to rest on the seabed. The ingots were found in three concentrations, each representing an area measuring no more than 2 m long × 1 m wide and located in the south-western, central, and north-eastern parts of the site (Figure 3.7). If from a shipwreck, these deposits should indicate the areas in the ship's hold where the ingots were stowed; although, why they should have been loaded in such a way is unknown. If deposited for ritual or votive purposes, the groupings might indicate that each was dropped from a different boat.



Figure 3.9. Late Bronze Age ceramic from la Motte (Agde): the sharp silhouette has been interpreted by Grimal (2018:2) as a schematic representation of Mont Saint-Loup (Grimal et al. 2018:2 fig. 1).

Alternatively, if one looks only at the types of objects recovered, the Rochelongue material perhaps is most similar to several deposits found off the southern coast of Britain, such as at Dover and Salcombe. The first, located in 1964 east of the Port of Dover, comprises a total of 352 complete and fragmented objects (axes, swords, bracelets) with a total weight of 60 kg and an associated chronology of 1200–1100 B.C. (Muckelroy 1980:101). Based on the inclusion of socketed axes of type 'Taunton–

Hademarscheny', Needham and Dean (1987:120) link this assemblage to metal workshops located in the north of France. As for the finds from Salcombe, these come from two different groups found some 400 m apart in the mouth of a river estuary. The first group of objects, Salcombe A, discovered in 1977 at Moore Sand (see Muckelroy 1980, 1981), contains 22 weapons or weapon fragments, a palstave-adze, cauldron handle, rectangular block or weight, Sicilian *strumento*, three gold objects or fragments of such, an iron awl with bone handle and a lump of tin (Needham et al. 2013:85). The second, so-called Salcombe B, assemblage was discovered in 2005 and investigated again in 2013. It has similar characteristics in terms of interpretation and chronology as the Moore Sand site and includes 280 copper ingots or fragments of such, 40 bun-shaped tin ingots, 15 bronze objects and nine gold ornaments (Wang et al. 2016:82). Despite the Rochelongue material being at least two centuries later in date it is remarkably comparable to the deposits in England in terms of object type heterogeneity and depositional context. If these sites represent the wrecks of simple watercraft, such as expanded dugouts, then the four concentrations of artefacts and materials at the Rochelongue site could represent the cargoes of four similar small crafts that were travelling together and were swamped or capsized by a storm. This could account for the material groupings, the dispersion of material on the site and the types of materials recovered, as well as the lack of any hull remains or ship's equipment, as such vessels would be unlikely to sink, instead being washed away or smashed on the reef or shore after overturning and spilling their contents.

3.3.4 Rochelongue underwater site: a contact zone?

The provenance and cultural adscriptions of the Rochelongue artefacts remain uncertain, and the nature of the assemblages is still being questioned. While most scholars believe it to be the result of shipwrecking (Abdelhamid 2007:4; Barbot 2000:34–35; Hugues 1965:175; Long 2004:129), and thus associated with trade and commercial activity, Jean Gascò (2014:235) suggested recently that it best represents a votive deposit, due to the absence of wooden hull or other ship remains, and to its location close to the mouth of the Herault River. Gascò's interpretation requires serious consideration, as the ritual practice of offering metal hoards—indeed, one of

the defining traits of the Launacien—is common in the region. Such deposits are known from numerous archaeological contexts linked to the European Bronze Age tradition, such as at Huelva (Spain), where a deposit of bronzes was found at the confluence of the Odiel and Tinto Rivers (Ruiz-Gálvez 1995). On the other hand, it is difficult to reconcile some of the material with this interpretation as ‘cultic behaviour’, such as the smelting and manufacturing waste, which typically are seen as evidence for metals recycling activity (Dietrich 2014:468).

Ultimately, and from a seascape perspective, the distinction between ritual and commercial activity may be a moot point, as ‘people in traditional societies in coastal areas, as elsewhere, would not have separated ritual and habitual actions’ (Cooney 2004:323). Thus, commercial dealings may have been consummated with ritual offerings or deposition representative of the materials being exchanged—in this case, raw and recycled metals on the one hand and metal handicraft works on the other. That such offerings might be made in the sea, just offshore, in the midst of the zone of contact, where land, riverine, and maritime trade routes converge, would not be unexpected. Particular objects, or the assemblage as a whole, might have served as ritual markers of the peripheral or transitional zones through which the various parties of the relationship network passed (Ruiz-Gálvez 1999). In the case of Rochelongue, the bent knives and broken axes could evince such practice. Conversely, the ingots and other objects in the assemblage might better represent the habitual actions, in this case the mining, smelting and trading of metals.

When considering matters of provenance and cultural adscription from a maritime perspective, Harpster (2013: 614) criticised the absence of ‘an effective, critical dialogue regarding the creation and use of the affiliations themselves’. In the case of the Rochelongue site, the cultural diversity of the artefacts has limited interpretive emphasis to specific narratives and contexts, especially the determination of ‘attributions based upon portions of the assemblage’ (Harpster 2013:604). Past studies established the cultural attribution of the site based on the origins of only a few artefacts from the collection. A direct consequence of this approach is the reliance

upon assumptions that increase the probability of an inaccurate cultural designation and a high degree of subjective conclusions.

The shipwreck found off the coast of Giglio is pertinent to this discussion. The recovered material was dated between the eighth and sixth centuries B.C. and included Etruscan amphorae and two or three bucchero *kantharoi* (two-handled drinking vessels). The presence of these ceramics led to the excavator's original conclusion that the ship was Etruscan (Bound and Vallentine 1983:115). Nevertheless, the same researcher also noted that the ship's cargo is complex and varied, containing at least one Phoenician amphora, along with Corinthian ware, including a *kothon*, *aryballoi* and fragments of an *oinochoe* (Bound 1991:14–35). Similarly, the sixth century B.C. Cap d'Antibes shipwreck, on the southern coast of France, yielded Etruscan amphorae and fine pottery, but a single fragment of a Phoenician or Punic oil lamp. Nevertheless, the latter showed signs of much use, and may provide the best evidence for the origin of the wreck (Hagy 1986:236).

The absence of an effective and critical dialogue for cultural affiliation can lead directly to misinterpretations of incomplete assemblages. One way of dealing with such artefact collections is through the conceptualisation of the assemblage. Franklin and colleagues view an assemblage as '*a group of objects found already-brought-together, representing the 'sum of human activities' long-since concluded*' (Renfrew and Paul 2008:578 original emphasis). The challenge then for archaeologists, when dealing with incomplete assemblages, is to extract meaning from the group of objects by reconstructing the associated human activities (i.e., to fill in the gaps). This research attempts to do just that by applying a network approach to reconstruct past activities, mobility, and communities through an examination of the movement of objects and the connectivity this implies.

3.4 Conclusion

This chapter has endeavoured to outline briefly the rationale and methodology for a new investigation of the Rochelongue underwater site based on characterisation of the

metallic finds, as opposed to the site as a whole, within the context of a contact zone. Provenances and cultural affiliations of the pieces, determined on the basis of material analysis, in turn will help to determine the indigenous and foreign cultures in direct sustained contact, in this case, likely of an economic nature, although never devoid of other socio-political considerations (Dietler 2010:13). The study also engages geographic and social approaches to represent maritime connectivity as a trans-Mediterranean network of varying intensities, which largely determine the levels of impact on the connected cultures (Horden and Purcell 2000:739; Morris 2003:43–46). This approach maintains that viewing maritime contact zones as ‘nodes of density in a matrix of connectivity’ (Horden and Purcell 2000: 393) may assist in the process of revealing participants and mechanisms of exchange within these complementary economic spheres (Leidwanger 2013:3302). This combined methodological approach attempts to shed light on the communities in contact, based on an understanding of communities as not merely made up of humans, but also of things—assemblages—and the connectivity and interactions between the two, respectively (Harris 2014:77). In this way, discussion of the Rochelongue underwater site can move beyond arguing about its chronology, cultural attribution and type characterisations, and instead concentrate more on what the material culture from the site has to say about the societies responsible for its deposition, however that might have occurred.

CHAPTER 4. SOCIAL NETWORK ANALYSIS AND ACTOR NETWORK THEORY

This chapter examines the theoretical framework underpinning social network analysis and discusses the applicability of such an approach to maritime archaeological contexts, and to the Rochelongue assemblage in particular. The effectiveness of using sociologically based network analysis in archaeology is well established (Brughmans 2010; Brughmans 2013b; Ingold 2011; Knappett 2011; Mills et al. 2013) but a corresponding theoretical application to create network models in the field of maritime archaeology has been relatively unexplored. The following discussion includes a review of the relevant literature relating to this approach, as well as a brief overview of work undertaken in social network analysis (SNA) relating to maritime contexts and the use of material culture as a linking element.

4.1 Introduction

As discussed hitherto, a lack of rigorous investigation, together with a lack of clarity in the definition of Rochelongue, both in terms of cultural affiliation and the nature of the site's formation, have left the archaeological context of the assemblage incomplete. The absence of effective and critical dialogue around cultural affiliation has led directly to the misinterpretation of this incomplete assemblage (as well as others). One way of dealing with such artefact collections is through 'conceptual re-assemblage' (Miller-Bonney et al. 2016). This process replicates incomplete practices of material production, maintenance, and reproduction using artefact assemblages as placeholders to reconstruct past action, mobility, and community through an examination of the movement of things (Miller-Bonney et al. 2016:9). The present thesis applies this process to the Rochelongue material culture in order to designate cultural affiliation more accurately and to draw conclusions about the associated communities by prefiguring divisions between human and non-human interaction and connectivity (Harris 2014:77).

This research adopts the concept of connectivity, as described by Horden and Purcell (2006:733), as 'the key variable in assessing the social and economic character' of any microecology (see Chapter 1). These authors argue that viewing the range of maritime facilities as 'nodes of density in a matrix of connectivity' may assist in the process of revealing participants and mechanisms of exchange within complementary economic spheres (Horden and Purcell 2000:393).

This thesis uses network theory to assess the usefulness of maritime connectivity and movement of metals as frameworks for recognising differences between object categories and within specific types, and as indicators of social structures and economic organisation. Specifically, this work employs actor-network theory (ANT) for its applicability to undertake re-assemblage and explore connectivity. In his discussion of the network concept and its implications, Latour (2005:46–154) introduced ANT as an adequate framework for reconstructing material cultures and interactions temporally and spatially. The main concept behind this theory is that human and non-human (artefactual) elements can be part of the same networks and have particular 'interests' (Vicsek et al. 2016:77). By introducing concepts such as 'relationality', Latour (2005) argued that entities have no essence in themselves; rather their properties and boundaries are formed and shaped through their relationships to other elements (Ritzer 2008:656). Concepts such as 'actor' and 'network', therefore, should not be understood and utilised independently, but as a part of a whole (Latour 2011:5). Relational theories like ANT consider that, without non-human elements, it is impossible to understand how society is integrated as a whole (Hodder 2012; Latour 1992).

This model is not without its detractors; Harris (2014:90), for example, has pointed out that 'any change to the network means an entirely new network has been produced. If we took this point of view literally, it would mean communities would have no endurance.' In this regard, ANT could benefit from an integration of approaches from SNA. Knappett (2011:9) noted that, by combining SNA with ANT, people and things, both methodologically and theoretically, can be brought together arguing that 'from ANT we have an effective means for thinking through the distributed nature of socio-

technologies and materiality’ and from SNA ‘we acquire an explicit methodology for characterizing connections’. Brughmans (2013) used examples of SNA in archaeological studies, such as Graham’s (2006) application to Roman networks and Sindbæk’s (2007) research on the emergence of towns in early Viking Age Scandinavia, to highlight the uncritical use of networks as theory and methods. Similarly, Collar (2015:9) argued that:

[...] relationships matter and this makes it clear how fundamental the theoretical assumptions underpinning representations of networks are to network science: when representing their data as a network, scholars must formulate exactly how they envisage some ties as dynamically affecting others.

Thus, the application of SNA can be used to explain social phenomena and highlight the relational data and inter-actor relationships that create the network. This is done visually utilising graph theory from mathematics, which represents a network diagrammatically as a set of actor-vertices—also called points or nodes (Vicsek et al. 2016:86).

4.2 Materiality and scale

Human ways of thinking and acting as well as ways of knowing and doing are integrated into material culture, even in the most insignificant objects (Knappett 2005). Currently, discussions about the interaction between humans and artefacts have moved from the study of material culture to a much broader concept of ‘materiality’ (Miller 2005, 2007). This term encompasses the processes of human life that are irreducibly embedded in the scope of both material and social spheres. Knappett (2011:8–10) argued that ‘we can understand the role of distributed materiality in human interconnectedness’ in the study of space and connectivity at diverse scales (the goal of this thesis research) by using ‘an object to act as a kind of marker of a non-present space (and time)’. This statement demonstrates the special significance of materiality in the study of artefacts as a pivotal element of social relations (Meskell 2005; Miller 2005; Tilley 2004). The definition from Tilley (1999:76) makes even clearer the repercussion of material culture in social life by understanding ‘that things create people as much as people make them’.

It is clear how an object can influence socio-cultural interactions at a micro-scale, but can we consider humans and non-humans as equally influenced when we analyse an interaction on a medium or macro scale? Knappett (2011:100) argues that an object can be considered a 'sign' because its use invokes a person, a gesture, or a feeling. Conceptualising an object as a sign then allows us to understand its transmission of meaning across space and time using Peirce's Sign Theory, or Semiotic (Knappett 2012a:87; Peirce 1932). This understanding establishes that a sign (or, here, an artefact) may function variably as icon, index or symbol, depending on the particular interpretation generated and transcending time and space through the transmission dynamic. Studies have demonstrated that following typologies of particular ceramics using a cognitive approach can help identify cultural transmissions on a meso-scale beyond functional interpretations (Broodbank 2004; Knappett 2010:88, 2012b). Combining the concept of maritime connectivity with an analysis of how metal objects and people interconnect across the sea space, the present research adopts a relational perspective in order to analyse human and non-human assemblages at a multi-scale level to characterise complex interdependencies based on cognition, agency and meaning (Figure 4.1).

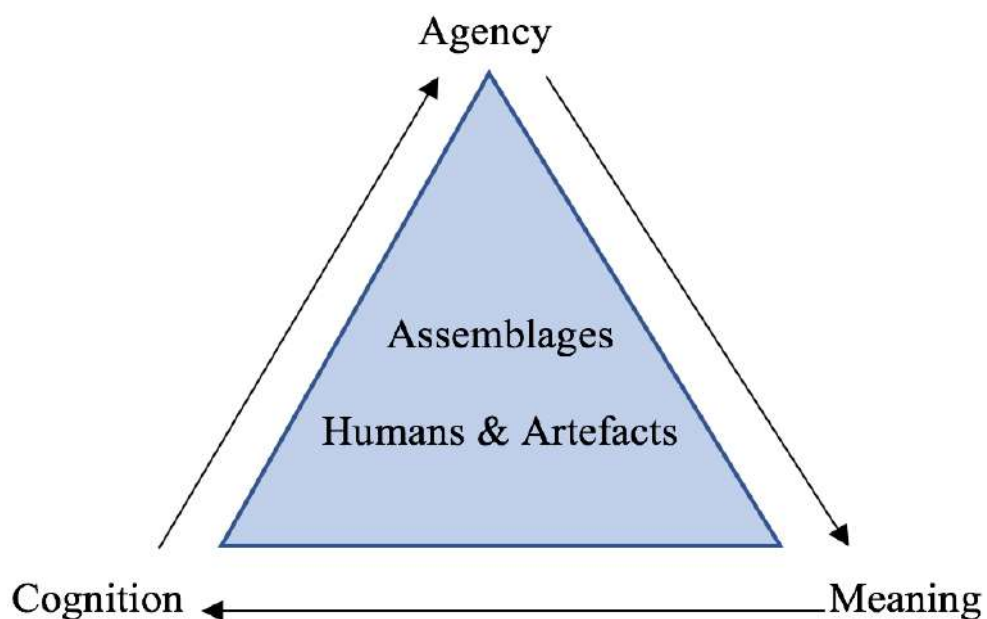


Figure 4.1. Interdependencies in the study of an archaeological assemblage (based on Peirce 1932:85).

4.3 Actor network theory

ANT encompasses the idea that culture can be understood as meanings, practices, and discourse when studying relations (Mützel 2009:876). Authors define it as an approach to understand how things, people, and ideas become connected and assembled into larger units (Czarniawska and Hernes 2005:1553). Bruno Latour (2005), one of the most prominent contributors to this field, argued that re-assembling structures can be simple under a 'social' approach used without assumptions about the nature of the phenomenon under study. The problem appears when 'social' means diverse typologies. In this sense, the term 'social' takes on a duality that refers firstly to the process of assembling and secondly to a specific type that differs from other material (Latour 2005:1). Latour then proposed ANT as a tool to redefine the notion of social by analysing the assemblage/network under five major uncertainties (Latour 2005:22):

1. The nature of groups: numerous contradictory ways exist for actors to be given an identity;
2. The nature of actions: in each course of action, a great variety of agents seem to intrude and displace the original goals;
3. The nature of objects: the type of agencies participating in interactions seems to remain wide open;
4. The nature of facts: the links of natural science with the rest of society seems to be the source of continued disputes; and
5. The type of studies: it is never clear in what sense precisely social science can be said to be empirical.

In ANT, 'objects are an effect of stable arrays or networks of relations. The suggestion is that objects hold together so long as those relations also hold together and do not change their shape' (Law 2002:91). Nevertheless, Harris (2014:77) identifies a limitation of this definition, since any change in the network implies a totally new network, otherwise cultural persistence would be impossible.

ANT, then, is embedded in an actor-network tension that, at least partially, defines its form so as to distinguish between ‘agency’ and ‘structure’ (Law and Hassard 1999:5). But what is a network to ANT? The theory finds more problems than solutions when dealing with this term specifically. Another term, ‘topology’, defined as a branch of mathematics that explores the character of objects in space (Law 2002:94), has been proposed as a resource to establish boundaries. It provides a means of conceiving the world as a flat surface, which then may be broken up into principalities of varying sizes (Law and Hassard 1999:6). For ANT, the term ‘network’ itself is an alternative topological system wherein elements retain their spatial integrity (Law and Hassard 1999:6). It provides a descriptive vocabulary, which makes possible the analysis of different patterns of connection representing different topological possibilities (Law and Hassard 1999:7). As a consequence, network is strongly linked to a logic of space trying to homogenise the character of links (Law and Hassard 1999:7). In conclusion, for ANT, a network creates regions and vice versa (Law 2002:97). This is an important idea in relation to the present research, as it provides an adequate framework for a trans-Mediterranean network (from either a Euclidean or non-Euclidean analysis). Based on this new scope in the study of space and connections, some researches have enhanced the role of digital humanities by opening up ‘new research directions that go beyond modern Cartesian notions to illuminate ancient conception of space’ (Knight 2017:253). A clear example of how ANT advocates perceive a network is provided in Law’s (2002:95) description of fifteenth- and sixteenth-century Portuguese vessels:

Hull, spars, sails, stays, stores, rudder, crew, water, winds, all of these entities (and many others) have to be held in place, so to speak functionally, if we are to be able to point to an object and call it a ship.

Against ANT, Law and Hassard (1999:9) argue that ‘what is interesting are matters, questions, and issues arising out of, or in relation to, actor–network and the various approaches to thinking materiality, ordering, distribution and hierarchy’. However, this statement does not detract from the application of ANT in archaeology, wherein it has been proved effective in the recovery of missing social relations linked to artefacts. A good example is Van Oyen’s study of the Roman imperial pottery *Terra Sigillata*, in

which he suggests that 'it would be helpful to take into account an ANT approach ... to defining the categories and then use components of classical network analysis' (Van Oyen 2016:51).

This thesis uses ANT as an interpretive framework, rather than as a principal theoretical approach. It considers ANT as an attempt to rethink how we report on and register agency. In this sense, network theory is more applicable to the 'socio-cultural connectivity' aims of the present research. As seen in previous examples, ANT can help better understand the process of reassembling an incomplete archaeological context, based on the fact that ANT:

- considers all actors in a network—humans or not—with equal value and agency;
- attempts to define and describe the links between humans and non-human actors in an assemblage, the latter being synonymous with network; and
- establishes that actors do not exist without networks, and networks do not exist without actors.

4.4 Social network analysis

The term social network has become popular thanks to online tools such as Facebook and Twitter, which allow users to connect with others in a virtual environment. This notion of network has influenced not only our daily lives, but also science. Currently, the network approach covers a range of interdisciplinary fields as diverse as computer sciences (Pham et al. 2011), physics (Hunt and Manzoni 2016), and social sciences (Lazega and Snijders 2015). In maritime archaeology, Social Network Analysis (SNA) is well established as a method, but its theoretical application to create network models still is an emerging initiative (Leidwanger and Knappett 2018).

SNA has been defined as an interdisciplinary behavioural science specialty. It is grounded in the observation that social actors are interdependent and that the links among them have important consequences for every individual (Freeman 2000:350).

Some authors see SNA as ‘its own paradigm’ (Leinhardt 1977), containing a unique approach to understanding the social world (Prell 2013:19). This statement is not free from criticism, as will be discussed in later sections of this thesis. From psychology to anthropology, the diverse fields to which SNA has been applied have emphasised different aspects, such as the interplay between cognitions and social relations (Prell 2013:20). As a result, a network can be defined most broadly as ‘a set of items ... with connections between them’ (Newman 2003:168). In this thesis, these ‘items’, which can be human or non-human, are referred to as ‘nodes’ or ‘vertices’ and the connection between them as ‘links’ or ‘edges’ (network terminology). A relationship network, then, would consist of additional information, which can be shown graphically (De Nooy et al. 2018). Network concepts can be used to abstract the phenomena under investigation (Figure 4.2) (Collar et al. 2015:4); for example, links between actors permit the flow of material goods, information, power, influence, social support and social control (Freeman 2000:350). Finally, the application of methods and theory from network science to archaeology has increased dramatically in recent years. Already in the 1960s, archaeologists were using incipient network methods. Voronoi tessellations (Thiessen polygons), for example, were used to model zones of influence (Renfrew 1975), but only in the last decade has network analysis become more widely applied with the use complex models (Collar et al. 2015:2; Mills 2017).

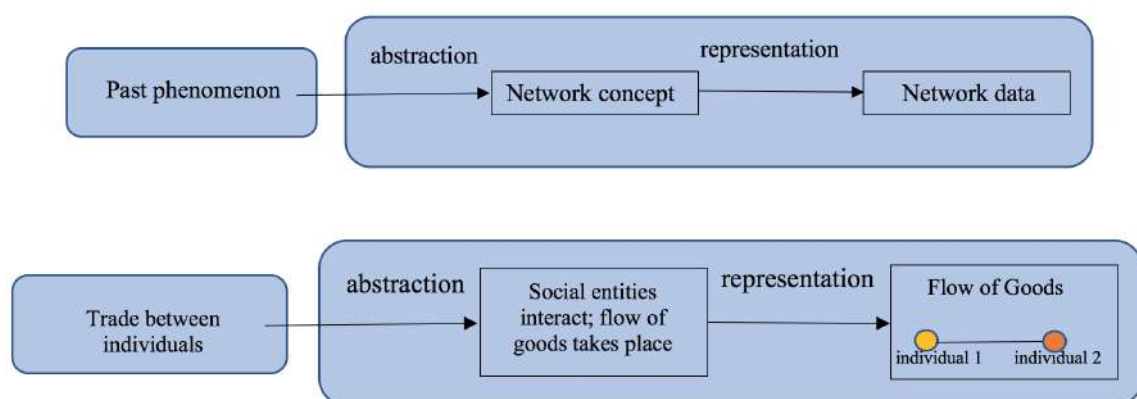


Figure 4.2. Representation of a network model and its application (from Collar et al. 2015:5).

4.4.1. Social psychology and networks.

SNA emerged from the studies of psychiatrist Jacob Moreno, who, together with Helen Jennings, developed a technique called 'sociometry' to explore how social relations affect psychological well being (Moreno 1934). This technique applied quantitative methods to the study of group structure and the position of individuals within the groups. Another psychiatrist, Kurt Lewin, contributed to the development of SNA with his so-called field theory (Lewin 1936, 1951), in which he argues three main points (Prell 2013:24):

1. Human behaviour must be understood as embedded within a 'field', defined as 'the totality of coexisting facts which are conceived as of as mutually interdependent' (Lewin 1951:240);
2. Individuals and groups can be represented in topological terms, where different spaces, such as one's family, work and so forth are displayed as vectors; and
3. Mathematical techniques can be used to analyse social space, with the aim of exploring the system of relations in which a group and its environment were situated.

Alex Bavelas, a former student of Lewin, made an important contribution with his research on how information travels within a small group of actors, and his introduction of the concept of 'centrality' (Freeman 2004). Others associated with Lewin, such as Leon Festinger, well known for his theory on cognitive dissonance (1957) Bryce Cartwright and Frank Harary, contributed extensively with their applications of graph theory to social relations and structural concepts. Twenty years later, Stanley Milgram (1967) tested their propositions empirically, leading to the now popular notion of 'six degrees of separation', better known as small-world theory (these terms will be taken up in more detail below).

4.4.2 Social anthropology and networks

A relevant figure in the application of networks to anthropology was Radcliffe-Brown, who noticed that networks could help anthropologists move beyond abstract

categories of 'culture' and 'class' (Prell 2013:30). He used the term 'social structure' as a definition of the complex networks of social relations that connect human beings (Radcliffe-Brown 1940:2). W. Lloyd Warner described societies and communities as composed of 'a group of mutually interacting individuals ... where each relation is a part of the total community and mutually depended upon all other parts' (Warner and Lunt 1941:13–14). The work 'Deep South', which Warner supervised, investigated the impact of racial differences on social stratification in the town of Natchez, Mississippi (Davis et al. 1941). The data gathered still are considered a fine example of two-mode network data (see Glossary Appendix 5), where the matrices used to structure the data consisted of columns representing events and rows representing actors (Prell 2013:31).

The Manchester School and London School of Economics provided important contributions to the field of social anthropology and the exploration of networks. The Manchester School and its founder, anthropologist Max Gluckman, emphasised interpersonal relations and how such relations could develop structures and patterns that demonstrated group norms (Mitchell 1969, 1974). At the London School of Economics, Elisabeth Bott (1955, 1957) was a key researcher who led a number of studies that introduced the concept of 'connectedness'—still in use today, although now known as 'density' (see Glossary Appendix 5)—to illustrate the difference between dispersed and connected networks. In summary, social anthropologists made important contributions to the discussion of culture through an empirical focus on social relations.

Sociology had a late impact on SNA, as it did not have specific relevance until the 1970s. More specifically, it is interesting to highlight Harrison White's contribution to the understanding of network as an analytic method. White and his collaborators proposed a 'complete' network that transferred focus from the individual to the group, thus allowing for a wider range of analytical possibilities (White et al. 1976). White's approach influenced Mark Granovetter (this author credits White's lectures and description of sociometric), and his work on 'strength of weak ties' as the degree of overlap of two individuals friendship networks varies directly with the strength of their tie to one another' (Granovetter 1973:1376). Thus, for example, information shared by

actor A with actor B, who are connected by strong ties (e.g., family or friendship), will be the same as that obtained by actor C, who also has strong ties with A and B (Figure 4.3). In contrast, actors D or E, connected to C through weak ties (e.g., mere acquaintances), may be disconnected from the network. These external actors, therefore, are more likely to be a source of new information (Borgatti et al. 2009:6).

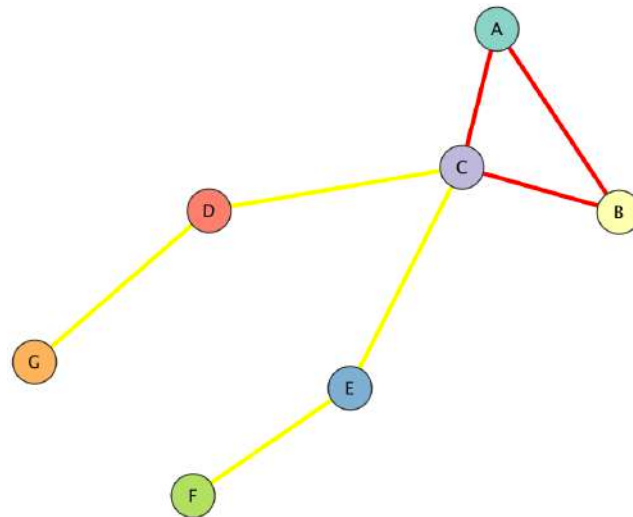


Figure 4.3. Illustrated example of 'strength of weak ties' theory, in which red links represent strong ties and yellow links represent weak ties (after Borgatti 2009:6).

SNA has increased in popularity recently, especially with the use of socio-economic theories such as small-world theory (Milgram 1967). Milgram's experiment in the 1960s demonstrated that, in most cases, short chains of acquaintances are sufficient to connect any two people on the planet. This fact is even more tangible with the prevalence of natural and technological networks today (e.g., Facebook and the popularisation of social media) (Leonesi 2015:121). Milgram's work was the inspiration that resulted in Duncan Watts' and Steven Strogatz's (1998) small-world theory (Figure 4.4), which consists of many local clusters in which all members are connected by short distances via a few more connected members (Menezes et al. 2017). In contrast to the small-world approach, authors such as Barabási and Albert (1999) argued that a 'free scale' would be a more accurate approximation for real-world networks. This model is

based on the idea that networks follow the pattern of a power law distribution (Barabási and Albert 1999). In this sense, well-connected nodes are continually adding new nodes following the assumption of the ‘rich–get–richer’ effect (Barabási et al. 2000). These theories revealed the possibilities for employment of computer simulations to exploring complex networks.

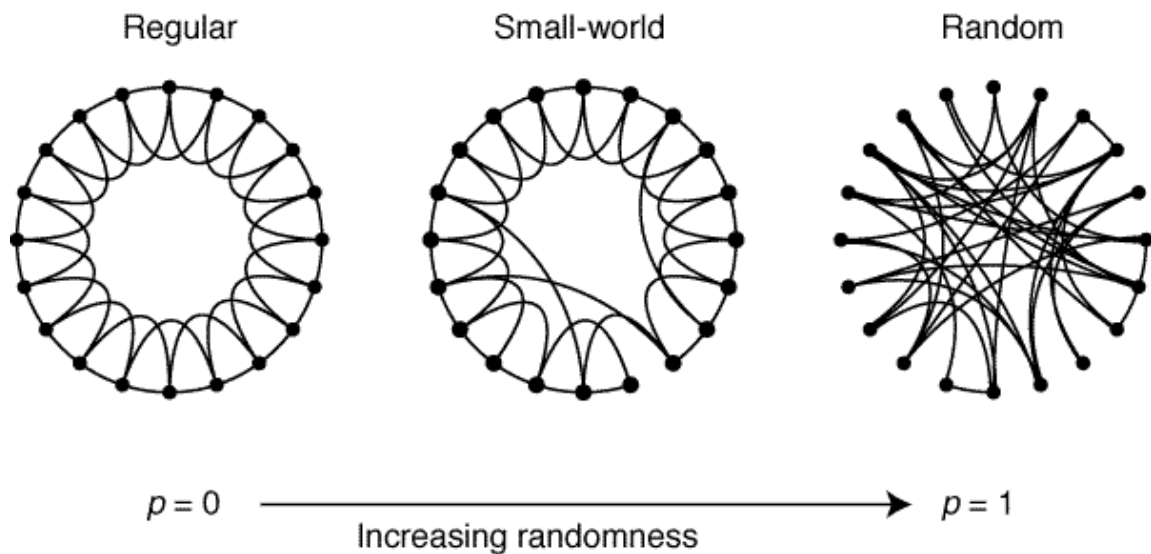


Figure 4.4. Small-world graph of a highly clustered network with an intermediate probability of randomness (after Watts and Strogatz 1998:441).

4.5 Archaeological Network Analysis

Network theory has contributed to a research approach using SNA, but how is it applicable to archaeology? Brughmans (2013a, 2013b, 2016), in his work about citation network analysis, presented an overview of the use of network theory and methodology in archaeology.

As the data from Brughmans study shows (Figure 4.5), the application of network scientific method and theory to archaeology has dramatically increased over the last decade, particularly due to conferences such as Computer Applications and Quantitative Methods in Archaeology (CAA, first edition in 2006); a series of publications titled Network Analysis in Archaeology (NAA); the journals *Nouvelles de*

l'Archéologie (NdA), *Archaeological Review from Cambridge* (ARC) and *Journal of Archaeological Method and Theory* (JAMT); and the volume *The Connected Past: Challenges to Network Studies in Archaeology and History* (TCP), edited by Tom Brughmans, Anna Collar and Fiona Coward (2016).

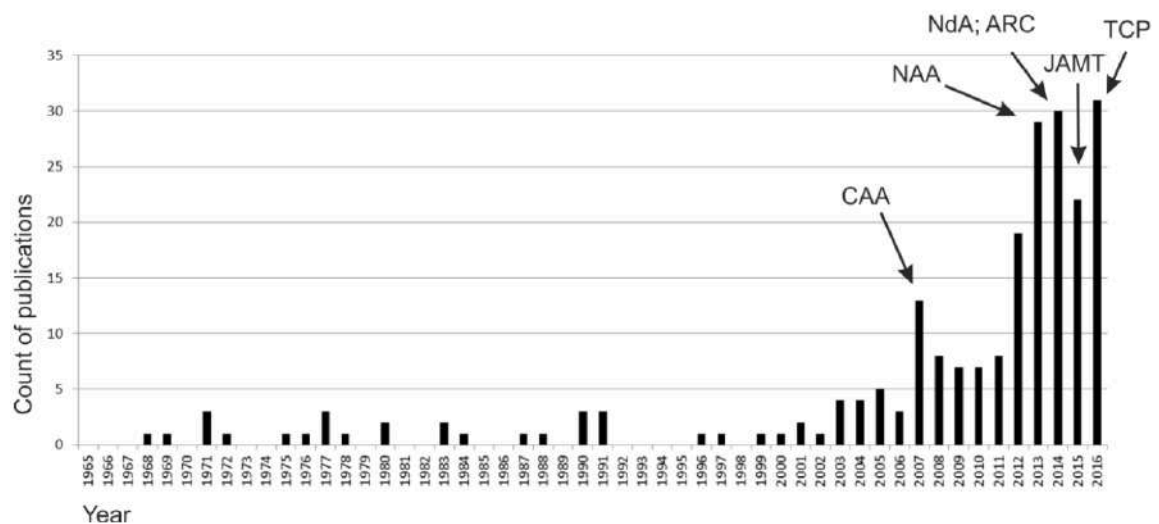


Figure 4.5. Publication output from archaeological network research (after Brughmans et al. 2016:7 fig. 1).

But what makes a network approach distinctive? One of the most potent ideas from social sciences is the notion that individuals are embedded in thick webs of social relations and interactions (Borgatti 2009:1). Network analysis provides a conceptual bridge between individual agents and complex systems that has obvious applications for archaeology (Brughmans 2013:625). Malkin's (2011:17) *Small Greek World* is a good example of how a network approach can change interpretation of archaeological contexts:

Imagine filling up the coastlines with dots (or 'nodes' in network parlance), representing all Greek maritime cities. Imagine the connecting lines ('ties') among them, as well as some content moving along those lines ('flows').

Malkin (2011:19) did not create a visual model in his work, but turning to a network approach in his archaeological analysis yielded a 'wide-angle vision of the ancient

Mediterranean'. His introduced concepts, including similarities, social relations, interactions and flows (see the Glossary, Appendix 5), provided the framework to define the relationships between actors in a network system. Interactions are produced in the context of social relations, and flows are those interchangeable items—tangible or intangible—that result from the interactions. In commercial trading, for example, merchants (social relations) reach an agreement (interactions) to exchange products. Armed with such network concepts, past phenomena can be abstracted into network concepts that then can be represented visually (Brandes et al. 2013:10; Collar et al. 2015:4). This process can reveal new insights into archaeological data, from which new interpretations are possible, which previously were beyond conventional archaeological analysis.

Currently there are two major approaches to characterising networks, depending on the theoretical and interpretive approaches: nodal position and network structure (Mills 2017:382). The first focuses on the position of a node, and how the network as a whole affects the behaviour and future of that node. On the other hand, network structure focuses on the entire network and its attributes, and how they might define variabilities such as centrality. According to SNA, centrality means that nodes in more central positions have not only more direct ties (hence more occasion to get first-hand information), but also enjoy controlling privileges over valuable information exchanged by their acquaintances (Hanneman and Riddle 2005a). In his study of hierarchy in Japan's initial Kofun Period, Mizoguchi (2009) used diverse measurements from centrality to determine that the relationship between social groups was more important for the development of hierarchies than the attributes of these groups (such as control of raw materials). Similarly, the ego-network study by Mol and colleagues of the fourteenth century site of Kelbey's Ridge 2, on the island of Saba, showed how centrality affects the analysis of a network. They demonstrated that the position of one person in a network could identify his or her opportunities to broker a deal or mediate between other people (Mol et al. 2015:278). Other examples of the use of relational networks in archaeology are Brughmans' studies of Roman pottery (Brughmans 2010; Brughmans and Poblome 2016), which analysed distribution (from the place of

production to the place of deposition) based on the idea that ‘social relations are channels of social contagion and persuasion, and as such instrumental to the diffusion process’ (Brughmans 2013a:635). Another popular type of network applicable to nodal position is the affiliation network (Golitko et al. 2012; Habiba et al. 2018; Phillips 2011), which identifies similar cultural entities based on the number of shared categorical attributes to infer levels of interaction.

The current surge in applications of complex network analysis to archaeology began in the early 2000s, and since then the adoption of network structure as a feasible analytical framework has grown also. Early on, archaeologists assimilated network theories popularised by physicists, such as small-world and scale-free theories (Barabási et al. 1999; Watts and Strogatz 1998), claiming that they could be applied almost universally to any real-world phenomena (Brughmans 2016:5). In their 2003 publication *Complex Systems and Archaeology* (University of Utah Press), Alexander Bentley and Hebert Maschner considered a large number of cases where network theory was used to address archaeological research questions; for example, by identifying power-law degree distributions. Coward (2010) employed an interesting application of small-world concepts in his archaeological analysis of the complex social interactions between Epipaleolithic and Early Neolithic peoples of Near eastern sites. He identified cultural groups linked by proximity and weak ties that created a small-world phenomenon (Coward 2010:23; on weak ties, see Granovetter 1973). An example of a scale-free approach is found in Sindbæk’s (2007) analysis of the organisation and communication dynamics of Early Viking Age sites in south Scandinavia using artefacts co-present in multiple sites for the basis of his network model. Of note in the resultant model is the small number of hubs with an average number of links, which the author used to argue that the settlements might have communicated as a scale-free network (Sindbæk 2007:70). From this perspective archaeological network science as a sub-discipline can be considered only as a reality since 2010. The period from 2012 to 2016 was considerably productive, with the publication of a number of edited volumes and special journal issues dedicated to theoretical and methodological matters specific to this area (Brughmans 2016:6).

4.5.1 Why use Network Analysis in Archaeology?

Carl Knappett's 2011 *An Archaeology of Interaction: Network Perspectives on Material Culture and Society* (Oxford University Press) played a pivotal role in integrating network methods and theory into archaeology (Knappett 2011:3–12). Knappett argued that network analysis can make an innovative contribution to archaeology because it:

- 'forces a consideration of relations between entities';
- has the 'flexibility to be both social and physical';
- is a 'strong method for articulating scales';
- 'can incorporate both people and objects' and
- 'can incorporate a temporal dimension'.

Mills (2013:381) provided some additional insights in his review of the application of network theory into archaeology, arguing several benefits, such as:

- Its ability to handle large data sets;
- Its compatibility with other analytical methods, geographic information systems (GIS) and agent-based models (ABMs);
- Its ability to produce complex computer visualisations; and
- Its basis in relational concepts commonly used in the study of the past.

Brughmans (2013:18) has argued that 'archaeologists only became aware of SNA once they had been inspired into network thinking by the exciting developments in complexity science, especially the work of Watts and Strogatz (1998) and Barabási et al. (2002)'. He also contended that archaeologists were not familiar with the earlier network studies in archaeology from the 1960s and 1970s, and noted that a number of issues needed to be addressed in future applications (Brughmans 2010:10):

1. The role of archaeological data in networks;
2. The diversity of network structures and their consequences and interpretation;
3. The critical use of quantitative tools; and
4. The influence of other disciplines, especially sociology.

Not surprisingly, other researchers put forth competing approaches. Ian Hodder, for example, considered a network analysis approach too simplistic for studying connectedness, as it lacks the 'stickiness' that is embedded in human relationships with material things (Hodder 2012:94). Instead, he employs a theory of entanglement, a thing-oriented approach that studies the interdependencies between people and things. To Hodder, objects become things when they enter the human realm. Simply put, things are objects with human relations, and these connections are what form the complex entanglements between societies and their material worlds. Thus, the term 'thing' in entanglement theory is synonymous with 'drawing together'; things not only draw together people, but other things as well.

Tim Ingold (2007a, 2007b) subscribes to a similar view of a 'thing', but uses the concept of 'meshwork' as opposed to network to attain a more accurate insight into the fluidity of social structures constituted of people and things. In Ingold's approach, 'the inhabited world is comprised not of objects, but of *things*'. As his concern is with life-processes, he focuses not on materiality as such, but on the 'fluxes and flows of *materials*' (Ingold 2010:3, emphases in original). For Ingold, a thing 'has the character ... of a knot whose constituent threads, far from being contained within it, trail beyond, only to become caught with other threads in other knots'; it is 'a certain gathering together of the threads of life' (Ingold 2010:4). Thus, the entanglement of things means a meshwork—a 'dense tangle of trails' (Ingold 2015:82)—of interwoven lines of growth and movement, rather than a network of connections (Ingold 2010:3, 2011:63, 2015:82).

Recently, sociologists have recognised the cultural contingency of social ties and network structure, but also the disconnect between sociological approaches that view culture as a 'dynamic process of meaning-making' and empirical social network analysis that has tended to ignore action and agency and treat social networks and culture as discrete realms rather than together (Pachuki and Breiger 2010:206). In response, some authors have identified the concept of 'cultural hole', which denotes 'contingencies of meaning, practice, and discourse that enable social structure' (Erikson 2013:219; Pachucki and Breiger 2010:215). Culture 'prods, evokes, and constitutes'

social networks in ways that can be modelled by new analytic methods, known in SNA as third generation (Pachuki and Breiger 2010:207). Such relational approaches seek cultural explanations as well for the structural presence—or absence—of ties.

4.5.2 Network analysis and maritime connectivity

As introduced in Chapter 1, the Mediterranean has been seen as a space of connectedness subdivided into territories (Braudel 1972). These territories are composed of interconnected micro-regions that vary in size ‘from small clusters to something approaching the entire Mediterranean’ (Horden and Purcell 2000:123). For some time, archaeologists have been concerned with the visualization of maritime contacts in order to create accurate contexts wherein the network models can be better interpreted. Two good examples are Stanford University’s ORBIS project (www.orbis.stanford.edu), the geospatial network model of the Roman world (Scheidel 2012), and Justin Leidwanger’s (2013) GIS modelling of sailing times and distances in Cyprus during the sixth century B.C. On the other hand, SNA models can reveal additional information through nodal attributes. A study of Sardinian obsidian circulation and early maritime navigation in the Neolithic, for example, used SNA to identify the strengths of inter-site relationships through time based on common patterns of obsidian exploitation (Freund and Batist 2014). The study showed strong evidence that Neolithic mariners were capable navigators by as early as the fifth millennium B.C., traveling upwards of 200 km across open water. Network models also have been used to demonstrate their limitations. In researching maritime networks in Early Medieval northern Europe, for example, Sindbæk (2015:112–113) used a small-world model visualization to interpret links between sites (e.g., the co-presence of one or more artefact types) as an expression of joint affiliation.

In this thesis, maritime network analysis is introduced as an appropriate approach to explore connectivity for sea and coastal spaces. The use of SNA in this research affects not just its theoretical framework, but also its methodology (as will be seen in next chapter); the ‘relationship between the past phenomena and network data representation (methods) are separated’ (Brughmans et al. 2016:7) (**Error! Reference**

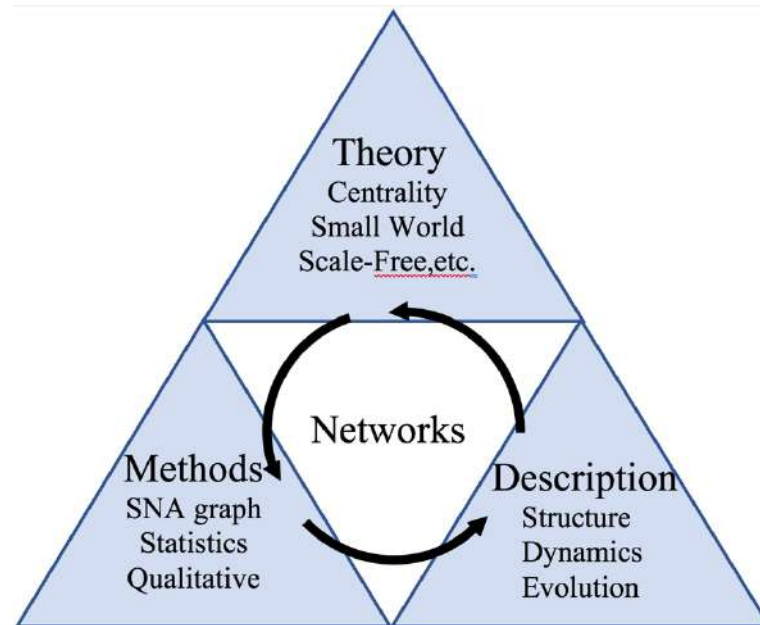


Figure 4.6. Network theory framework (after Sindbæk 2015:106 fig. 1).

source not found.). Questions arise, though, when trying to implement specific analysis within this theoretical framework; namely, how to find adapted archaeological contexts of mobility and exchanges? The answer is two-fold: first, by studying transport contexts and, second, by studying the emporia context—in short, by using information provided by shipwrecks and contact zones/harbours (Gras 2000:22). Maritime archaeologists (e.g., Leidwanger et al. 2014) have turned their focus to studying maritime trade and associated interactions through inter-regional and local trade based on ‘nodes of density in a matrix of connectivity’ (Horden and Purcell 2000:393) in order to reveal participants and mechanisms of exchange within these complementary economic spheres. Harbour and contact zones can be interpreted as nodes in a matrix where diverse cultures converged. On the other hand, it can be questioned whether shipwrecks represent nodes or links. Carrie Fulton (2016:9) argues that shipwrecks must be interpreted as ‘an intertwined system of multiple ports with multiple nodes of production and distribution for each item on board’ instead of a static dot in a map. Without categorically specifying the Rochelongue material assemblage as resulting from a shipwreck, this research adopts a similar interpretation of contact zone (chapter

3), viewing it as representing multiple ports and multiple stages of production, consumption, and distribution for each item in the assemblage.

4.6 Conclusion

This chapter reviews the application of a network analysis approach in archaeology. This theoretical approach permits an abstraction of the phenomena being studied and facilitates a direct analysis of the relationship between humans and (non-human) things. This perspective fits into the overarching framework of this study—materiality. In practice, this analytical approach can be incorporated easily into the study of how actor networks and network structures interact and impact upon each other (Mills 2017:380). Using the Rochelongue material as a case study, links between actors illustrate the flow of material goods, information, power, influence, social support and social control. By exploring the relationships between the structural positions of actors in a network and the moment at which they adopt an innovation, this theoretical framework and model will help to reveal information about developing relationships in maritime trade during the past.

CHAPTER 5. METHODS

This chapter describes the multiple methods used in this research starting with the standard typological assessment of artefacts (ingots/raw materials and manufactured goods) from the Rochelongue collection. The chapter then discusses the rationale behind the selection of samples from metal artefacts and how they were recorded and analysed by scientific techniques, such as lead isotope analysis (LIA), inductively coupled plasma mass spectrometry (ICP-MS) or manual energy dispersive x-ray fluorescence (EDXRF) for provenance studies. Finally, this chapter outlines the archaeological application of data using a geo-referential information system (GIS) and social network analysis (SNA) to create a maritime connectivity model (MCM) that uses material culture as a proxy to analyse cultural interaction and mobility.

5.1 Introduction

As presented in the literature review (Chapter 3), the Rochelongue site still lacks a conclusive cultural ascription or depositional characterisation—such identification probably remains unlikely as outlined in previous chapters—. This research aims to move beyond such questions, deeming them superfluous to the higher level of interpretation that the site material affords. Specifying a cultural affiliation for the site is largely meaningless in light of the heterogeneous nature of the material, which likely reflects a variety of contacts with local, continental, and eastern Mediterranean cultures. Similarly, differentiating between the site as a ritual deposit or commercial venture (shipwreck) is probably unhelpful, given that it is improbable that any such distinction was made in antiquity as commercial or other transactional practices and rituals were likely intertwined. Thus, a new research framework is necessary to open the site to interpretations based on broader socio-economical perspectives. The proposed approach is to treat Rochelongue as a ‘contact site’ and the material culture as representative of a ‘zone of interaction’.

Within this framework, this research analyses the Rochelongue metal assemblage using a combination of geographic, social, and material culture methodologies in order to reach a more in-depth interpretation of the site and explore its broader implications for culture contact and maritime connectivity. Cultural interactions based on seaborne connectivity (c.f. Arnaud 2005; Braudel 1972; Horden and Purcell 2000) cannot be approached without an analysis of the geographical configurations of coastal spaces. Then again, for the purpose of explaining these phenomena in a broader sense and avoiding environmental (geographical) determinism, maritime connectivity in the past must also be considered from materialistic and social perspectives (Leidwanger 2013:3303). Beyond the physical, an idea that individuals are integrated into webs of social relations and interactions (borrowed from the social sciences), can play a pivotal role in understanding complex systems (Borgatti et al. 2014:4). By combining SNA with Actor Network Theory (ANT), people and things can be brought together both methodologically and theoretically (see Chapter 4), since ‘from ANT we have an effective means for thinking through the distributed nature of socio-technologies’ and from SNA ‘we acquire an explicit methodology for characterizing connections’ (Knappett 2011:9).

Knappett’s statement expresses the last level of this analysis of maritime connectivity: materiality, understood here as an analytical concept simultaneously acknowledging technological and anthropological factors of artefacts (see Chapter 4 section 4.3) (Jones 2004:330). Considering that metal artefacts comprise almost the entirety of the assemblage associated with Rochelongue, EDXRF, LIA and ICP-MS are proposed as effective methods for investigating the provenance of these archaeological materials (Gale and Stos-Gale 2000:503; Stos-Gale and Gale 2009:203). The data set resulting from such provenance studies can be used to complement the efficacy of a standard typological approach that distinguishes between local and external metallic products.

5.2 Permits and collaboration

This thesis was undertaken in collaboration with the Ephebe Museum at Cap d'Agde, France. The necessary permissions were obtained from the French Ministry of Culture, from the Museum and from the Department of Underwater and Subsea Archaeological Research (*Département de recherches archéologiques subaquatiques et sous-marines*, or DRASSM) to study the collection (copies of approvals/permits provided in Appendix 5). The formal agreement signed with the Museum and DRASSM provided access to study the Rochelongue material and excavation archives and to sample a number of materials for analyses. This research also was part of a cotutelle agreement between Flinders University and the University of Cadiz. This co-joined programme was essential to have access to a dedicated computer laboratory that could process the data with GIS and network modelling software. Finally, elemental and lead isotope analyses were conducted by SGIker (General Research Services) at the Geochronology and Isotope Geochemistry Research Facility of the University of the Basque Country (UPV/EHU), Spain.

5.3 The catalogue

The Rochelongue assemblage consists of 4,640 catalogue entries, which correspond to a total mass of 1.3 tons, a weight amount that differs slightly from prior publications (see Chapter 3). A number of pieces detailed in Bouscaras' inventory¹⁰ are missing, while others associated with the Ephebe Museum collection are excluded because they were not mentioned in the original inventory and therefore their provenance is uncertain (for more details, see Chapter 6).

In the past three decades, metals research has developed extraordinarily in three directions: the paleo-metallurgy, restoration, and paleo-manufacture. The approaches taken to address the assemblage in this research are twofold; on the one hand determining their paleo-manufacture (Guillaumet 2003) and on the other hand

¹⁰ 1964–1970 excavation reports, DRASSM Archives (see Chapter 3:9–16 for a summary of this diary).

grouping the artefacts by functional categories (Table 5.1), in order to simply evaluate the minimum number of individuals (MNI) and determine the socio-economic domains

Table 5.1. Group divisions for the Rochelongue artefact catalogue (after Bataille 2007:346 Fig.2).

Category	Family	Type
Jewellery and Clothing Accessories	Clothing Jewellery	Fibulae, Belt Buckles, Pins Bracelets, Rings, Torques, Pearls
Tools and Handcrafts	Woodwork	Chisels, Adzes, Axes, Scissors, Others
	Agriculture and Farming	Adzes, Axes, Sickles, Shovels, Others
	Metal Handcraft	Hammers, Anvils, Piles, Chisels, Gravers, Others
Domestic Utensils	Cutting Preparation Cooking Service	Knives Hooks, Forks, Strainers Cooking Pots, Grills Plates, Cups, Others
Transportation	Horse Harness Chariot	Snaffle Bits, Rings Wheels, Wheel Tyres and Guides
Hardware	Locksmith / Frames	Keys, Metal Plaques, Mechanisms, Hinges, Others
	Construction	Chains, Crochets, Nails, Others
	Diverse	Shafts, Scrap, Slag, Others
Jewellery and Clothing Accessories	Clothing Jewellery	Fibulae, Belt Buckles, Pins Bracelets, Rings, Torques, Pearls
Tools and Handcrafts	Woodwork	Chisels, Adzes, Axes, Scissors, Others
	Agriculture and Farming	Adzes, Axes, Sickles, Shovels, Others
	Metal Handcraft	Hammers, Anvils, Piles, Chisels, Gravers, Others

to which they are related. This research has opted for a typological and a social approach. A difference of treatment is perceptible according to the generally well-known 'standard' visual characteristics. In this sense, authors such as Benjamin Jennings (2016:90) argued that decorative elements used on bracelets, for example, can be used to assist with the identification of artisanal traditions, regional or community preference and the selection of specific designs. This study applies attributes from style and design following recent publications as criteria to recognise a number of principal types (Guilaine et al. 2017). Although, as mentioned above, while it

is possible to perceive the adscription of certain types of bracelets to specific geographical areas, it is necessary to have more extensive regional catalogues to establish a more consistent distribution map of these objects (Guilaine et al. 2017:28).

In this sense general typological groups were created. Bracelets and other objects with clear characteristics, such as socketed axes or weapons artefacts, were consequently grouped under their specific different types. Non-decorated rings, or other objects fragmented in several pieces or directly non-identifiable due to the corrosion, however, were considered as a 'diverse' group. Finally, during the cataloguing, artefacts were grouped by determining the MNI.

5.3.1 Metals recording

The study of quantitative and technical features of a metal assemblage are essential to complete the understanding of the production and consumption of the objects. They provide additional insights into the definition of the corpus, often considered only through their typological aspects. The functional presentation of the different categories and types of metal objects associated with assemblages are in this sense an illustration of the society (Bataille 2007:345; Bataille and Guillaumet 2006:126; Briand et al. 2013:3). In the case of metal hoards during the Bronze Age, there is some consensus on seeing 'artefacts' as an expression of ritual behavior. 'Raw metal', however, still provokes interpretations as a material collected for recycling (Dietrich 2014). The range of artefacts available in an assemblage, allows the identification of the different practical activities represented on the archaeological site giving us the opportunity to link the archaeological context with a functional sphere whether trading, domestic or ritualistic (Guillaumet 2003).

Each piece was initially examined macroscopically. Two excel files were created: one for object measurements and a second one for categories and information to calculate total % mass and MNI. The vast majority of the artefacts were restored during the years after the salvage so any possibility of evaluating their state of corrosion or existence of sediments inside or on the surface, was impossible. In the catalogue (Appendix 1), each piece is the subject of an individual artefact sheet, or entry, that

includes the object's inventory number, a short description, primary dimensions, photograph(s) and an illustration, if necessary (Figure 5.1). The technical drawings covered a front view, a section, and a profile. The publication of the artefacts (Photographs/Illustrations) in this thesis is based on a selective sorting of the material and a storage by type predefined before the commencement of the study.

The screenshot shows a digital form for an object catalogue entry. At the top, it reads 'Catalogue Rochelongue Shipwreck', 'Enrique Aragon Nuñez', and 'Flinders University - Australia'. The 'Research number inventory' is 'RCH1.2017.00850'. The 'Artefact Typology' is 'Fibulae', 'Family' is 'Jewellery and clothing accessories', 'Category' is 'Jewellery', and 'Weight_kg_' is '0.008'. The 'Length' is '7.60' and 'Width' is '2.00'. The 'Description' is 'Double spring fibulae that conserves the two springs and mechanism of needle along with the main body.' There is a photograph of the object next to a 7cm scale bar. Below the description, there is a 'Metal Sample:' field with 'S0041'. To the left, there are checkboxes for 'LIA', 'XRF', and 'SEM', all of which are checked. To the right of the 'Metal Sample' field, there are two technical drawings: a line drawing of the object and a photograph of the object with a scale bar.

Figure 5.1. Example of object catalogue entry (by author).

5.3.2 Minimum number of individuals

The determination of minimum number of individuals (MNI) followed the methods developed by Gerard Bataille (2006, 2007). The study of the metal assemblage from Rochelongue presented two major problems:

1. The quantity, variety and the state of conservation of the objects: Apart from the objects restored and on display in the museum, the rest of the material was stored in plastic bags or boxes packed into crates, some twenty in total. As for the copper fragments, a total of 3,000 pieces were on display (Figure 5.2A), with

no previous documentation and intermixed with anachronic artefacts (e.g., nineteenth-century copper sheet).

2. Previous attempts at counting and analysing without any comprehensive and systematic method: Jean Guilaine and his team (LabEx ArcHiMedE) previously attempted some tests by counting, but the results of their sampling have yet to be published. Elemental analysis also was attempted during the 1970s, but the results were limited by the technology of the time (Junghans et al. 1974).



Figure 5.2. A) Copper ingots and fragments; B) bronze axes on display in the Ephebe Museum at Cap d'Agde, France (photographs by Frederique Nicot).

As a consequence, the first phase of this work was to identify and classify the fragments of objects using the aforementioned categorical methods and determination of MNI. This process, together with the archaeological information, determined which artefacts were the most relevant for sampling and analysis.

The basic rules of quantification to establish the minimum number of metallic individuals are quite simple. The first step is recognising each fragment and then classifying it by its family of objects; this makes it possible to determine the number of remains. The elements found in larger quantities make it possible to estimate a global MNI, by type of object, without reference to the chronological or stratigraphic levels. Secondly, it is possible to weight this global MNI by a precise typo-chronological analysis; thereby, enabling an adaptation of the criteria to discriminate according to the preservation condition of the objects. Field data can also be used in this weighting to establish MNIs by structure, area, or stratigraphy. In the case of Rochelongue, the field data is restricted by limitations in the early stage of the excavation and methods used to record the data, which were somewhat inaccurate.

This MNI method seems to be a fairly straightforward process, but in practice it is not so simple. The great variability of the metallic objects, as well as their state of preservation, most often fragmentary, complicate the task. Depending on the object type, the discriminating elements are based on dimensions, as well as on the complexity of the object, thereby becoming more or less numerous. The determination of the MNI of fibulae and bracelets, two of the most frequent types in the Rochelongue assemblage, do not have this same complexity, as demonstrated by the following examples.

Example 1: Determining the MNI of fibulae

Fibulae comprise several elements: a spring (or hinge), arch, foot and barb. These different parts have typological variations that provide good chronological markers. Care must be taken, since an element can be found in several fragments. Before any global count, therefore, it is necessary to establish the number of remains of the different parts. This, then, is the most represented element that will give the overall MNI of the fibulae. Counting by type—de facto, then, chronologically—is facilitated by establishing the theoretical characteristics that differentiate the different elements. This makes it possible to obtain an MNI weighted by the typology of the objects. To find the most relevant MNI, it is necessary to determine the typology of all the elements in

the collection. However, this is not possible in all cases, as the elements are not always attributable to a specific type.

Example 2: Determining the MNI of ring-type objects

For ring-type objects (rings, bracelets, armbands, etc.), it is necessary first to note the shape and thickness of the sections when identifying types. This makes it possible to determine the fragments that can theoretically belong to the same individual specimen. Within the groups thus defined, it is necessary then to classify each element according to its arc of curvature and its preserved length in order to determine the diameter of the complete object. To count an individual, these three data points must correlate. For each type, the fragments that, when virtually assembled, form a circle, give an MNI of one (e.g., two semicircles of the same type and diameter). This method is valid for ring-type objects that are not distinguished by a specific morphology or decoration.

Once the MNIs of the different types of artefact are established, they are grouped in so-called the functional categories. These are large families of material culture, such as weapons, tools, and ornaments. The details of the different categories and types of associated objects are summarised in the Table 5.1.

The work of identification and registration of the palaeo-manufactured metal allows the gathering of a large amount of data. This approach creates a catalogue based on techno-typological classification using identifiable and repetitive manufacturing processes. In techno-typology, the unique object does not exist, but necessarily belongs to a group linked by manufacturing processes. This group is established on the basis of criteria related to the manufacture and operation of the object. Secondly, the comparison between the initial shapes and the manufacturing stages makes it possible to group objects into large families.

The study of the assemblage using MNI in association with technological typologies creates object sets that characterise the site and its overall functionality. The works carried out using this method make it possible to specify in a certain way the presence of craftsmen or metalworkers and their activities.

5.4 Provenance studies (LIA, EDXRF, ICP-MS)

The purpose of the proposed metallic chemical and microscopic analyses is to generate new information on the sampled metallic objects. In the case of raw/semi-processed copper, which is represented in large numbers at the Rochelongue site, the sampling and analyses enabled comparative studies with existing data on local mining activities (Ambert 1995; Guilaine et al. 2017; Verger and Pernet 2013), with well-studied external archaeological contexts, such as mined ores from the southwest Iberian Peninsula (Hunt 2003; Montero Ruiz and Renzi 2012; Montero Ruiz et al. 2012b; Murillo-Barroso et al. 2016; Renzi et al. 2012), and with other potential sources from the rest of the Mediterranean (Gale and Stos-Gale 2000; Stos-Gale and Gale 2009). To complete the full scope of this chemical and microscopic investigation, a selection of belt buckles, fibulae and other manufactured artefacts were sampled, as they represent a diagnostic artefact group linked to Oriental cultural contact and influence (Almagro Gorbea 2010; Arnal et al. 1970:50; Duval et al. 1974:22–41; Rafel et al. 2008:244).

The qualitative and quantitative data gathered from analysis of the metal samples allowed a provenance study of the collection's metallic material and highlighted the connection between potential ore sources and the ultimate context of use. The analytical results provided valuable numerical data (e.g., chemical composition of the alloys) that can be compared to categorical data, such as typology, geographical area and archaeological context.

The techniques used in the metals provenance study were numerous. The identification of source or technology are important for assessing production, trade and use/consumption, but also for establishing the similarity network model and understanding the interaction of the diverse actors involved in metals trading.

When comparing ancient metals with potential mineral ores, it is essential to consider the sensitivity of these metals to the variables of their technological trajectories, such as oxidation, volatilisation and metal-slag affinity during metallurgical operations, which can make it difficult to identify their relation to a specific ores (Pernicka 1999, 2014). For this reason, the order of magnitude of minor and trace elements is

considered more important for provenance studies than total composition. This method values compositional data, especially for corroded samples, which offer important supporting evidence to LIA data in the discussion of provenance (Pernicka 2014).

5.4.1 Portable energy dispersive X-Ray fluorescence (EDXRF)

This application allows for the elemental characterisation of materials. One major issue with the application of EDXRF for archaeological material is surface sensitivity, which in the case of metals (due to surface corrosion) can be a critical restriction (Frahm and Doonan 2013; Malainey 2011:485; Nørgaard 2017). Still, EDXRF is suitable when used as a preliminary analytical survey technique (Pollard and Heron 1996:48–49). The Rochelongue artefacts selected for sampling were analysed using pEDXRF to establish whether they were possible alloys by assessing composition and additives. Furthermore this analysis allowed a technological assessment, differentiating between direct or indirect procedures used for the manufacture of the metal (Edwards and Vandenabeele 2012:80). Finally, this process was applied to a total of 91 samples that assisted in the selection of the most significant artefact for further testing.

The data set was measured using a handheld X-ray fluorescence (XRF) spectrometer (INNOV-X Alpha) (**Error! Reference source not found.**A) from the National Archaeological Museum of Spain. This device was equipped with an X-ray tube and silver anode with working conditions of 35kV, 20 μ A. The acquisition times were set at 40 seconds and the values of the quantitative data were calculated from a validated calibration with certified patterns. Results of the analysis are expressed as weight per cent (wt%) for each of the elements detected (Appendix 3, Table 1). For silver (Ag) and antimony (Sb), the detection limit is 0.15 wt%, but for the rest of the elements the limit of detection is 0.02 wt%. The error in the measurements is approximately $\pm 1\%$ for the majority elements and $\pm 2\text{--}5\%$ for the minority elements. Measurement error for elements of composition below 0.1 wt% can reach $\pm 40\%$.

The surface of corroded bronze ornaments consists mostly of copper carbonates, oxides, and chlorides. Chemical processes change the elemental composition in such a

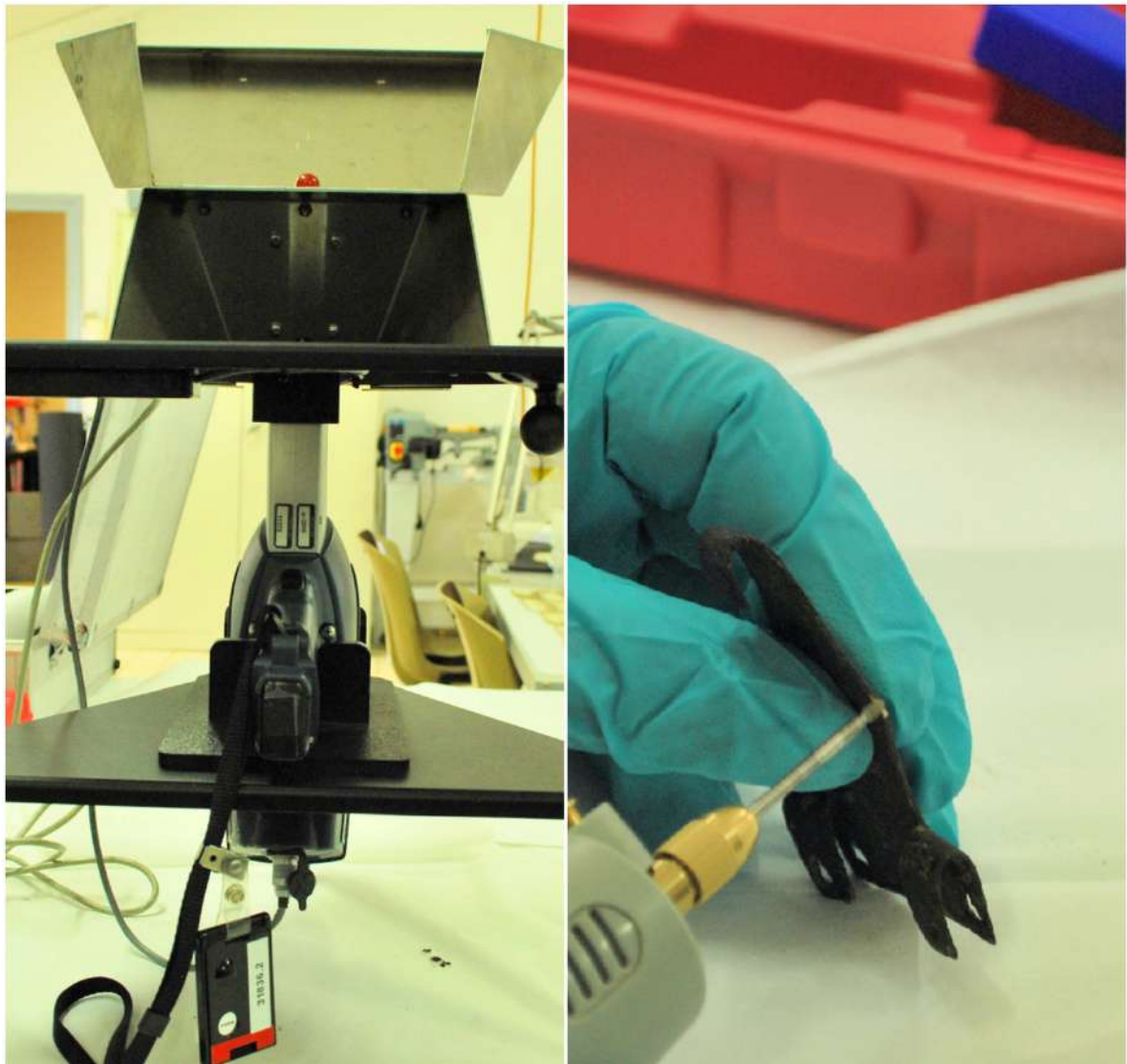


Figure 5.3. XRF analysis apparatus and process: A) INNOV-X Alpha spectrometer; B) artefact surface polishing (photographs by author).

manner that the original alloy cannot be traced using a non-destructive method (Nørgaard 2017). For this reason, a small sample of the artefact was extracted and its surface polished before the measurement was taken.

5.4.2 Lead isotope analysis (LIA) and inductively coupled plasma mass spectrometry (ICP-MS)

Forty samples from the Rochelongue assemblage were selected for LIA and ICP-MS analyses. These techniques are used to identify proportions of different isotopes of the same element, which can provide insights into the provenance of archaeological

materials (Doonan and Dungworth 2013:67). LIA has been applied to identify ore deposits exploited for the production of metals in antiquity (Pollard 2007:192–194; Pollard and Heron 1996:322–340). The identification of potential mining ores, i.e. provenance, and context of use is possible via direct comparison with available lead isotope databases (Ling et al. 2014:116). Some lead isotope data for the west Languedoc region is publicly available (Ambert 2001; Ambert et al. 2001), as well as data from ores and metal artefacts of the same period from north-eastern, south-eastern and southern Iberia (Montero Ruiz et al. 2007; Rafel et al. 2010a; Rovira Hortalá et al. 2008; Rovira and Montero 2018). Additionally, there is lead isotope data available for galena, copper, and tin ingots from the Phoenician shipwrecks at Bajo de la Campana and Mazarrón (Polzer 2014; Renzi et al. 2009)

The study has followed the guidelines set by the project ‘Arqueometalurgia de la Peninsula Iberica’ from the Spanish National Research Council under the direction of Ignacio Montero (Montero Ruiz 2018). The study also took into account geochemical data provided by publications that addresses the geochemical area of France (Ambert 1995; Ambert et al. 2001, 2009; Guilaine et al. 2017; Verger and Pernet 2013) and the Iberian Peninsula (Hunt 2003; Montero Ruiz 2018; Murillo Barroso 2016; Montero Ruiz et al. 2012; Renzi et al. 2012). Ignacio Montero (as one of the supervisors of this thesis) also kindly provided unpublished geochemical. Only results with direct application for this research have been reported in this thesis. In this sense, data that was not considered appropriate for discussion has been set aside for future research work (see Chapter 7:230–233 for discussion).

5.4.3 Sampling method and sample treatment

All artefact samples were recorded on individual forms (compiled in Appendix 2). Sample records include artefact type and number, sample number, part of the artefact or location from where the sample was taken, method of sampling, sample weight and photographs of the artefact and sample (Figure 5.4). Museum conservator Frederique Nicot carried out all the destructive sampling of artefacts. For raw metal or waste (e.g., ingots and slag, respectively), he extracted approximately 20 mg of sample using a drill.

He used one 1.5-mm diameter titanium drill bit to drill through the exterior surface corrosion layer until he reached clean metal (Wang et al. 2016:83). He then replaced the drill bit with a clean one and resumed drilling, this time into the clean interior metal. He collected the extruded metal drill shavings as the sample.

Moïra conservation Protocole de prélèvements - Bronzes de Rochelongue
Enrique Aragon Nunez - Flinders University - Australia

S 0044 Fibule (fragment)

2013.00.365

Alliage cuivreux

N°relocalisation: AS.64.587.190

Ancien numéro: 1816

Date du prélèvement: 06/07/2017

Poids de l'échantillon: 16 mg

Poids de l'artefact après prélèvement: 2.000 g

Mode de prélèvement:

☐ Mèche en titane; 1.5 mm de diamètre

☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer:

/

Localisation du prélèvement réalisé et zoom

Photos du prélèvement

Figure 5.4. Example of the sample recording form (courtesy of Frédérique Nicot).

For all other artefacts, representing manufactured objects (e.g., axes, arrowheads and bracelets), he sampled a broken or damaged specimen, from which he took a fragment from the damaged area where the edge of the object was visible. He placed the collected samples individually into small, labelled glass vials (**Figure 5.5**) along with some vapour phase corrosion inhibitor (VPCI), in this case a small piece of a Senson P15E Vapaguard™ pad, and sealed them closed. The samples jars were packaged in an airtight container with a silica gel pack to limit humidity changes during transport to the analytical laboratory.

Ninety-four artefacts, a representative percentage of the complete collection, were sampled (Burmeister and Aitken 2012; Jedrzejewska 1961:27). This number enabled meaningful data collection and ensured that the results are statistically significant. Collaboration with the Ephebe Museum conservator was vital for minimising the impact of the sampling process, ensuring consistency throughout the process and adhering to appropriate procedures for artefact restoration.

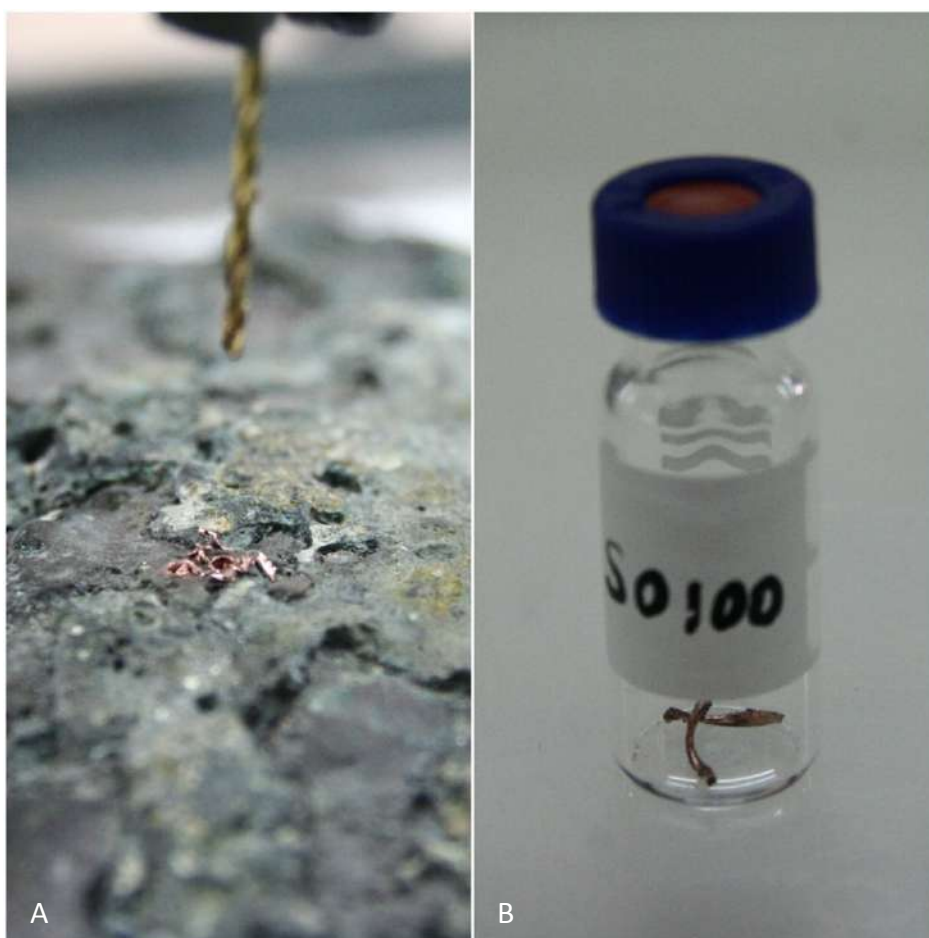


Figure 5.5. Artefact sampling: A) sample extraction using a drill; B) glass vial with a collected sample (photographs by Frédérique Nicot).

Although the sampling process is destructive, its impact, even if minimal, was mitigated by restoring the artefact using colour-matched microcrystalline wax or epoxy resin. All samples were analysed by the SGiker Geochronology and Isotope Geochemistry Facility

of the University of the Basque Country (UPV/EHU) in Spain. For ICP-MS analysis, samples were dissolved either in *aqua regia* (for Sn and Sb determinations) or concentrated nitric acid (HNO_3) (for all other elemental determinations) in a closed Savillex PFA vessel set on a hot plate at 120°C for 24 hours. Dilution after dissolution was done gravimetrically using an electronic balance with precision of 0.1 mg in order to prevent errors induced by volumetric dilutions. Quantitative determination of analytes of interest was accomplished by means of a Thermo Scientific XSERIES 2 Quadrupole ICP-MS equipped with collision cell (CCT), an interphase specific for elevated total dissolved solids (Xt cones) and shielded torch. A concentric nebulizer and quartz expansion Peltier-cooled chamber were employed. Rh and in solution, used as internal standard, and multi-elemental solutions for the initial tuning and calibration of the mass spectrometer, and for quality control (QC) of the results were prepared from 100 ppm high-purity standard solutions for ICP, stabilised in diluted HNO_3 . Internal standard was added online with an automatic addition kit in order to prevent random errors. Further details on the instrumental method are given in García de Madinabeitia et al. (2008). The recoveries in % for the QC solutions are given in the table of results. Error estimation for each element is established using the error propagation equation of Miller and Miller (2018) .

For the case of LIA the preparation of the samples was carried out in vertical laminar flow PP booths and Class A total extraction (ISO-5), located in an ISO-7 clean room. To purify the Pb, the residue of the evaporation was taken up in a 1 mL solution of 1N hydrochloric acid (HCl) and processed by liquid chromatography with Sr resin, following a protocol adapted from Gale (1996). A final solution of 0.4 mL of 6N HCl was obtained with the purified Pb, which was brought to dryness and stored until its spectrometric measurement was obtained.

The lead samples were diluted with 1.5 mL of 0.32N HNO_3 to a final concentration of 150–200 ng Pb/g solution. The preparation solutions were then introduced as wet aerosols into a Thermo Fisher Scientific Neptune MC-ICP-MS by means of a PFA micro-operator with nominal aspiration of 100 mL/min (Elemental Scientific) and a double-pass cyclonic-Scott double expansion chamber.

The actual base lines (electronica and chemistry) were subtracted from the measurements of a chemical target for 60 seconds prior to each sample. The spectrometric measurement has been carried out in 105 cycles with an integration time of 8 seconds per cycle. The instrumental mass fractionation also was corrected internally with the addition to the sample of a proportionate amount of thallium reference material NBS-997 with an isotopic ratio $^{205}\text{Tl}/^{203}\text{Tl}$ of 2.3889 (Thirlwall 2002). The reliability and reproducibility of the method have been verified by sporadic measurements of the NBS981 certified reference material interspersed with the measurement of the test sample, and under the same conditions. The average values for NBS981 of this study are listed in Table 1 in Appendix 3.

5.5 Maritime connectivity model (MCM)

A MCM is applied in this study as an approach to explore connectivity for sea and coastal spaces. The model has two parts. First a SNA based on a two-mode network and an Ego-network to analyse the 'exports' of Launacien artefacts—mainly bracelets—which is applied to visualise trade interactions at inter-regional and local scale. The SNA assists in the process of revealing participants and mechanisms of exchange within complementary economic spheres. Second, the GIS that using the environmental and technological mobility constraints applied to this thesis create cartographies and a navigational model during the LBA-EIA based on current knowledge of nautical technology for this historical time. The results of this study demonstrate the costs, as well as the navigation times, which can ultimately help to answer some of the questions posed in this research. The navigational model focuses on winds and waves, separating speed and orientation of the wind.

Both models are completed by using a similarity network analysis based on the 'coefficient of difficulty in navigation' that ultimately allows assessing the influence of different actors that could potentially intervene in the process of cultural interaction in western Languedoc from a maritime approach.

5.5.1 Network analysis model

This notion of 'network' influences not only science but also our daily lives (Prell 2013). Currently, the 'network approach' covers a range of interdisciplinary fields as diverse as computer sciences, physics, social science and digital humanities. In maritime archaeology, SNA is well established as a method (Knappett 2011), but its theoretical application to create network models is an emerging initiative (Collar et al. 2015). Social relations are channels of cultural contagion and persuasion, and as such are embedded in a diffusion process (Brughmans 2013b). In this sense, a network is a set of actor 'nodes' (humans and archaeological artefacts) with connections between them 'links'. Actors can be connected directly to each other (one-mode-network) or connected indirectly through a second category (two-mode-network). The application of the SNA model permits us to expose additional information that nodes can show through their attributes (Borgatti et al. 2009).

Generating a network model from this research addresses how maritime connectivity was manifested in material culture by stressing the important social relationships between actors. In this research, a two-mode-network was created and then converted into an ego-network-model (ENM). Manufactured artefacts were used as a proxy creating calculations on centrality, betweenness, and closeness. Both models were applied to the Rochelongue assemblage in order to generate a more in-depth interpretation of the site (Freeman 1982). These specific network models are based on a 'socio-metric method for the analysis of the direct social relations an individual engages in' (Mol et al. 2015:275). On this basis, this model combines multi-scalar data and thereby explores sites as a 'nexus of material relations' (Mol et al. 2015:275).

5.5.2 Two-mode and Ego-network-model

This research used a two-mode network, that represents ties between nodes of two different kinds (Mills 2017:383). This two-mode network is later collapsed into a one-mode network, that in this case has been represented as ego-network. Ego-network is defined as a network consisting of a node (called ego) the nodes directly connected to the ego and the edges between the other nodes (called alters) (Collar et al. 2015:21).

These two models are used to conceptualise, visualise, and analyse the direct network around one node, referred to as the ego, which in this case is the Rochelongue site. The edges connecting the site to other nodes in the network will be defined by the artefacts of the Rochelongue assemblage. The Rochelongue site is not technically a fixed node, such as a settlement, production centre, or other locale, since it represents a somewhat random event (whether as shipwreck, votive, or other deposit) that occurred along a network edge. This does not negate, however, the applicability of the ENM and is effective for representing the connections represented by the site artefacts.

Network models based on the typology/categories of artefacts enables interrogation of the dataset presenting the information in a visually accessible and intuitive structure. In order to create and identify patterns and trends in the material groups, the SNA software (Visone 2.17) was used to create network graphs connecting sites and artefact categories for visualisation and data analysis.

This research is not centred on the use of the various statistical and mathematical functions exploited in SNA (e.g. Scott and Carrington 2011), but rather to use the graph operations of Visone to produce visual representations of the connections and structure within the data (De Nooy et al. 2005). The SNA techniques, such as centrality or betweenness was applied to cluster vertices of similar strength and improving the arrangement of data for visual inspection or statistical interrogation (De Nooy et al. 2005:20–21; Krempel 2014:560).

The primary categories for nodes used in network models have been compiled from recent publications relating to Launacien and associated artefacts (Graells 2010, 2013a; Graells and Lorrio 2017; Guilaine et al. 2017; Verger and Pernet 2013). Sites can thus be related to others through co-occurrence of types, and vice versa, so that typology or sites can be related by occurrence on or of the same classes of object. The rationale behind this type of network is that it is assumed that the greater the similarity between assemblages at different sites, the greater the probability that these sites (and their populations in consequence) were in frequent or intense interaction and contact than the sites with less similarity in assemblages (Peeples and Roberts Jr 2013). Calculating

pairwise similarities between site assemblages results in a network that can be seen as a proxy for social interactions and has become one popular basis for analysing social networks in archaeology (Hart and Engelbrecht 2012; Mills et al. 2013; Mills et al. 2015; Munson 2013). In terms of the typological element data, this could illustrate the flow of material goods, information, affect, power, influence, social support, and social control (Figure 5.6). By focusing on exploring the relationships between the structural positions of actors in a network and the moment at which they adopt an innovation, this model reveals information about developing relationships in maritime trade during the past.

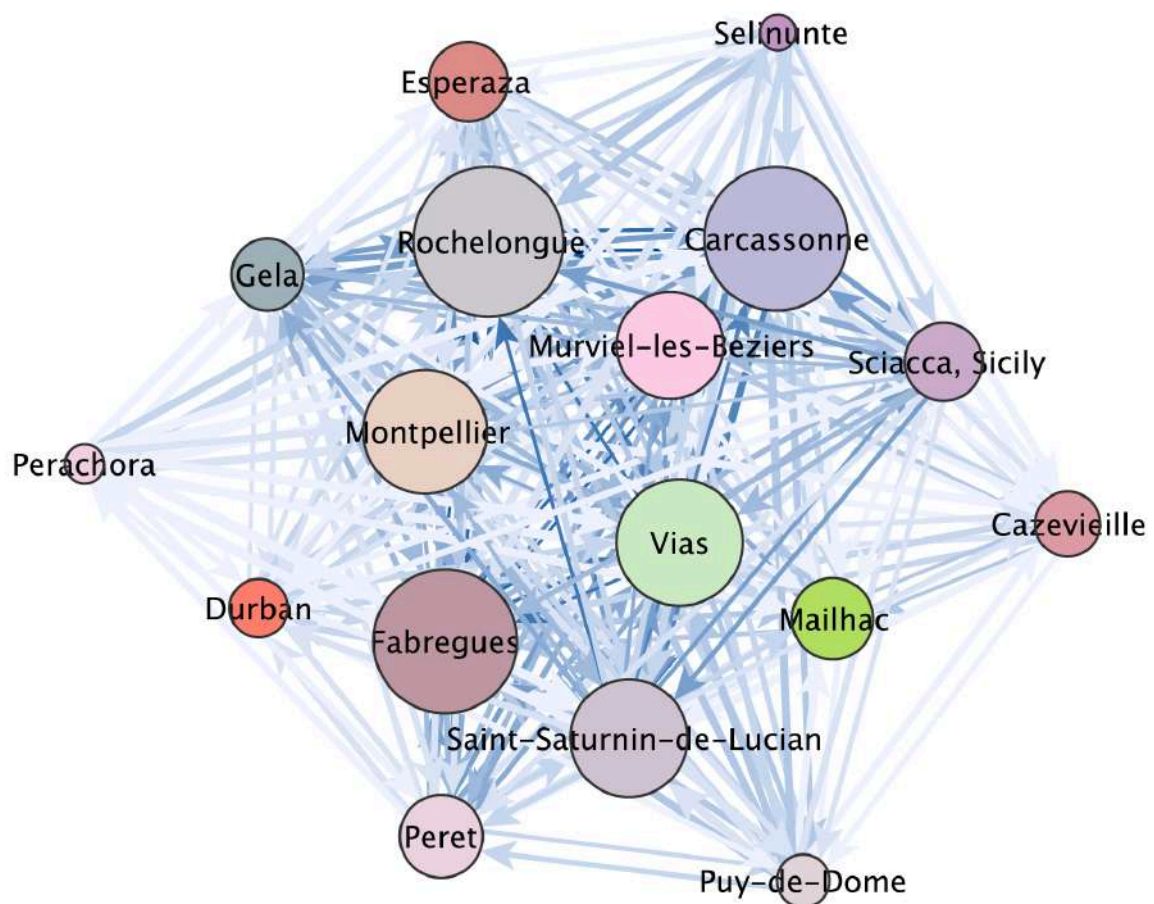


Figure 5.6. Ego-network of the Rochelongue assemblage.

Several statistical calculations can be made using SNA:

- **Centrality:** The general goal of a centrality measure is to provide a ranking of the nodes or edges, i.e. a node centrality is a function that assigns a value to each one, so that they can be ordered according to this value. Centrality measures usually exploit structures and capture the embedding of nodes or edges within the network. Centrality measures are also used in network clustering, where the goal is to provide a grouping of nodes or edges. To give a basic example the degree centrality assigns the number of links a particular node has with other nodes, e.g. if a node has ten links, it has a degree centrality of ten (Hanneman and Riddle 2005b).
- **Betweenness:** The betweenness of a node is defined as the number of times it acts as a bridge on the shortest path between two other step. Thus, nodes with high betweenness can be regarded as important waypoints on the connections between other ones but also as bottlenecks in the network (Hanneman and Riddle 2005).
- **Closeness** The closeness of a node is defined as the inverted sum of its shortest paths to all others in the network. This means that nodes with a high closeness can reach all others in fewer steps than those with low closeness in the network (Hanneman and Riddle 2005).
- **Similarity:** Similarity is used as a criteria for social connectivity/interaction. The use of this criteria allows the creation of a similarity network model that complements the ENM by describing the weighted, unweighted, symmetric, and asymmetric similarities and then rank correlations among uniformly weighted attributes (Habiba et al. 2018:64). The difficulty of navigation coefficients (obtained from the GIS model as seen in the next section) will be used as similarity measure establishing a weighted link in a range between 0 to 400 between any two nodes A and B in the network.

The diverse data set uses a script designed to use the CSV (comma separated value) file format (Appendix 3). Microsoft Excel is used to produce files in this format from any tabular data. Tables are formatted with each of the samples/sites/observations as rows and each of the categorical variables as columns. The first row of the spreadsheet is a header that labels each of the columns. The first column contains the name of each

unit. Row names have to be unique, i.e. they cannot be repeated. All of the remaining columns contain numerical count or percent data.

An adjacency matrix (Figure 5.7) is created to show the correlation between sites (Appendix 3). The adjacency matrix is then a table of rows and columns with the node labels as row and column header. When there is a link between two nodes, for example node A and node C, the corresponding cell value at row A and column C is set to 1. When there is no link between two nodes the respective cell value is set to 0. The adjacency matrix of the network would then look like the following example¹¹.

	A	B	C	D	E
A	0	0	1	0	1
B	0	0	1	1	0
C	1	1	0	0	1
D	0	1	0	0	1
E	1	0	1	1	0

Figure 5.7. An example adjacency matrix (from Visone 2017:17).

5.5.3 Use of a geographical information system (GIS) in maritime connectivity

A geographical information system (GIS) was created to assist with the geographical visualisation and interpretation of the maritime connectivity datasets. This model was developed with the help of Lazaro Lagostena and the ‘Seminario Agustin de Horozco’ research group of the University of Cadiz (<https://agustindehorozco.uca.es>), specialised in geo-spatial analysis in an archaeological-historical context.

This model allows for the testing of hypotheses and the formulation of conclusions about the strategic position of west Languedoc within the broader Mediterranean network (Gascó et al. 2014; Graells 2013a). In addition, this GIS shows variables

¹¹ In the case of undirected networks this matrix is symmetric over the diagonal, whereas in directed networks this it can become asymmetric. Instead of first it is necessary to specify a decimal value as weight for the edges.

(maritime accessibility, time, distance, etc.) that could affect interpretation of the archaeological assemblage (Leidwanger 2013:3303). Navigation time/cost has been evaluated using environmental and nautical data as a method to create cartographies and to model navigation during the LBA–EIA. Thus, the nautical capacities of a hypothetical ship, appropriate for the time scope of this research, must first be defined. Secondly, maritime mobility must be addressed, since the creation of layers for the sea encounters different problems than those associated with traditional terrestrial models.

5.5.4 The vessel

Casson (1995:282–291) and Whitewright (2011:9–10) have suggested that ancient sailing ships could sail at 4–6 knots in the open sea with favourable winds, and at 1.5–2 knots when operating against the wind (see Figure 5.8). In the case of warships, experimental archaeology has demonstrated that a ship with an average sailing speed of 5.6 knots could sustain a speed of 5.8 knots under oar for more than an hour, and could achieve a peak speed of 7 knots (Drakidès et al. 2010:96).

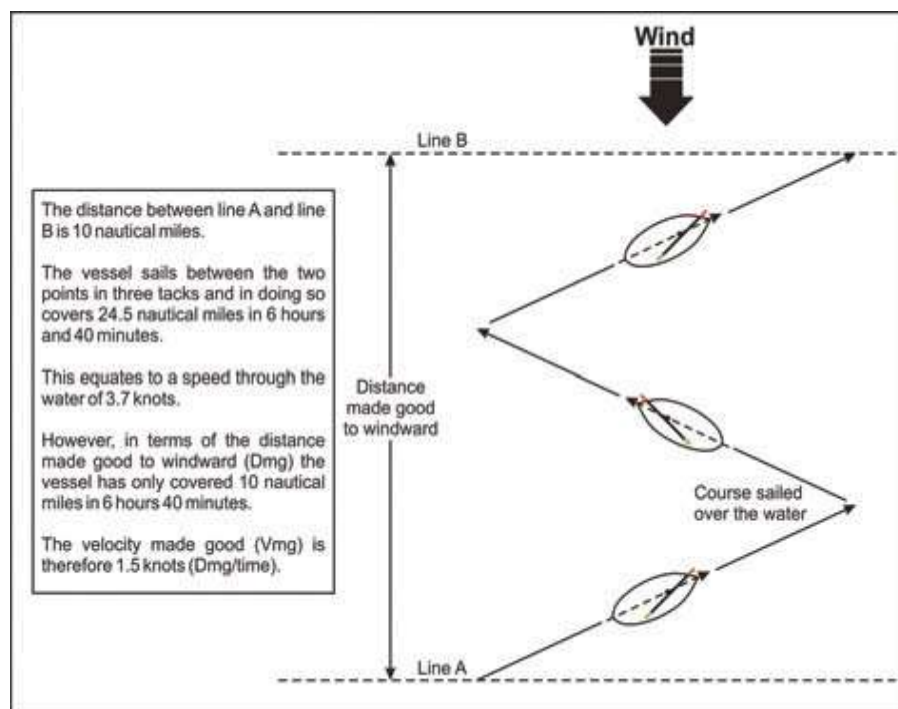


Figure 5.8. Velocity made good (Whitewright 2010:3).

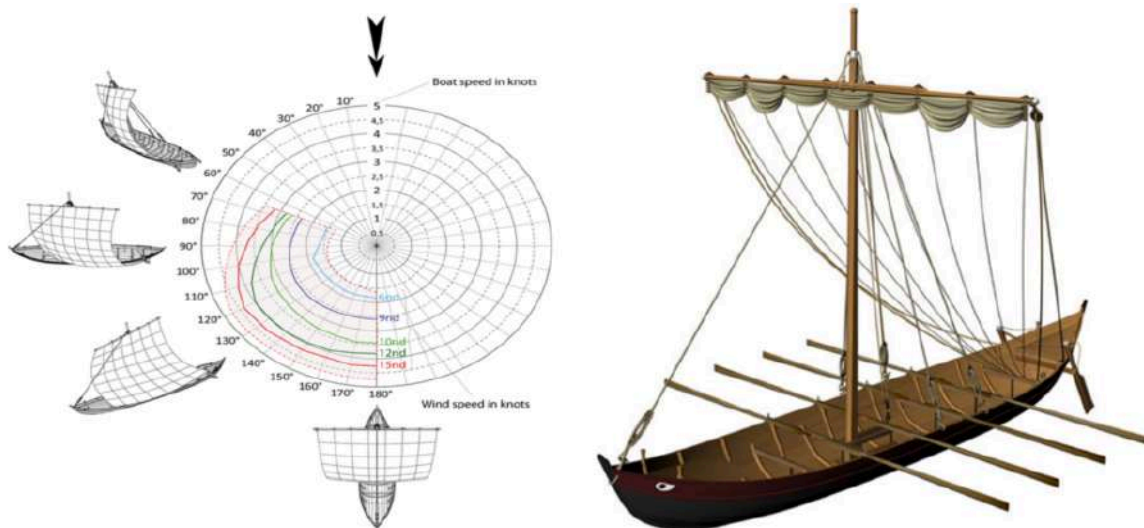
These are general approximations for navigation in antiquity, but are not specific to the LBA-EIA. For this research, the values applied to the GIS model were extracted from the sea trials of *Gyptis* (Table 5.2), a reconstruction of the Greek Jules Verne 9 ship excavated at Marseille (Pomey 2006b; Pomey and Poveda 2018).

Table 5.2. *Gyptis* specifications and sea trial results (Pomey and Poveda 2018:54 table I).

Boat dimensions	Length Overall	9.85 m
	Breadth	1.88 m
	Draught	0.29 m
	Height Overall	6.80 m
	Freeboard	1.0 m
	Displacement	0.75 tons
	Ballast	0.72 tons
	Tonnage	1.6–2.0 tons
Sail dimensions	Width	4.5 m
	Height	5.5 m
	Area	24.75 m ²
	Basic weight	410 g/m ²
Speed under oars	4 rowers	2.5 knots
	6 rowers	3.5 knots
Speed under sail	Travel speed	2.5 knots

The model is restricted to cabotage navigation for small boats dating between the seventh and sixth centuries B.C., for which the most abundant evidence exists (Nantet and Pomey 2016:107). These parameters also allow the model to be based on a restrictive navigation criterion, such that the results present the most conservative scenario.

Based on archaeological evidence from the Jules-Verne 9 shipwreck, dated to the last quarter of the sixth century B.C. (525–510 B.C.), *Gyptis* is the most reliable and best tested reconstruction available for a boat of this period (**Error! Reference source not**



found.). Various experimental trials provide detailed data on its technical capabilities

Figure 5.9. A) Polar diagram summarising *Gyptis'* capacities at different points of sail (Pomey and Poveda 2018:54 fig. 13); B) 3D rendering of *Gyptis*, the reconstruction of the Jules-Verne 9 shipwreck (Pomey and Poveda 2018:50 fig. 7).

(Pomey and Poveda 2018). Information obtained from the publications of the reconstruction and sea trials (

Table 5.3) is highlighted as follows:

- Nautical characteristics:
 - Quarter rudders (steering oars) are effective in controlling the ship;
 - The square sail performs best with sustained winds at the stern; and
 - Based on the nature and shape of the keel, the boat's ability to overcome the wind without leeway is reliable up to 75 degrees.
- Speed:
 - The boat's maximum rowing speed is 3.5 knots;
 - The boat's speed under medium breeze is 5–6 knots; and
 - The boat's low freeboard restricts its operational ability to winds and seas of no more than 15 knots and 1-m waves, respectively.

- Tonnage

- The maximum tonnage of a small boat like this is approximately two tons. Although there are larger examples from this period, even one (Jules-Verne 7) excavated alongside remains of another boat from the same time period (the Jules-Verne 7 ship) of twelve tons that is more suited to long-distance trade, but as there is no replica. For this reason and because the model was restricted to cabotage this second example has not been used.

Table 5.3. Estimated tonnage for shipwrecks dating from the seventh and sixth centuries B.C. (Nantet and Pomey 2016:108, table 24).

Shipwrecks	Chronology (B.C.)	Location	Cargo	Tonnage (tons)
Tanit	750–700	Israel	Homogeneous (amphorae)	>10
Elissa	750–700	Israel	Homogeneous (amphorae)	>10
Mazarrón 1	650–600	Spain	Heterogeneous	2.5
Mazarrón 2	650–600	Spain	Heterogeneous	2–2.8
Rochelongue	650–550	France	Heterogeneous	1.3
Giglio	600–580	Italy	Heterogeneous	?
Bajo de la Campana	650–600	Spain	Heterogeneous	>2
Pabuç Burnu	600–550	Turkey	Heterogeneous	16
Bon Porte 1	540–510	France	Homogeneous (amphorae)	1.5
Pointe Lequin 1A	530–510	France	Homogeneous (amphorae & pottery)	4–5
Cala San-Viçent	530–500	Spain	Homogeneous (amphorae & pottery)	30
Jules Verne 9	510–500	France	Homogeneous (amphorae & pottery)	2
Jules Verne 7	525–500	France	Homogeneous (amphorae & pottery)	12.2
Grand Ribaud F	510–490	France	Homogeneous (amphorae & pottery)	40
Gela 1	500–490	Italy	Heterogeneous	40

-

5.5.5 Modelling distance and time across the sea

Over the past few years, the use of isochrones has been used in several studies to create mobility models, as an effective visualisation of time and distance (Leidwanger 2013; Safadi 2016). The tools from GIS allow us to analyse mobility, by associating a series of values within a raster layer of the terrain. In the case of this research, it was necessary to create a layer where the terrain is the sea and the values are represented by variables that condition mobility. In the case of land, it is usually the slope of the land, but for the sea, factors of winds and waves, including separating speed and orientation, was applied. Beyond errors introduced by data interpolation and the scale of the study, there is an assumption that the current environmental conditions are similar to the ancient ones and, therefore, can be used to model palaeoclimatic conditions (Murray 1987).

Data was collected from the European Centre for Medium-Range Weather Forecast (<https://www.ecmwf.int/en/forecasts/datasets/browse-reanalysis-datasets>) and used to build the model, enabling the creation of four main layers of information:

1. Significant height of combined wind waves and swell;
2. 10 metre U wind component;
3. 10 metre V wind component; and
4. 10 metre wind gusts since previous post-processing.

These layers were converted to a raster tagged image file format (TIFF) compatible with ArcGIS software. A representative sample was selected, making the mean of ten years every two years from 1992 to 2010 and taking the first of every month that may correspond with the four seasons of the year starting on the first of January, first of April, first of July and first of October. The information provided by this raw data gives information on wind speed, wave height and the two components of wind direction (which are reclassified in the same layer, expressing the angle of the wind direction

being 0 degree to the north). The process to assess distance costs requires the consideration of these four parameters. This information, for each of the four samples per station, is reclassified according to the values in **Table 5.4**.

Table 5.4. Wind transformation values.

Wind speed (knots)	Vessel speed (knots)	h/m
0.5	1.5	36
1	1.5	36
1.5	1.5	36
2	1.5	36
2.5	1.5	36
3	2	27
3.5	2.5	21.6
4	3	18
4.5	3.5	15.4
5	4	13.5
5.5	4.5	12
6	5	10.8
6.5	5.5	9.8
7	6	9
7.5	6	9
8	6	9
8.5	6	9
9	6	9
9.5	6	9
10	6	9
10.5	6	9
11	6	9
11.5	6	9
12	6	9

Wind speed is the main parameter, since it provides the boat's propulsion and overwhelmingly is the most determinant factor for the speed of the boat. A minimum boat speed of 1.5 knots is set for low (or no) wind, which is the average speed achieved simply by rowing. Even though researchers estimated a rowing speed of 2.5 knots for *Gyptis*, the model uses the more conservative minimum speed to better reflect coastal navigation and local LBA-EIA nautical capabilities. Looking at the table values overall, it is clear that high winds (over six knots) will severely restrict the sailing route of a vessel

with a maximum speed under sail of six knots. Such conditions are most likely to be encountered in open-sea navigation, but since the case study here is modelling cabotage/coastal sailing, lower wind speeds are more typical.

ArcGIS software uses inverse velocity values (hours per metre) to calculate an isochrone map (depicting areas of equal travel time). Thus, a value of 1 in the resulting raster corresponds to one metre distance per one hour. Boat and wind speed values, then, must first be converted to standardised values, which is accomplished as shown in **Table 5.5**. Speed is converting from knots to kilometres per hour (1 knot = 1.852 km/h) and then inverted to h/km. Finally, the result is multiplied by 100,000 (1×10^5 , or 1E05) so that the input values are scaled to an appropriate magnitude for reclassifying the raster, and rounded to simpler numbers greater than one.

Table 5.5. Transforming values for raster.

knots	km/h	h/km	h/m	h/m × 1E05	Round
6	11.112	0.089993	9.00E-05	8.99928006	9.0
5.5	10.186	0.098174	9.82E-05	9.81739643	9.8
5	9.26	0.107991	0.000107991	10.7991361	10.8
4.5	8.334	0.119990	0.00011999	11.9990401	12.0
4	7.408	0.134989	0.00013499	13.498921	13.5
3.5	6.482	0.154273	0.00015423	15.427332	15.4
3	5.556	0.179986	0.00017998	17.99856	18.0
2.5	4.63	0.215983	0.00021593	21.598271	21.6
2	3.704	0.269978	0.00026998	26.997842	27.0
1.5	2.778	0.194369	0.00035991	35.997122	36.0

The second factor to be considered is wave height. The type of vessel assumed for this model would have had serious troubles navigating seas with waves higher than 1.5 m. Table 5.6 shows a standardisation of wave height values for the ArcGIS software input. The standardised value essentially is a multiplier that penalises a particular path of navigation based on sea conditions. Areas of the sea beyond the navigable zone (i.e., in sight of land) could have been excluded from the calculation, but instead were included

to serve as a limit parameter. This raster is multiplied by the previous one for wind speeds, such that for values for which wave height is normal, the cost multiplier is one (no impact), whereas for those values that lie outside this range, the cost multiplier is five. The multiplier is standardised such that the minimum speed of the boat, no matter the conditions, is 1.5 knots.

Table 5.6. Standardised values for wave heights.

Wave height (m)	Value
0.09–0.50	1
0.50–1.50	1
1.50–1.87	5
1.87–2.47	5
2.47–3.30	5

The third factor to be considered is wind direction. Wind direction relative to the path of travel differs from the other parameters in that it is a horizontal cost factor multiplier (ArcGIS Cost Distance tools). It limits the cost depending on an external factor shown in an attribute table, such as **Table 5.7** and **Table 5.8**.

Table 5.7 shows that when a vessel is running before the wind (i.e., when the angle of the wind is 0 degrees relative to the movement of the boat), the cost is multiplied by 1, thereby having no impact. For cases in which the boat is reaching (i.e., sailing 90 degrees to the wind), the cost of travel increases 2.5 times. This is because boats of this type had poor windward sailing characteristics, which improved markedly only after the development of the wineglass-shaped hull and fore-and-aft sail. These modifiers increase the cost of travel, since a straight line cannot be followed. A value of 44 degrees is applied to areas for which no wind angle is nominated (i.e., where the wind does not blow or no sail is deployed). To include this calculation in the cost, it was decided to use an estimated cost multiplier of 4, corresponding to the minimum speed under oar of 1.5 knots.

Table 5.7. Established values of wind directions.

Wind Direction	Degree
N	0
NE	45
E	90
SE	135
S	180
SW	225
W	270
NW	315
Wind 0	180

Table 5.8. Standardised values for wind direction.

Angle	Value
0	1
44	4
45	1.5
90	2.5
135	3.5
180	4

The last factor is coastal visibility, which is used to estimate sea areas of cabotage, or coastal navigation. This calculation is based on the following formula:

$$\text{visibility (km)} = \sqrt{12,756 \times \text{height}}$$

Assuming optimum conditions, global visibility places no straight-line distance limitation on human vision. Visibility is limited only by the curvature of the earth itself, while approximating the surface of the earth as a perfect sphere.

Therefore, the effective distance of coastal visibility for a sailor on a boat, with an assumed height (above sea level) of one metre, is determined using this visibility equation, where the *height* variable is the differential height of the immediate coastal topography to the hypothetical sailor. The topographic height (elevation) of the coast is determined using a digital topographic model of the Mediterranean basin with a resolution of 250 m. Coastal elevation, in this case, is defined as the maximum elevation of the land extending from the seashore 200 km directly inland.

Finally, the visibility and navigation criteria are normalised for travel times with units of weeks. Since the navigation model assumes only daytime sailing, effective travel speeds are multiplied by the average number of daylight hours for the particular month of travel times seven (days per week). The average daylight hours were set at 10 for December, 12 for April and November and 14 for July.

5.5.6 Model analysis

Based on the parameters of the model, two types of results were obtained to help evaluate maritime connectivity with respect to the Rochelongue site. Using the Route Distance tool, least cost path (LCP) maps were generated. With the Cost Route tool, it is possible to calculate the best route to travel from the source, in this case Rochelongue, to each location on the raster surface, in this case a number of important western Mediterranean seaports.

The second result is the evaluation of values per season. The data reflects the difficulty of navigation per season (Appendix 4). The mean of these values gives us not only the most favourable navigation routes, but also quantifies the difficulty of navigation (the navigational difficulty coefficient) between 0 and 400. This coefficient is used as a similarity value: the greater the difficulty of navigating between two points, the less connectivity there is between them and, as a consequence, the less the contact frequency, which means that there is less similarity. The use of this coefficient allows for the creation of clusters of the different actors in the model based on their maritime connectivity. The results from these two analyses will be discussed in detail in the next chapter.

5.6 Conclusions

The methodology outlined in this chapter is crucial for addressing questions related to maritime connectivity and the movement of metallic objects in the western Mediterranean during the EIA in general, and more specifically for putting them in relation with the subject case study. The chemical, microscopic and typological artefact analyses of the Rochelongue assemblage provide valuable numeric data, such as elemental and isotopic compositions of pure or alloyed metals, which allow for comparisons with other sites and help place this collection in a wider geographical area and archaeological context. The MCM, despite the limitations and assumptions set out in this chapter, has added values of interest when compared with archaeological information obtained by more traditional methods (see Chapter 6).

This combined methodological approach attempts to shed light on the communities in contact based on an understanding that they are not merely made up of people, but also of things—assemblages of artefacts—as well as the connections and interactions—together, the connectivity—between the two. In this way, the following chapters of results and discussion will not only interrogate the site chronology, cultural attribution and type characterisation, but also will concentrate on what the material culture from the site has to say about the societies responsible for its deposition.

CHAPTER 6. RESULTS

6.1. Introduction

This chapter presents the results of the data collection, generation and evaluation conducted for this research. Section 1 presents and discusses the author's recording of the Rochelongue artefact assemblage at the Ephebe Museum at Cap d'Agde in January and February 2017. The catalogue describes the main characteristics of the artefacts, including physical description, preserved dimensions (length, width, height, thickness, etc.), weight, chronology, typology, object category/family/type and minimum number of individuals (MNI). Section 2 presents the results of metallurgical analyses that further characterise some of the material. These include chemical, isotopic and microscopic analyses, the results of which provide information about metal provenance and technological processes. Finally, section 3 presents the results of maritime connectivity modelling of the most diagnostic artefact types, as determined by their find spots distribution. This involves a geospatial assessment using GIS data and least-cost-path analysis based on maritime geographical features, as well as data from the social network model constructed for them, which are visualised in a social map.

6.2. Artefacts Recording

The remains associated with the Rochelongue site currently are held in the Ephebe Museum at Cap d'Agde, in southern France. The assemblage, as it exists today, was consolidated in 2012 from three separate collections held by the Ephebe Museum, Andre Bouscaras and the Archaeological Museum of Biterrois at Beziers. One of the discoveries of the present research, which included an in-depth review of the diaries written by the site's finder and excavator, is that a significant number of artefacts traditionally ascribed to the site, and exhibited alongside other Rochelongue artefacts, may not in fact be part of the assemblage. These items include four lead ingots (RCH1.2017.01170–01172 and RCH1.2017.00640), which are not mentioned in Bouscaras' diaries and would be extremely rare finds for this period (See Aguilera and

Montero Ruiz 2018); bronze sword RCH1.2017.01073 (**Figure 6.1**), of which also there is no mention in the diaries, despite its spectacular preservation; and a group of tin ingots. The tin ingots are a good example on how such misallied artefacts have affected interpretation of the site. The present location of the ingots is uncertain, but they are not amongst the Ephebe Museum's holdings. Bouscaras certainly mentions the ingots in his diaries, but not in relation to the Rochelongue site he discovered in 1964. Bouscaras found and excavated several shipwrecks along the Languedoc coast and kept meticulous records of all of the items he retrieved. A careful reading of these records reveals that this group of tin ingots previously thought to be part of the Rochelongue assemblage actually was an isolated discovery in 1961 at another location about which we have little archaeological information to make possible any further cultural adscription.

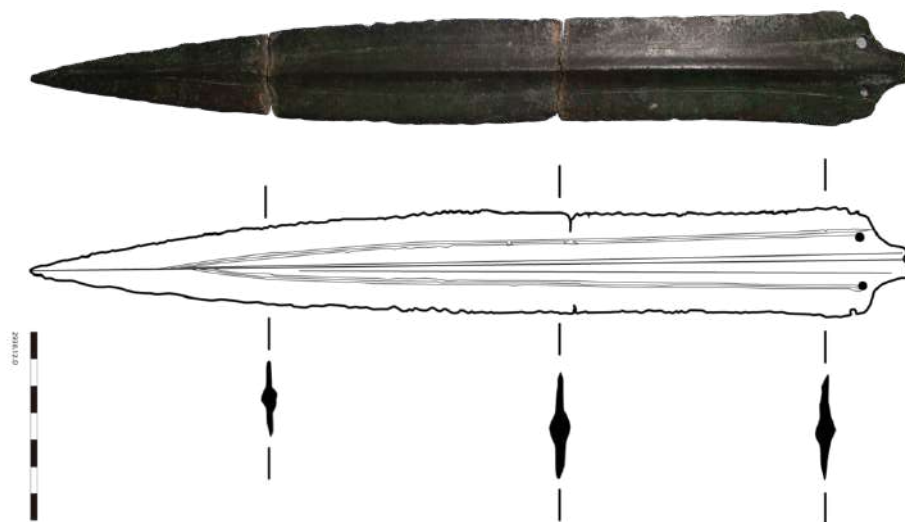


Figure 6.1. Bronze short sword exhibited in the 'Rochelongue Shipwreck of the Bronzes' (*L'épave des Bronzes de Rochelongue*) exhibition at the Ephebe Museum at Cap d'Agde, France (Source: Enrique Aragon).

This error in the site inventory has affected scholarly interpretations. Dominique Garcia (2002:38) mentions the ingots in an article about pre-colonial contacts and associates them, and the Rochelongue site, to the tin trade with the British Isles. Selma Abdelhamid (2015:5–6) presumes, somewhat tentatively, that the Rochelongue site is

the remains of a Phoenician shipwreck, from which ‘an unknown number of tin and lead tablets as well as galena were recovered.’ Garcia’s article has since been cited on numerous occasions, most recently by Quanyu Wang (2016:89), who states that:

The shipwreck at Rochelonge, Agde, southeast France, which comprised 32 tin ingots...remains very poorly published and the tin ingots have yet to be analysed archeometallurgically. The maritime movement of copper, tin, bronze and gold throughout Bronze Age Europe remains only directly evidenced at a few shipwreck sites.

The bronze sword is referenced only once, by Dedet and Marchand (2015:602 fig.7), who describe it as ‘a short sword in three roughly equal sections, with pistilliform blade and very fine point and with a simple tang’ (translated from the original French by author).¹² There is absolutely no mention of this object in Bouscaras’ field diaries, nor in any of his original publications for the Société Archéologique de Béziers (Bouscaras 1964b, 1965, 1966, 1967, 1968), which can only mean that the sword was not part of the excavated material recovered from the Rochelongue site.

Furthermore, no intrusive items deposited during later chronological periods, but raised during the course of the excavation, are included in this catalogue. These materials are documented in the excavation journals, but most date to the Roman era and were found in areas adjacent to the Rochelongue site proper (see Chapter 3).

Finally, artefacts such as iron nails, which no longer exist due primarily to their poor state of preservation when found, or those that are located in private collections, such as the stone anchor, are not described in this catalogue since they could not be inspected personally and analysed or sampled. Nevertheless, they still are considered part of the assemblage and are included in the discussion in the following chapter.

The catalogue follows the order espoused in the methodology of this research described in Chapter 5. Nomenclature and standardisation of category/family/type correspond to existing published literature. Every artefact is introduced and defined typologically by group and sub-group, and is associated with chronologically related

¹² ‘[U]ne épée courte débitée en trois tronçons de tailles proches, à lame pistilliforme et pointe très effilée, avec une languette simple’.

sites. The catalogue is complemented by a detailed artefact form for each artefact, all of which are compiled in Appendix 1.

A. Weapons and Accessories

Artefact type 'weapons and accessories' includes weapons (spears, arrows, swords, daggers, knives) and armour, as well as complementary elements, such as harnesses and decorative appliques. Traditionally, weapons are seen as identifiers of a warrior or the warrior class. They were obtained through merit (Bouvier 2002:128; Graells 2010:329), and it has been argued that their use was restricted to their owners (Sopeña Genzor 1987). Weapons most frequently are found in funerary contexts, and are exceptional in habitation sites (Gabaldón 2004; Quesada-Sanz 1997:162).

The value of a weapon that is deposited (i.e., removed from its primary purpose) does not diminish, but rather is transformed—from an economic and martial value to a symbolic one (Huth 2017; Javaloyas et al. 2015). As such, a deposited weapon can be considered as much an element of prestige as when it was in active use (Graells 2010: 329, Jovayolas et al 2015). In west Languedoc, metal armaments found in archaeological contexts are primarily weapons. Armour elements, such as shields and chest plates, are infrequent and only become more common towards the end of the EIA, with their use increasing in later periods, especially from the sixth century B.C. on. Defensive elements are well represented in the Gulf of Leon at necropoleis, such as at Negabous (Perpignan), Martinet (Castres) and Peyros (Couffoulens) (Graells 2014a:102–106). As for the Rochelongue site, weapons represent just six percent of the total assemblage, with the majority items being spearheads and spear bases. It is difficult to imagine the bronze plates found in the collection (see group under catalogue number RCH1.2017.01431) as being part of some type of defensive armament, but the possibility cannot be discarded completely. Special attention in this regard is warranted especially for object RCH1.2017.01427, the structure and edge perforations of which remind some researchers of pectoral shields (e.g., Graells 2014:122).

A.1. Spearheads

The Rochelongue assemblage contains 13 spear or javelin heads, exclusively of bronze. Based on previous studies, the spearheads represent a number of different provenances, and find archaeological parallels at sites associated with Launacien hoards (Guilaine et al. 2017:179), such as Carcassone (Aude) (Guilaine 1969:144 pl.15), St. Saturnin (Garcia 1987:13 fig.6, no.10) and Croix-de-Mus (Hérault) (Soutou and Arnal 1963). Following the classification criteria of the monographic study of the Launacien deposit (Guilaine et al. 2017), based primarily on dimensions, the Rochelongue spearheads can be categorised as:

- Small, including a subdivision between small and small-to-medium spearheads (from 8–9 cm up to 10–12 cm);
- Medium, including a subdivision between medium and medium-to-large spearheads (from c. 14–16 cm);
- Large, including a subdivision between large and very large (c. 18 cm and over 20 cm).

Most of the studied objects of this type have a leaf-shaped blade with a central, slightly expanded rib (**Figure 6.2**). Nevertheless, it is difficult to characterise more precisely the whole of these finds, due to their fragmentary condition and the dissimilarity between them. For this reason, javelins and spears have been lumped into the same category.

A.2 Spear-butts

These objects are made from rolled bronze sheet with welded edges and are roughly conical in shape. The socketed end is open to receive the bottom end of the spear-shaft, while the distal end is either pointed or rounded. Some of the Rochelongue examples (RCH1.2017.01071, RCH1.2017.01072, RCH1.2017.01235, RCH1.2017.01236) have attachment holes by which the shaft end could be locked into the socket.

These spear-butts capped the bottom end of the wooden spear-shaft and protected it when braced against or planted into the ground; made of bronze, they would not rust. Some have suggested that these objects might, in fact, be spearheads (Graells 2010:325), but their shape and fabrication do not seem particularly well suited for such

purpose. That is not to discount the possibility that they could serve as a secondary weapon point should the spearhead break during combat. They also may have served as a counterweight to aid in the handling of the weapon. Again, the method of fabrication from bronze sheet makes this somewhat doubtful, as they are not particularly weighty. This is more obvious when the Rochelongue examples are compared to the Greek butt-spike, known as a *sauroter*. The latter is a longer and more solid bronze spear-butt terminating in a sharpened spike that clearly served as both counterweight and armour-piercing weapon (Hanson 1991:24, 71–76, 83; Richter 1915:398 no.1450).

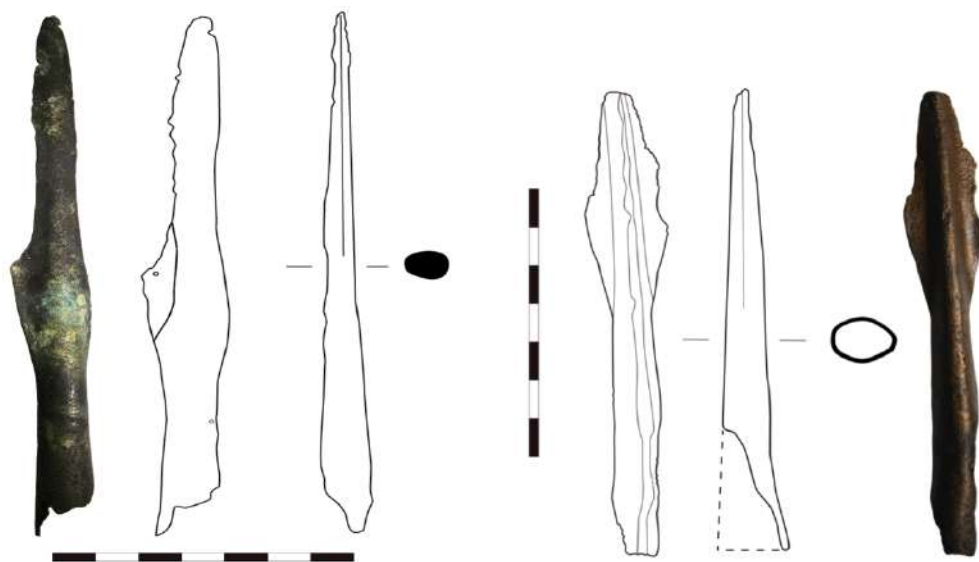


Figure 6.2. Two of the spearheads (RCH1.2017.01064 and RCH1.2017.01066) in the Rochelongue assemblage (photographs and illustrations by author).

Also, amongst the assemblage objects is a group of cylindrical socked objects with one or two perforations that also most likely are spear-butts (RCH1.2017.00811, RCH1.2017.00815, RCH1.2017.01314–01321). Nevertheless, due to the uncertainty of this identification, these objects are assigned to the ‘Divers’ category.

A.3 Arrowheads

Unlike the social distinction evident in the possession of swords and daggers, there is no such certainty of any similar association with bows and arrows (Gascó 2006:147). During the Bronze Age, the identifiable models for arrowheads already were established by the EBA, and they continue relatively unchanged into the EIA (Briard and Mohen 1983). Arrowheads normally were made of bronze and had a triangular shape with a flat peduncle or sometimes with an axial rib, the latter being more common in the EBA and MBA. Other types of triangular arrows show some functional variations.

In the Rochelongue assemblage, we can identify two different models of arrowheads: one is defined by ailerons (e.g., RCH1.2017.00560) and the other by a lanceolate body (e.g., RCH1.2017.00561). Both have a more-or-less developed peduncle, the upper part of which is reinforced by bulging.

The type with ailerons is present in level I of the oppidum of Cayla (Taffanel 1956). It also is found in burial 142 of the Moulin necropolis, which is dated to c. 750–725 B.C. (Taffanel et al. 1998:121); however, this type remained in use during the IA until the third century B.C. (Guilaine et al. 2017:182). The lanceolate type arrowhead traditionally has been linked to the eastern Mediterranean (Guilaine and Solier 1966), but some scholars have argued that it most likely has a local provenance (Gascó 2006:157).

Few bronze arrowheads have been found in Launacien hoards. Jean Gascó (2006:150) explains this absence by arguing that ‘[i]f such objects were only intended for remelting, the arrowheads represent only a small amount of metal and this may explain their near absence...’; adding that ‘[t]hey also may be few because such arrowheads no longer held a prominent place in production, and likewise are scarce in contemporary habitats, most coming from burials’ (translated from the original French by the author).¹³ This makes the Rochelongue assemblage, with its twelve arrowheads,

¹³ Si les objets étaient seulement destinés à la refonte, les pointes de flèche représentent de faible poids en métal et cela peut expliquer leur quasi absence [...]. Elles peuvent être également en petit nombre parce que ces pointes de flèches ne tiennent plus une place notable dans les productions: elles sont aussi peu abondantes dans les habitats contemporains, la plupart provenant de sépultures.

an exception, even though these objects still represent a small portion of the total number of artefacts from the site. Bouscaras and Hugues (1972:178) claim to have raised a total of twelve arrow heads at Rochelongue, which this author was able to confirm in their field diaries. Currently, though, only eight examples remain in the collection of the Ephebe Museum. One of the missing arrowheads is shown in Bouscaras and Hugues (1972:177 fig. 2, no. 6), while the other missing pieces are shown in the field diaries.

A.4. Swords, daggers and knives

In general, sword finds largely are absent from Launacien metal hoards; nevertheless, among the diverse fragments that cannot be confirmed due to the lack of archaeological context, such as the one item from the Briatexte deposit (Salmon 1887:421), there are several relevant remains that can be mentioned here. The Carcassonne deposit includes fragments from the tip of a Carp's Tongue sword of Venat type. Such swords are common on the Iberian Peninsula, the Terra Fort (Heraut) metal hoard containing the pistilliform type (Roudil 1972:206 fig.82) and the deposit at Farigouriere (Var) containing both Forel and pistilliform types (Courtois 1957)1957).

Daggers and knives similarly are rare finds amongst the Launacien metal deposits. Only one possible dagger fragment is mentioned in connection with the metal hoard at Saint-Jean de la Blaquière (Garcia 1993:276 fig.138, no. 4). Dagger blades of the LBA in central-western Languedoc typically have two rivet holes positioned on the same line (Guilaine et al. 1989:121). As for knives, only the deposits of Launac and Bautares Peret have possible knife fragments (Cazalis de Fondouce 1900:138 fig.112, no.5; Garcia 1993), and they are associated with regional productions (Guilaine et al. 2017:183).

With regards to daggers, except for the Rochelongue assemblage, wherein three pieces of possible daggers have been identified, these objects are absent in Launacien deposits (Guilaine 2017:183).

Ignoring the above-mentioned bronze sword (RCH1.2017.01073), which has no verifiable association with the site, the Rochelongue assemblage contains thirteen items that likely are related to swords, daggers or knives. Dedet and Marchand

(2015:601, fig. 7, no. 2) described two fragments (RCH1.2017.00562 and RCH1.2017.00563) as parts of the scabbard locket of an antennae sword; the scabbard, most likely made from leather, did not survive. Another object (RCH1.2017.01053) also can be interpreted as part of a locket. Two other objects (RCH1.2017.01070 and RCH1.2017.01076) are hollow conical caps (one with a circular base) that are identified as possible chapes for sword or dagger scabbards (Dedet and Marchand 2015:601, fig. 7, nos 6 and 7).

Finally, four additional artefacts from the collection possibly are related to swords: a fragment of a rectilinear blade with no other distinguishing feature or perforation (RCH1.2017.01059) and three proximal ends of tanged daggers (RCH1.2017.01058, RCH1.2017.00554 and RCH1.2017.00820) (Dedet and Marchand 2015:601, fig. 7, nos 3–5). The latter have vertical, rather than parallel, perforations that are similar to some of the iron knives found in the necropolis of Mailhac (Verger and Pernet 2013:49). A number of other objects (RCH1.2017.00556, RCH1.2017.01057, RCH1.2017.01397 and RCH1.2017.01059) are assigned to this category, as they are blade fragments or at least exhibit a ‘cutting’ functionality. Interestingly, object RCH1.2017.01059 also has been interpreted as an ingot-bar (Guilane et al. 2017:128), but its size (approximately 14 cm long and 3 mm thick), curvilinear shape and bevelled edges raises the possibility that it is part of a blade.

A.5. Bows

One final object type related to weapons is the bow. Dedet and Marchand (2015:602 fig.7 no. 23) describe one element in the Rochelongue collection (RCH1.2017.00777) as having a notch to accommodate the bowstring. Following this interpretation, there are several other objects in the collection (RCH1.2017.00923, RCH1.2017.00930, RCH1.2017.00931 and RCH1.2017.00932) that can be added to this same category. Nevertheless, due to the fragmentary nature of these pieces and the lack of obvious parallels, their identification as bow elements is tentative at best and so here they are included in the general ‘Diverse’ category of artefacts.

Another enigmatic object commonly found in Launacien metal deposits is the Launacien type of lance or javelin heel, the so-called ‘talon Launacien’ (RCH1.2017.00413). Identification of these objects is uncertain and still under debate. Some authors have interpreted them as limb-tips for bows (Gascó and Pueyo 2003), while others argue that their morphology is unsuitable for the proposed functionality and, instead, such objects should be seen as ornamental finials (Guilaine et al. 2017:253; Verger et al. 2007:112–114). Because of the lack of a clear identification for these objects (Guilaine et al. 2017:131), they are not grouped with weapons, but instead are categorised here in the ‘Diverse’ artefacts group.

B. Tools

B.1. Winged axes

Winged axes are a typical component of Launacien metal hoards, found, for example, at Launac (Guilaine et al. 2017:40 pl. 2, no. 1) and Vias (Guilaine et al. 2017:184 fig. 3, no. 1), but never in large numbers. None of the winged axes in the Rochelongue assemblage are identical. One example (RCH1.2017.01327) has parallel sides and folded wings at the proximal end that do not touch. A second example (RCH1.2017.00694) is characterised by longer wings and a blade with a half-moon edge. The third axe (RCH1.2017.00693) is a terminal-winged axe with an elongated body that tapers significantly from both flared ends to the middle.

The common presence of winged axes in the south and absence of other well-established types has led some to consider them the classic model of the Final Bronze III for the Provençal and Languedoc regions, as far west as the Pyrenees (Guilaine 1972; Guilaine et al. 2017; Taffanel 1974; Tendille 1985).

B.2. Palstave axe

Another type of axe is the stopped-palstave axe (*hache á talon*, in French). The Rochelongue example (RCH1.2017.01328) has a long (21 cm) body with cast flanges and stop bar, a quadrangular section on the hafting side of the stop bar and an oval section on the blade side, and the blade has a slightly raised central ridge running down

its length. This type of axe appears associated with contexts of the MBA-LBA (Chardenoux and Courtois 1979). Most have been discovered in the Massif-Central, a highland region in the middle of Southern France, and especially at Corrèze, Cantal and Puy-de-Dôme (Campolo and Garcia 2004:22).

B.3. Flat axe

The last type of axe represented in the Rochelongue assemblage is the simple flat axe (RCH1.2017.00691). It is similar to models from the EBA (Chardenoux and Courtois 1979).

B.4 Adzes

Adzed are woodworking tools used for cutting and shaping. They are similar to axes, but with the cutting edge perpendicular to the handle rather than parallel. Such tools are typical of early and middle Bronze Age deposits in France and surrounding continental regions. The body typically had a ring on one of the sides and no folded fins. There is one such adze (RCH1.2017.00698) in the Rochelongue assemblage; it has a narrow body and sub-parallel edges, the ring is broken and there is some slight wear in the trapezoidal section of the cutting edge. It also differs slightly from the archetypal form in that its edges have a convex profile in the zone of fitting and its fins are less pronounced. At only 9.4 cm long, it is smaller than the classic variety, such as examples found in the deposits of Castellás and Saint-Saturnin, which measure between 11 and 12 cm long, respectively. Because of their general morphology, these tools are characterised by straight sub-terminal fins whose large surface contrasts with the narrowness of the instruments. There are few comparable pieces in the whole of southern France, and they all are associated with Launacien assemblages, and so are considered archaisms (Guilaine et al. 2017:187).

B.5 Axes with socket and bevelled blade

A variety of axes characterised by a socket, a typically simple and short body, concave edges, tracing little developed, on both sides the lower half of the piece is giving an angular characteristic appearance. The upper part draws a rounded or even as an ogive

curve. According to Guilaine (1972) it is possible to distinguish meridional metal hoards in this group into a variety without ring and a variety with ring, being this last much more abundant (Chardenoux and Courtois 1979).

B.5.1 Launacien axes: Rochelongue assemblage have eleven objects under the name "Launacien axes" (e.g. RCH1.2017.00681, RCH1.2017.00673 or RCH1.2017.00692) are grouped pieces comprising: A sub-circular or quadrangular sleeve, with a broader tendency along the axis of the faces; two small internal growths can develop symmetrically on the broadest sides; A prominent body, of rounded profile, sometimes double, a lateral ring; concave edges and a slightly convex edge, rarely straight most of the times. We can distinguish between decorated and undecorated sub-types; the latter is the most common. On the "Launacienne" decorated axes (e.g. RCH1.2017.00566 (bis), RCH1.2017.01240, RCH1.2017.01249) is that of thin ribs in relief, parallel and little divergent, vertical, finished or not by a small spherical refilling. The absence of these small balls can correspond to a deliberate choice, but one cannot exclude in certain cases the result of a secondary alteration. The layout of the decoration may vary. The number of nerves can usually range from 3 to 5. Their width also varies from 3 to 5 cm, but it is possible to find shorter or longer examples.

B.5.2 Rochelongue axes: In the series of axes from the Launacien complex, the type "Rochelongue" with a total number in the collection of 91 objects refers to the axes with rectangular or sub-rectangular socket and not having a fixing ring. Within this group, a narrow body model and a wide body model can be distinguished, both of which can be decorated. This type is characterised by a socket of quadrangular morphology, sub-rectangular generally, sometimes hexagonal outside, the junction of the two halves of the piece favouring a reflection of the two symmetrical edges.

In spite of the rectangular morphology of the socket, the sections often show a certain roundness of the angles. Vertical ridges exist quite often in opposition, inside the sleeve, arranged by two lines but sometimes four-corner is also present. The sleeve is wider than tall. It can be distinguished short bodies copies (decorated or not) (e.g. RCH1.2017.01284, RCH1.2017.00433) and large body copies (decorated or not) (e.g. RCH1.2017.01238, RCH1.2017.01237, RCH1.2017.00724, RCH1.2017.01239,

RCH1.2017.00726). The body is considered by authors such as Guilaine et al. (2017:194) as a strong typological index depending on its thickness¹⁴.

B.5.3 Miniature axes: Rochelongue assemblage contain a number of six miniature axes (RCH1.2017.0081, RCH1.2017.00816, RCH1.2017.01329, RCH1.2017.01330, RCH1.2017.01360). Under this name, designated small specimens, mostly less than 5 cm in length, which can appear in the Launacien hoards. These small objects have no functional value. Rare are the intact pieces. Many are characterised by an incomplete mouth, more or less important areas without material, a ring without perforations, defects of casting and burrs at various points of the parts which have not been deburred. We find the two types with ring (similar in aspect to a reduced version of Launacien axes) or without ring (following the model of Rochelongue).

B.6 Hammer

The hammers identified in Rochelongue are pieces with round, quadrangular or hexagonal socket having a short and wide body and rectilinear edges, sometimes concave. The functional part is flat or slightly curved, often widened by the use. In Rochelongue there are 24 objects in this group (e.g. RCH1.2017.00769, RCH1.2017.00771, RCH1.2017.00789). Some of the pieces present a decoration in V or X (e.g. RCH1.2017.00770, RCH1.2017.00775, RCH1.2017.00774). The Rochelongue deposit is the site with the largest number of this type of objects although one fragment was located in Launac and another in the deposit of Briatexte (Guilaine et al. 2017:206). This hammer model is known from the LBA III-EIA (Guilaine 1972).

B.7 Chisel/Gouge

The chisels are generally narrow pieces lying next to their small width. They have a round or oval socket more rarely quadrangular. The head may be short and bulge or wide and not prominent. In Rochelongue, a seven of these objects has been located along with other fragments that could belong to the same group (24). They are not

¹⁴ This criterion has been applied to my study.

common in the deposits of Launacien, although examples have been found in Launac, Péret, Carcassonne and Saint Saturnin (Guilaine et al. 2017:206).

C. Jewellery and Clothing elements

The elements of adornment and clothing in metal are certainly the best represented artefact of all the studied material groups. The group consists of many types of objects, mostly made of copper alloys. Essential to the setting up of chronologies from the end of the Bronze Age to the beginning of the Iron Age, they were most often approached in this perspective (Nordez 2017). They also have a significant place in the definition of cultural groups recognised for this period. Finally, these artefacts of small dimensions, are an important indicator of the mobility of people or goods across the various mainland and Mediterranean regions.

C.1 Fibulae

Fibulae are considered prestige items and mostly have been found in burials (Lo Schiavo 2010). Besides their chronological significance, they also can provide valuable information regarding cross-cultural interactions and local preferences, particularly when differentiating between imported objects and local imitations (Fig. 6). The continued study of such artefacts therefore is essential to understanding socio-cultural impacts in the region, such as assimilation, adaptation or hybridisation of foreign goods and practices (Vives-Ferrándiz 2009).

The interest of this category of adornment lies in its morphological and technological diversity. The study of fibulae has contributed to the establishment of major chronological frameworks (Lo Schiavo 2010; Navarro 1970; Pauli 1971; Pohl 1972; Primas 1970). The shape of the arch in the body of a fibulae appeared as the most relevant general criterion for defining families of fibulae. Comparing the shape often in relation to the form from the spring, groups of fibulae can be isolated. The decoration of the bow, or some other detail (the size of the fibula, for example) allow for further classification (Duval et al. 1974).

The Rochelongue groups exemplify how object diversity affects the interpretation of geographical origin and chronology:

- Fibulae Sanguisuga: One fibula (RCH1.2017.00545) of is type is preserved in the assemblage. The object is in a good state of preservation, only the needle is missing. The morphology of the fibula belongs to the wide group of fibulas a sanguisuga with 'staffa lunga', with or without decoration (Lo Schiavo 2010:496–502). This type has a wide distribution throughout Italy, particularly in southern Italy and around Sala Consilina (Salerno, Campania). The group is dated between eighth–seventh century B.C. (Graells 2014b:236).
- Fibulae Serpentiniform. A fragment (RCH1.2017.00544) corresponds to a central fragment of a fibula so called 'croissant' of a serpentiniform fibula (Arnal et al. 1972:7; Lo Schiavo 2010: tab. 565–568), type S4 by G. Mansfeld (1973). This type of fibulae mostly appears in Bologna (Italy). However, is registered an important number in the north-eastern of Italy as well. The proposed date for this kind of fibulae has been between the seventh and sixth century B.C. (Naso 2003), although the review of the chronology carried out by M. Trachsel (2004:226–234) proposes an ascription to the beginning of s. eighth–seventh century B.C. (Graells 2014b:237).
- Double Spring Fibulae: Twelve double spring fibulae (e.g. RCH1.2017.00855, RCH1.2017.00848, RCH1.2017.00849, RCH1.2017.00850) has been identified in Rochelongue's assemblage (among six other fragments of spring that can be associate to this model). The double-spring fibulae are characterised by being made in a single shank that is wound in a spring way in two different points and gives shape, by two inflections–the double spring– that define the bridge, the foot and the needle (Graells 2014b:246–249). These fibulae are dated between the second half of seventh–first half of the sixth century B.C. (Graells 2008:94). Traditionally double-spring fibulae have been considered as elements of Phoenician character (see Lorrio 2008:247; Torres 2002:196 for discussion). However, its abundance in contexts where the Phoenician presence is null or low, leads to R. Graells (2014b:249) to consider that these pieces are local productions. This author also argues to consider the eastern part of the Iberian Peninsula 'in a very broad sense, needing a detailed study' as the origin of this

typology linked to Phoenician commercial activity, but not necessarily of Phoenician origin.

- Fibulae 'pivot': Two fragments (RCH1.2017.00551, RCH1.2017.00552) of the so-called fibulae Pivot are in the assemblage. These types of fibulae are characterised by a movement of the needle by a pivot and not by a spring. This model has served to justify particularly high chronologies around the tenth-ninth centuries B.C. specially for sites in the Iberian Peninsula (Castro Martínez 1994:20–130). However recent archaeological contexts (López Cachero and Rovira 2012) with fibulae of this type in the northeast of the Iberian Peninsula, has shown a finest chronology from the end of the eighth–beginnings of seventh centuries B.C. that expand until the beginning of sixth century B.C. (Graells 2014b:250). It is proposed that these types would respond to Cypriot prototypes subsequently reinterpreted in areas of Italian and Iberian Peninsula (Marlasca et al. 2005:1041; Rovira Hortalá et al. 2008:450). Although some models from southern Italy shows similitudes (Lo Sciavo 2010:646–647) with an early chronology ca. 900–850 B.C. (Graells 2014b:252). The fibulas found in Rochelongue find direct parallels in sites such as Calvari, Can Piteu and Sant Jaume d'en Serra in Catalonia (Armada et al. 2005; Rovira Hortalá et al. 2008). For all of them based on their elemental composition it has been proposed a local production (Graells 2014b:253).
- Fibulae Plate: There are three fragments of this kind of fibulae (RCH1.2017.00547, RCH1.2017.00548, RCH1.2017.00846). Traditionally identified as a production from the northeast of the Iberian Peninsula, characterised by a complexity in the double-spring system of bilateral bars and springs joined by rhomboidal plates, this model is dated in the sixth century B.C. (Graells 2014b:254). A direct parallel to the several fragments in Rochelongue assemblage is the one found at the LBA-EIA necropolis of Agullana (Girona, Catalonia) (De Palol 1944) where a complete example of this type of fibula was recovered. The reconstruction of the fibulae from Agullana (Arnal et al. 1970:54; De Palol 1944:119) (Arnal et al.1970:54; De Palol 1944:119) give us an idea of its

appearance and opens the possibility that the three fragments conserved in Rochelongue actually correspond to the same object.

C.2 Pendants

The term pendant may include elements of necklaces or parts used in the composition of complex ornaments (pectoral, belts, etc.). This element is quite abundant when we look at the Rochelongue deposit. These remains are generally considered to be costume ornaments, headdresses or composite belt embellishments. They have also been interpreted as pendants of harness straps, intended for their clatter to attract attention. Although these pieces are rare in hoards, they are well represented in the tumultuous sepulchres of eastern Languedoc (Guilaine et al. 2017:209).

Rochelongue provides a very varied panoply in pendants and elements of adornments in comparison with Launacien hoards, presenting diversity such as rings with terminal ball, double rings, plates as fixation of chains ended by rings, etc. in this group I find interesting to highlight some specific types that can provide us further information about long-distance contacts.

- Triangular Pendants: represented by ten objects (see RCH1.2017.00969) in Rochelongue. Having a extensive chronology between LBA to sixth century B.C., this kind of objects are commonly found in the tumuli necropolis in Langedoc (Vallon 1984). Also, as local context it is found at the site of La Motte (Agde) with 39 copies (slightly different in design) interpreted as women's clothing (Verger et al. 2007). These triangular pendants also are found in the northeast of the Iberian Peninsula, at sites such as Coll del Moro in the Serra d'Àlmors and Marçà (Graells 2014b:270).

Generally, these triangular pendants are found in a wide geographical area including the Alps, Switzerland, Germany, Hungary, Poland, etc. Associated to maritime exchanges of this model some examples of these objects are located at Selinonte and Sciacca (Sicily) but also is registered one in Alicante (Spain) (for distribution, see Guilaine et al. 2017: 305 chart 15).

- Wheel pendant: Two types can be recognized within this group (Graells 2014b: 270) the pendants with central core, in Rochelongue there are 3 copies (RCH1.2017.00917, RCH1.2017.00918 and RCH1.2017.00524) and pendants with two circles joined, of which only one possible fragment has been found in the collection (RCH1.2017.00912). The first model is located in sites as Saint-Julien de Pézenas (Mansel 1998) or Avinyonet del Penedès (Verger and Pernet 2014:215; Graells 2010, 2014b). Regarding to the variety with two circles has been documented in Saint-Saturnin metal hoard (Hérault) (Guilaine et al. 2017: 265), Sant Jaume (Alcanar, Catalonia) (Garcia and Vital 2006), and in the Carcassonne deposit (Guilaine 1969).
- Crotales pendant: Two examples of this object are in Rochelongue assemblage (RCH1.2017.00529, RCH1.2017.00759). This model shows a strong concentration in Jura area (France) and a dispersion between the Seine and Bourgogne (Piningre 1996:99). Not many examples of this objects are found in the Gulf of Leon (Graells 2014b:271) with few examples in Rossay (Vienne, Lyon), La Rivière-Drugeon (Doubs) for France and possibly in the necropolis of La Herreria and Avinyonet del Penedès (Spain) (Verger and Pernet 2014:215, Graells 2014b:271) finally an example of this kind of pendant was found in Selinunte (Sicily) (Verger and Pernet 2014:228).
- Pendant Cage: There are only two examples of this type of pendants in the Rochelongue deposit (RCH1.2017.00757, RCH1.2017.00957). The only nearby parallels are found in the necropolis of Mas de Mussols (Catalonia) (Graells 2010:53; Maluquer de Motes 1984). Both types find parallels in the Jura area, although their simplicity makes them approximate productions of the south of Italy, Balkans or even Macedonia (Graells 2014b: 271).

C.3 Bracelets

Like fibulae, bracelets are among the most numerous ornaments on Launacien sites. They come in various forms, whose cultural and chronological meanings vary according to type and region (Jennings 2016:90). The adornment reliefs present large varieties of

protuberances variously arranged (contiguous, grouped or separated by gaps, nets, etc.) and varied profile (angular, rounded, crushed). All types of sections are represented (filiform, flat, massive, hollow). Moreover, the bracelets may be closed or opened and have other modifications. Thus, some arm- or leg-bands can be fixed by interlocking or lateral rods or bars. This mix of features makes it possible to recognise a number of principal types. The largest groups that can be differentiated are bracelets with solid section (**Figure 6.3** and **Figure 6.4**) and annular sets with hollow section (**Figure 6.5**).

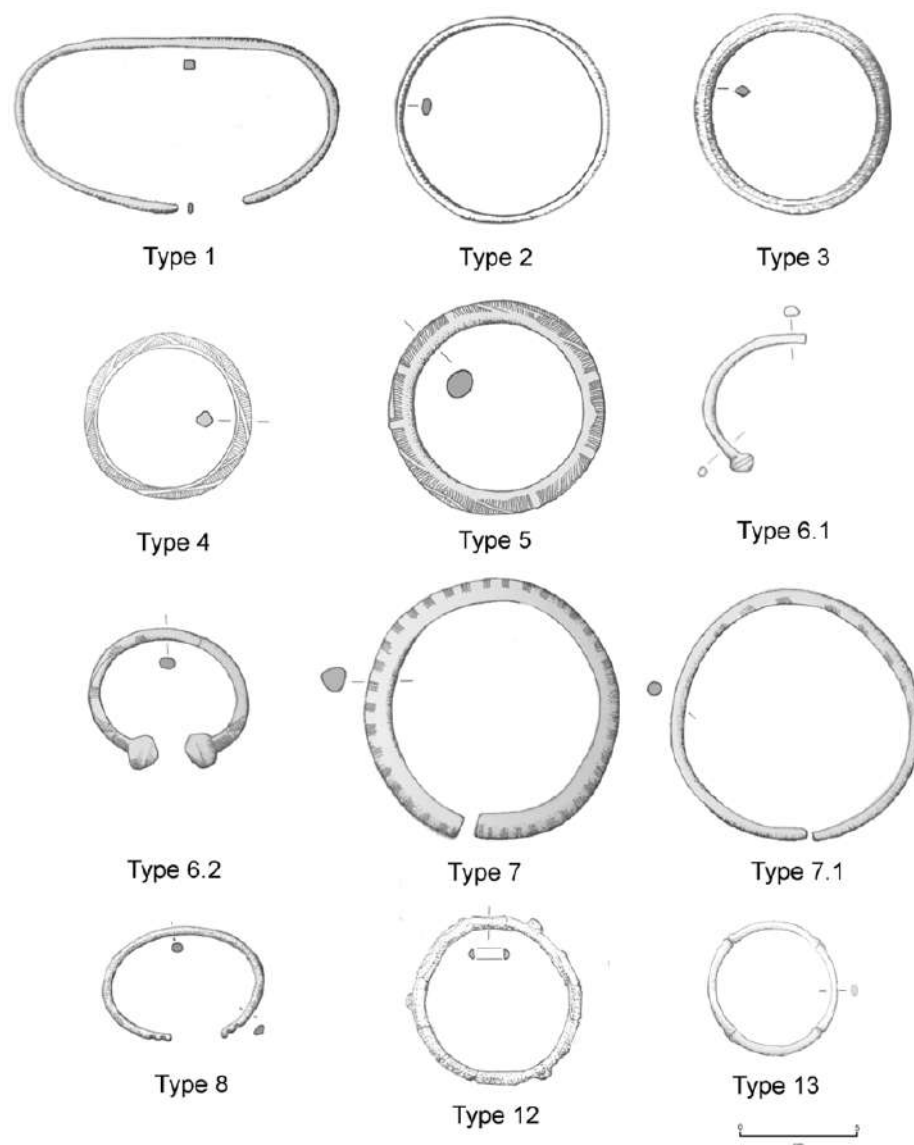


Figure 6.3. Typology of bracelets with solid section at Languedoc, LBA-EIA (from Guilaine et al. 2017:29–31, fig. 1).

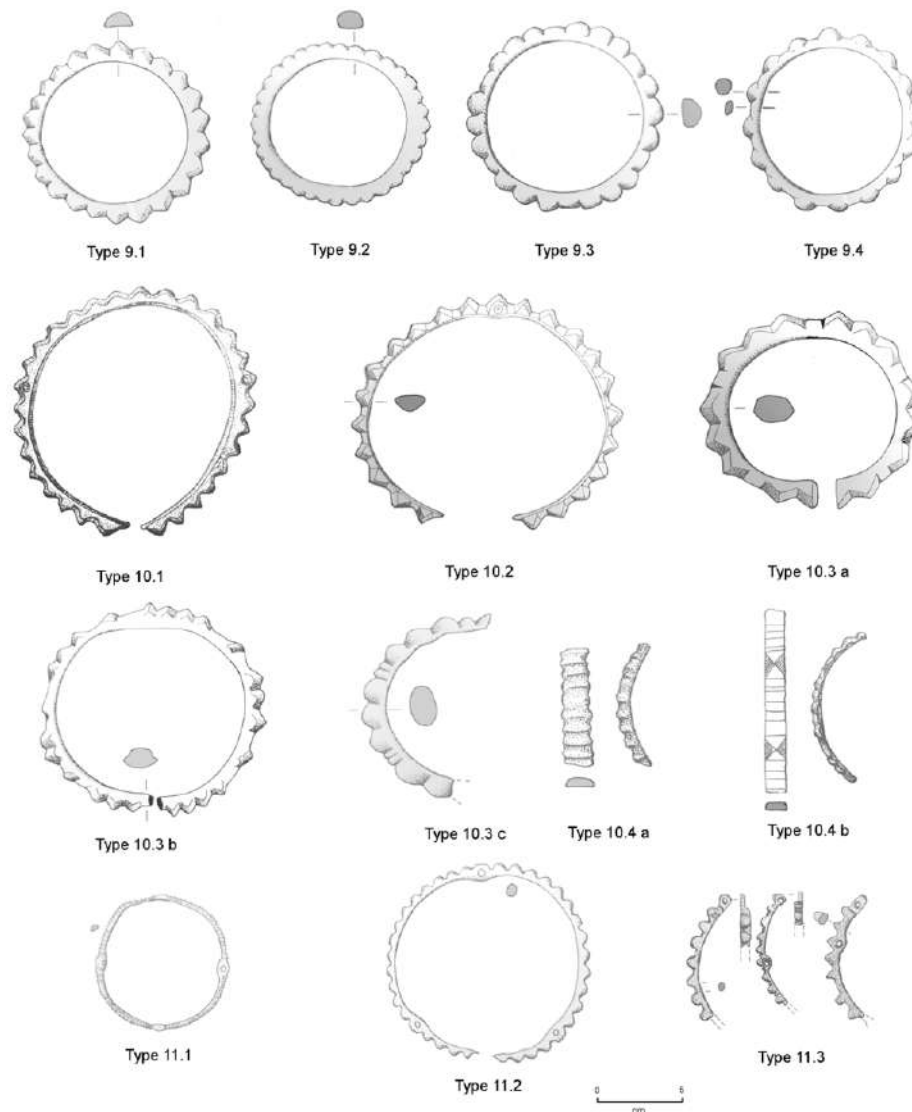


Figure 6.4. Typology for bracelets with solid section at Languedoc, LBA-EIA (from Guilaine et al. 2017:29–31 fig. 2).

Bracelets and armbands with solid sections are sorted according to the descriptive typology proposed by Guilaine et al. (2017:28). Ring adornments with solid section are grouped generally by their section thickness and morphology. Sub-groups are based on decorative or other features of elaboration and morphological variations. From simple shapes (Type 1) there are varieties with circular or oval section (Type 2) and rhombic (Type 3). Certain groups have a characteristic complex Grand Bassin I type decoration (Type 4), while others are more simply decorated with ribbons (Type 5) or small

terminals (Type 6). The same criteria –thin or thick section– is applied to open and decorated bracelets (Types 7 and 8).

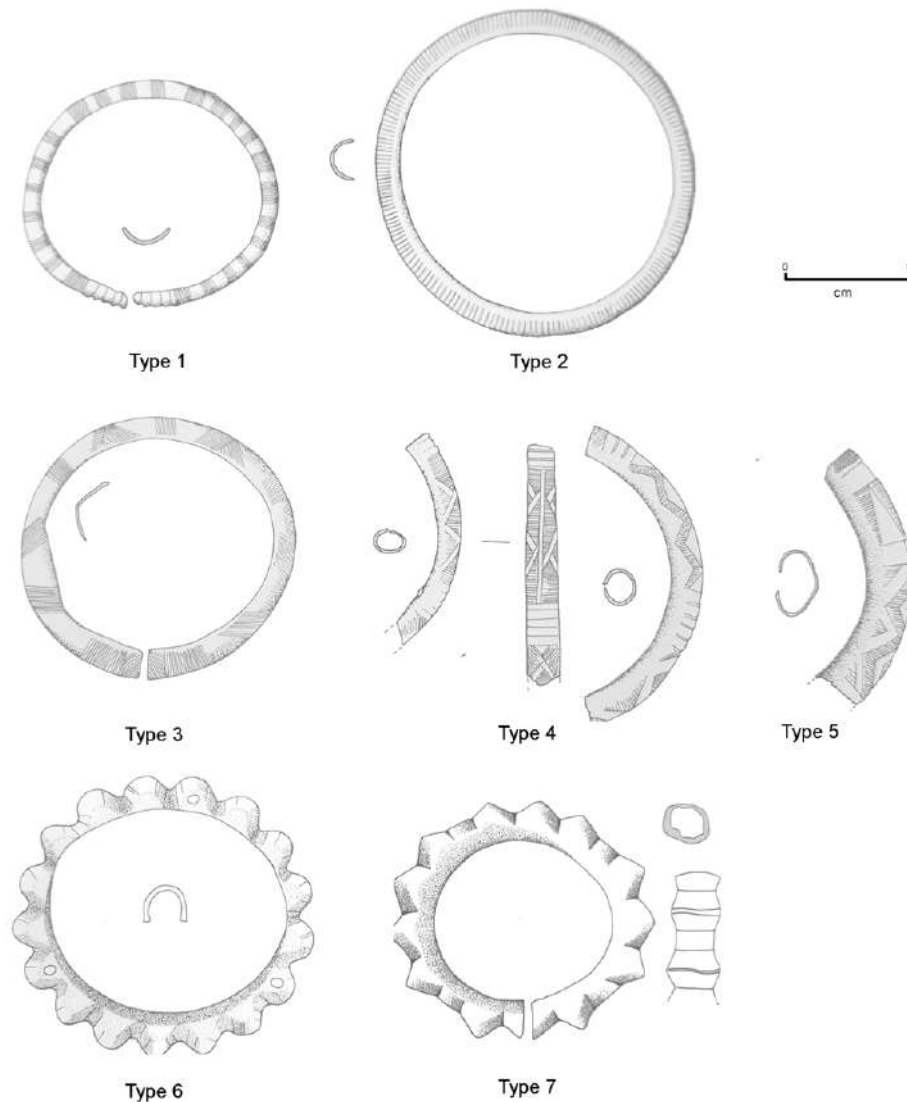


Figure 6.5. Typology for bracelets with hollow section at Languedoc, LBA–EIA (from Guilaïne et al. 2017:29–31 fig. 3).

Ring adornments are grouped according to their circumference, open or closed; band thickness (section diameter); and elaborations, including etched decorative patterns, relief. The embossed ornaments are classified in three broad categories, each with a number of subtypes: bracelets, leg rings with high relief, arm-ds and leg-bands with a narrow band (Type 11). Finally, some original types have been retained although having

statistically only anecdotal value: bracelets with corrugated ends, bracelets with ringed lights (big spaces around the main body of the object) (Type 12) or annular ornaments with large space between bulging areas (Type 13).

Although is possible to perceive the adscription of certain types of bracelets to specific geographical areas, it is necessary to have more extensive regional catalogues to establish a more consistent distribution maps of these objects (Guilaine et al. 2017:28). Currently we are far from this point, however, is possible to identify few interesting features regarding to the dispersion of certain models. In Rochelongue assemblage there are a total of 628 bracelets (**Figure 6.6**). Whether most of the models have an extensive local dispersion, some of them can be found beyond the limits, in Mediterranean contexts such as Sicily or even Greece (Verger 2005).

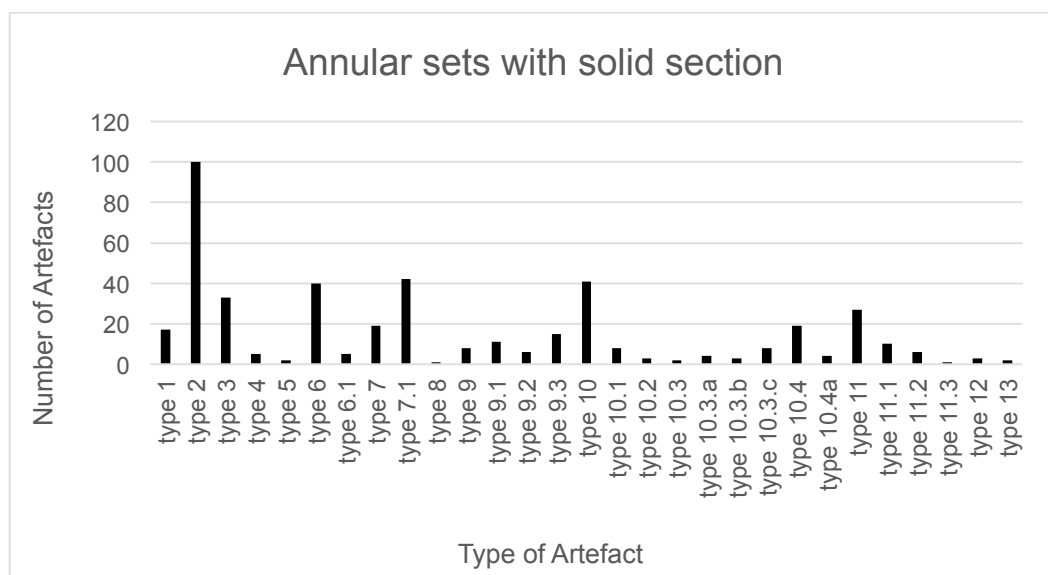


Figure 6.6. Number of bracelets (with solid section) by type in the Rochelongue assemblage.

Type 1 (e.g. RCH1.2017.00007, RCH1.2017.00028, RCH1.2017.00063) appear frequently associated to necropolis context having a large dispersion in areas of the Pyrenees, southwest and Midwest of France as well as in the area of Catalonia (Gallart 1991; Milcent 2004; Mohen 1980). In the same line Type 2, the most common in Rochelongue (a total of 100 between complete pieces and fragments) (e.g. RCH1.2017.00033,

RCH1.2017.00034, RCH1.2017.00035) are generally found in the necropolis of Grand Bassin I (e.g. Peyrou, Agde) (Nickels et al. 1989) and can be also found in central France (Milcent 2004). On the other hand, other models as Type 3 (e.g. RCH1.2017.00002, RCH1.2017.00017, RCH1.2017.00161) are found in more particular contexts. In Peyrou (Agde) were found 41 specimens of this Type 3 dated between the second half of the seventh century and the beginning of the sixth century B.C. (Nickels et al. 1989:448-454). Some of these burials showed pottery and other elements (fibulae) that are interpreted with a provenance from Greek colonies of Sicily such as Megara Hyblaea (Guilaine et al. 2017:266). Also, three bracelets of this type have been in the sanctuary of the Greek city of Perachora (Corinth, Greece) (Verger 2005). Also linked with Mediterranean context it's the Type 7 (e.g. RCH1.2017.00156, RCH1.2017.00212, RCH1.2017.00453).

A very popular model for the south of France and with significant presence in the central part of the country in the so called 'tumuli' necropolis. The chronology for these bracelets is around the second half of the seventh century and the beginning of the sixth century BC. This echo is ratified with a complete copy in the sanctuary of Bitalemi (Gela, Sicily). (Guilaine et al. 2017:267, Verger 2005). Finally, the Type 10 shows several subtypes associated to archaeological context of the Greek colonies of Sicily. In this sense, in the sanctuary of Bitalemi (Gela) a complete specimen and a fragment (Verger 2005) of subtype 1 (e.g. RCH1.2017.00454, RCH1.2017.00086, RCH1.2017.00130, RCH1.2017.01117) were found. Likewise, two fragments of subtype 2 (e.g. RCH1.2017.00143, RCH1.2017.00105) are known for a deposit of Sciaca (Sicily) (Guilaine et al. 2017:268). Recently this kind of bracelet (also close to Type 11) are started to be identified in few sites of the northeast of the Iberian Peninsula in sites as for example, Empuries, La Escudilla or Aldovesta (Graells 2014b:269; Mascort i Roca et al. 2015).

Separately the annular sets with hollow section (Types 1, 2, 3, 4, 5,6 and 7) have been classified into seven types, all relating to decoration and in correspondence with the bracelet section: convex, semi-circular, triangular, circular. The presence of this group of objects (15) in Rochelongue assemblage is no high compared with the previous

group (627) and only Types 1,2,4,6 and 7 are present into the collection. An overview on the types part of this group allow us to see also a certain connexion (as already Verger pointing out in several publications, (Verger 2000, 2005; Verger and Pernet 2013) with continental areas together with an interesting expansion to specific areas of the Mediterranean Sea. The Type 1 (RCH1.2017.00245, RCH1.2017.00246) have an important presence in the southern hoards (Milcent 2004). This type is also well represented in Bitalemi (Sicily) and especially in the Veneroso collection in Sciacca which contains at least seven fragments (Guilaine et al. 2017: 269, Verger 2000, Verger and Pernet 2014). Type 2 is well depicted in Launac hoard (11 fragments) (Guilaine et al. 2017) and well known in other deposits as Cross-de-Mus that presents a homogeneous series with decoration of continuous parallel incisions, as Rochelongue's examples. Numerous fragments are recognized in the Saint-Saturnin depot (Garcia 2004). Type 4 (RCH1.2017.00243, RCH1.2017.00244) shows a dense distribution in Bourgogne and on the Jura plateau (Switzerland) with some extensions to central France. Such ornaments are among the Gallic imports in Sicily. A richly ornamented fragment of Bitalemi can be compared to the Viols-en-Laval (Herauld) copy (Guilaine 2017:270). Is worthy to notice that fragments of the Launacien deposits are not very similar (specially in decorative motifs) to the northern models. However, the two fragments (that seems to be part of same object) find a clear parallel with the ones found at Fliebs, Austria (Sydow 1995:107 pl. 40, no. 99). Type 6 (RCH1.2017.00236, RCH1.2017.00237, RCH1.2017.00238, RCH1.2017.00467, RCH1.2017.01103) is relatively well represented in Rochelongue (if we take into account the total number of this group). This model is especially attested in Saint-Saturnin hoard but have been found in a humid context in Saint-Julien-de-Concelles (Loire-Atlantique) and Moulins (l'Allier) having an interesting dispersion in l'Armorique and Normandie (Guilaine et al. 2017: 271). The most distant copy was found in the sanctuary of Perachora (Greece) (Verger 2000). Finally regarding to Type 7 (RCH1.2017.00235, RCH1.2017.00441, RCH1.2017.00469, RCH1.2017.01102, RCH1.2017.01110) the entire Veneroso collection in Sciacca (Sicily) has provided numerous fragments that cover the entire range of

variants present in the Languedoc ensemble. Other identical fragments have been found in Bitalemi (Verger and Pernet 2013).

At the end of the LBA, the bracelets seem essentially revealing of the female costume. In the same way, as most of the elements of adornment which follow (torque, earring, pendants, etc), their diversity brings to light, in contexts as burials, the numerical importance of the metallic productions in bronze, destined for women. Unlike fibulae, constituting a lot of furniture and whose types are found over large areas, bracelets are characterized rather by very local modes, specific to a region or a site.

C.4 Other ring ornaments

Others of annular elements complete the range—already diverse— of the jewellery and clothing category. Some elements as torques, earrings, rings or pearls experience a more local dispersion while artefacts as the so called—open discs—appeared to be connected to continental areas and to Greek contexts as the Hera Sanctuary at Perachora (Greece) (Verger 2000, Verger and Pernet 2014).

C.4.1 Torques: Three twisted or helicoidally torque fragments were identified at Rochelongue (RCH1.2017.00589, RCH1.2017.00209, RCH1.2017.00571). This, type is rare, but we know several copies especially in the deposit of Arz a Uchentein (Ariege, France), among which some have undergone incomplete twists (Guilaine et al. 2017).

C.4.2 Ear pins: A piece of this type was identified at the Rochelongue deposit. An initial assessment of these objects (Galan and Soutou 1959:235; Guilaine et al. 2017) showed that the distribution is centred in the west Languedoc. The linked chronology for this object is around seventh century B.C.

C.4.3 Discs with central bulge: Remains of open-worked discs in bronze have been attributed to discoidal feminine ornaments probably worn at the level of the belt (Guilaine and Cantet 2007:235; Guilaine et al. 2017). Four copies of these discs have been identified in Rochelongue (RCH1.2017.00992(bis); RCH1.2017.00995; RCH1.2017.00994; RCH1.2017.00993). These elements are in the form of curvilinear flat plates with sub-triangular section. The decoration consists of contiguous hatch triangles or toothed detaches pointing towards the inner part of the piece. This pattern

emerges, in symmetry, reserving triangular spaces, point oriented outwards. This decoration is characteristic from Jura areas and other western regions (France/Switzerland) (Déchelette 1908; Millotte 1963a) with a chronology between seventh–sixth century B.C. Fragments discovered in Perachora (Corinth, Greece) is related to the types found in Switzerland (Verger 2005:104).

C.4.4 Rings: Closed rings with a solid section are known in Launacien hoards, without being typical of these sets. These pieces could have had very diverse focal points: part of pins, elements of chains, meshes, pieces of harnessing etc. Rings are certainly underestimated as archaeological object and the information that can provide because of the difficulty of their interpretation. The few copies concerned are indeed firm rings, generally of section in 'D' with diameters between 15 and 20 mm. The site of Rochelongue has delivered a good series of this kind of objects (RCH1.2017.00283, RCH1.2017.00284, RCH1.2017.00285, RCH1.2017.00286, RCH1.2017.00287, RCH1.2017.00288). A special case for Rochelongue is formed by rings presenting discontinuous reliefs, in certain occasions with up to four protuberances.

C.5 Beads

There are no beads in the Launacien hoards (Guilaine et al. 2017:235). Rochelongue assemblage present many objects that can be easily mistaken as beads but most of them are part of rings or chains. The number RCH1.2017.00754 it can be interpreted as a bead, but it can be also part of a hairpin. However, the number RCH1.2017.00937 is a group of four fragments of rounded pieces that together with RCH1.2017.00938, RCH1.2017.00939 and RCH1.2017.00940 (small cylinders) seems to be decorative vitreous bead part of a neckless. The presence of vitreous beads seems to be linked to the problematic of the commercialization of amber during LBA–EIA (Milcent 2013). In this sense even amber is not present in the collection, the beads seem to be indirect evidence of trade with the Alpine and northern Italian area behind the trading of amber artefacts (Graells 2014b: 259).

C.6 Hairpins

Following the LBA-EIA, hairpins continue to be a costume element whose representation is variable according to the regions and sites, especially for central-European area (Dubreucq 2012:45). Some of these hair-pins appear as cultural markers due to their peculiarities. For the case of Launacien hoards hair-pins are not a characteristic element (Guilaine et al. 2017). However, is significant the presence in the Rochelongue site of various kinds of hair-pins: globular head and helicoidal stem (RCH1.2017.00567) or bi-convex head (RCH1.2017.00972, RCH1.2017.00977) together with a number of fragments that are ambiguous in for clear interpretation and can be part of bracelets. The so-called *scalptorium* (RCH1.2017.01018) is considered in this group. This object is a 'personal accessory' sometimes associated with tweezers and hair-pins, its presence is not registered for Launacien hoards. The one at Rochelongue is a rammed-up piece with a smooth shank and a bifurcated end (Soutou 1959).

C.7 Buckles

Buckle belts are not common in Launacien deposits. A single fragment in Launac (Guilaine et al. 2017), another in Vénat (Coffyn et al. 1981) and one more Arz in Uchentein (Ariège) (Guilaine et al. 2017: 209) are the only registered for this kind of archaeological context. However, they are frequent in incineration burials in the Languedoc area and in the area of Catalonia, having an important extension in several areas of the Iberian Peninsula (**Figure 6.7**) (see Graells and Lorrio 2017: for more complete study of these artefact) .The buckle belts elements in Rochelongue consist essentially of three types: The so-called 'Acebuchal' type, the 'Fleury' and the ones formed by quadrangular plate.

C.7.1 Type Acebuchal: The 'Acebuchal' type characterized by presenting a hook; rhomboidal plate; open notches; with trapezoidal heel; and anchoring system exclusively by three holes for attachment to the leather belt - or exceptionally four-or incorporating in addition two tabs on its back.

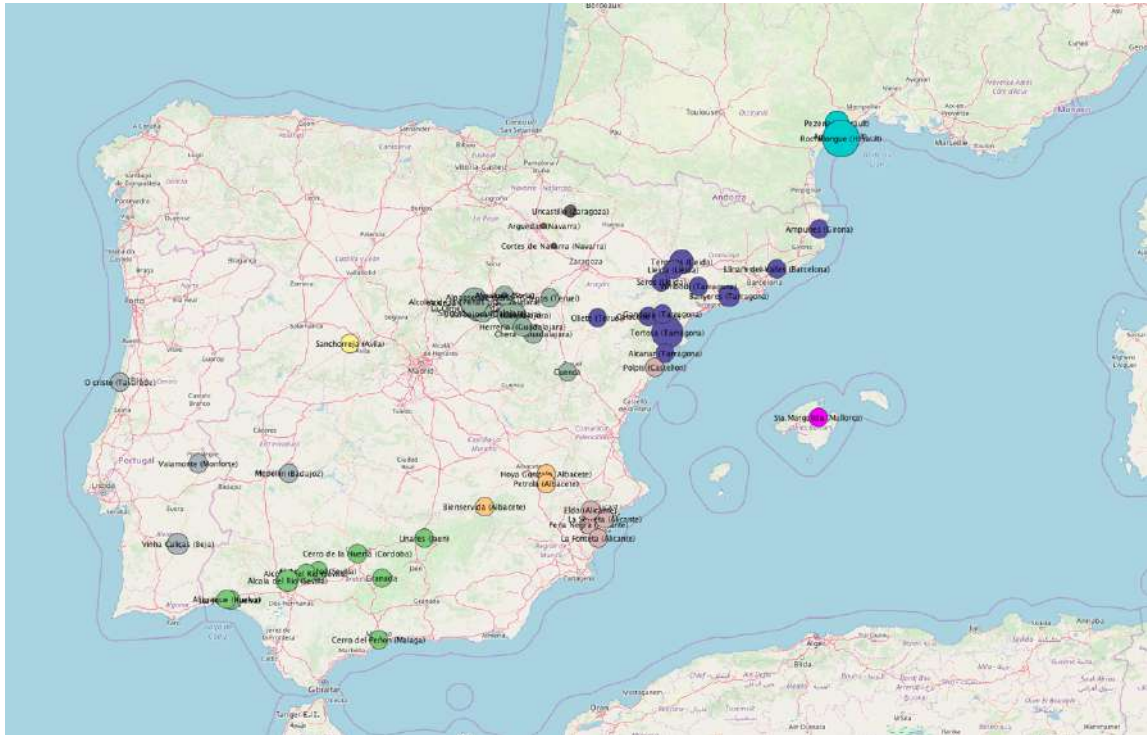


Figure 6.7. Distribution of belt buckles; node size reflects relative number of belt buckles and node colour is based on areas of distribution (based on information from Graells and Lorrio 2017)

This model presents mostly decoration with geometric figures (**Figure 6.8**) with concentric circles and spirals. Sometimes the central plate is decorated with a cross, rhombus, rectangles and more rarely a central 'X'. The presence of snake motifs in the area of the hook is significant. In Rochelongue there are 14 objects of this category (e.g., RCH1.2017.00783, RCH1.2017.00777, RCH1.2017.00833). The decorative motifs cover the series AA2, AB1, BA2 and BA3 of the typology proposed by Graells and Lorrio (2017).

For these models is proposed a chronology of the first quarter of the sixth century B.C. for the Gulf of Leon. The examples of Rochelongue find parallels in well-documented archaeological contexts of the area of Catalonia such as Sant Jaume (Alcanar, Tarragona), habitat of the Tossal Redó (Calaceite, Teruel) or the M.43 tomb of the Coll del Moro necropolis (Gandesa, Tarragona). Some of these contexts, such as the necropolis of Mas de Mussols (La Palma, Tarragona), can extend the chronology until the middle of the 6th century B.C. (Graells and Lorrio 2017: 97-98).

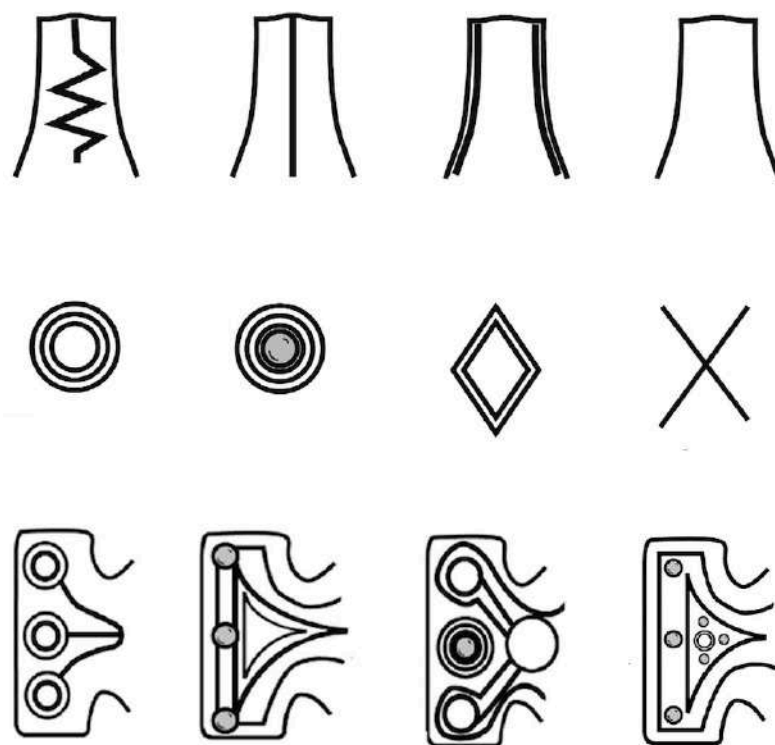


Figure 6.8. Some of the design decoration from Acebuchal buckle belts of Rochelongue (Source: after Graells and Lorrio 2017:48–50 fig.10,11 and 12)

C.7.2 Buckle Type Fleury: The buckle belts with a hook appear for the first time in Catalonia and in the south of France at the end of the seventh century B.C. under this Fleury type. They are pieces with the rhomboid body decorated with gaps in all its surface and characterized by a strong longitudinal rib that runs through the body of the plate and the hook. This kind of ribs seems to persist in latter models as decoration. Graells and Lorrio (2017:66) argued that some buckle belts found in the site of La Motte (Agde) that shows italic influence from the alps, are actually the prototype of the Fleury models. In Rochelongue a number of 10 objects are integrated in this group (e.g. RCH1.2017.00784, RCH1.2017.00822, RCH1.2017.00831). Most of the examples of this type of belt are concentrated in the western area of the Gulf of León, covering Catalonia and southeast France. However, a fragment found in Leganes (Madrid) (Penedo et al. 2001) open an interesting discussion about the interaction between the coast and the interior (Graells and Lorrio 2017:71) as I will discuss further in chapter 8. The proposed Chronology for the Fleury buckle belts is ca. 625–575 B.C. (Graells and

Lorrio 2017:72). However, some archaeological contexts as Can Piteu–Can Roqueta (Sabadell, Barcelona) (López Cachero and Rovira 2012) suggest a temporal range between ca. 675–550 B.C.

C.7.3 Buckle with quadrangular plate: This type come from Middle Valley of the Ebro and the central-eastern of the Iberian Peninsula and they are relatively varied from the point of view of morphology and decoration. The example from Rochelongue (RCH1.2017.00788) is quite simple. A trapezoidal shape ending in a hook and non-decorated plate. At the back the main body of the object has a rib crossing. This buckle is completed with three holes as attachment system. Even some parallels show decoration inspired by Fleury's type, quadrangular plate need to be considered as a more tardive model (Graells and Lorrio 2017:79).

An evolution of these belts is the so-called 'buckle belts with application of decorative plate' in gold or silver. These models are chronologically later than the previous ones an example of this object from Mailhac (Janin et al. 2002:88) provides a precise chronology, between ca. 525-475 B.C. (Graells and Lorrio 2017:86). In Rochelongue this type of belts have not been found, although three decorated metal fragments (RCH1.2017.01367) seem to coincide with the type of decoration that were added to these belts (**Figure 6.9**). Finally, in Rochelongue there are three fragments of a less frequent typology as the rectangular belt plate with a hook, decorated with moldings. This object (RCH1.2017.00905, RCH1.2017.00844) find parallels in some protohistoric incineration necropolises in the northeast of the Iberian Peninsula, in sites such as El Coll, Barcelona (Muñoz 2006), El Pla de la Bruguera (Clop et al. 1998:26–27 fig.11) or in Can Piteu-Can Roqueta, Sabadell (López Cachero 2005).

C.8 Buttons or appliques

Under this generic term several pieces generally attributed to clothing were classified (Nickels et al. 1989; Taffanel et al. 1998). At Rochelongue, there are a total of 564 objects that can be considered buttons or appliques. These types of buttons are also known in Launac depot, Carcassonne and Saint-Saturnin (Guilaine et al. 2017). The Rochelongue site also comes with two small flat circular buttons (e.g. RCH1.2017.00748

and RCH1.2017.00749) and some quadrangular examples (RCH1.2017.00760, RCH1.2017.00765, RCH1.2017.00863, RCH1.2017.00864). These flat or calotte buttons are present in the incineration burials of west Languedoc with a chronology of the seventh century B.C.

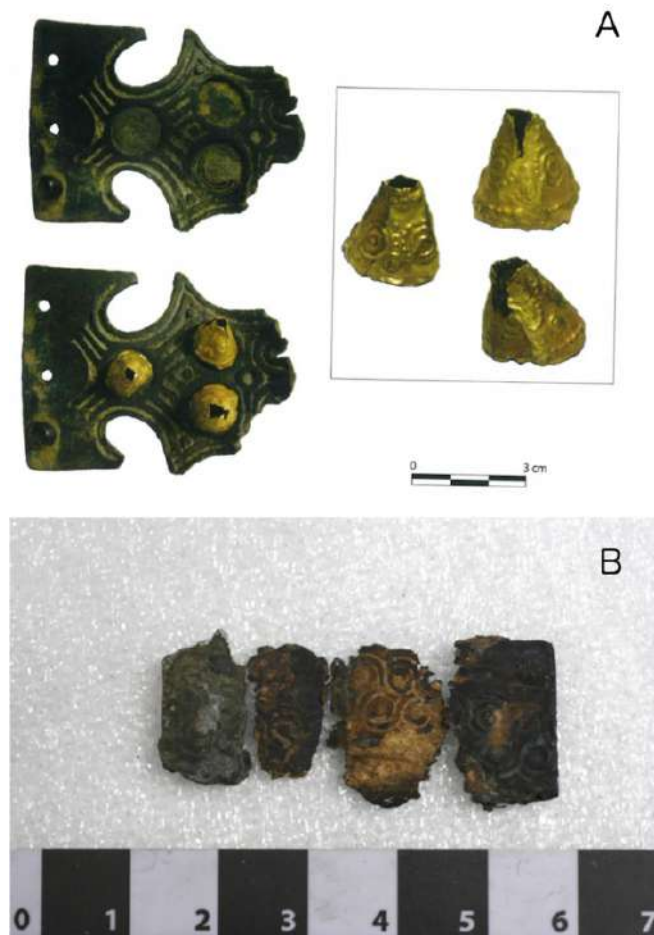


Figure 6.9. A) Belt buckle from Albacete Museum (from Graells and Lorrio 2017:249, Cat. C, n. 9, pl. 13); B) Fragments from Rochelongue assemblage (photograph by author)

D. Diverse

D.1 Harness

Solid rings with a solid section are known in Launacien hoards without being typical of these assemblages. The deposit of Rochelongue contain 392 of these objects. These

pieces have very different functions: rings, complement of pins, elements of necklaces, clothes or belts, elements of chains, meshes, pieces of harnessing, etc.

During the second half of the seventh century BC appear new metal elements that introduce new techniques and decorative motifs in rope or elements in relief, widely studied (Armada and Rovira 2011; Graells 2008:66–72, 2010:214–219; Graells and Sardà 2007; Maluquer de Motes 1984; Neumaier 1996; Rafel 1997; Rafel et al. 2010a:55–56). This type of pendants with this concrete decoration is found in many of the decorative elements of the Rochelongue assemblage (e.g. RCH1.2017.00522, RCH1.2017.00782, RCH1.2017.01163). Relevant elements such as the support of Calceite (Armada and Rovira 2011; Graells and Armada 2011) or Peyros (Gailledrat 2013) are in this decorative dynamic that also includes important samples of pendants with zoomorphic motifs that extend to more distant areas such as Islas Balearic Islands or Levantine areas of the Iberian Peninsula (Graells and Lorrio 2017: 71–78). For these pendants, an influence of the Sardinian toreutic (Sardinia) (Rafel 2002) or even Greek (Graells and Sardà 2007) has been proposed.

Among the harnessing elements, it is necessary to distinguish a crossing button found at Rochelongue (RCH1.2017.00753) with similarity discoveries at Launac and Croix-de-Mus (Hérault). These objects correspond to the type 'Ringfubknopf' of Kossack (1954). These hemispherical objects present a belly with a cross. These objects were found in a functional context in tomb 99 of the Great Basin I necropolis at Mailhac (Aude) accompanied by small ornamental buttons bridles and horse jaws; this set is dated to the seventh century B.C. Finally, some round or quadrangular elements equipped with a lateral ring which Rochelongue has several copies, can be mentioned to be included in this group.

D.2 Appliques

These saddlery trimmings are well known in Europe (Kossack, 1954) since they regularly appear in burials together with remains of a harness and carriage. They are also frequently found in metal hoards. At Rochelongue (e.g. RCH1.2017.00860, RCH1.2017.00861, RCH1.2017.00862, RCH1.2017.00863, RCH1.2017.00864,

RCH1.2017.00865, RCH1.2017.00867) they are circular and have a small central depression; the belly is made up of a double bar. From Rochelongue assemblage we have some others appliques with small conical shape on its upper face. Another type together with this category are rectangular plates, flat, provided with a belly off centre.

D.3 Metal Vessels.

The metallic tableware elements constitute a document of chronological and cultural interest, since they are frequently linked to foreign imports (Guilaine et al. 2017:242). Essentially linked to the wine service, they are in a small number with respect to the Launacien contexts. In these metal deposits the most common forms are the bowls with pearl edge and the so-called 'situlas' conical vessel in bronze highlighting the one found in Saint-Saturnin (Garcia 1987). These objects have traditionally been linked to the Etruscan world because of their typology, although recently, based on their metal composition, a possible local origin has been proposed (Guilaine et al. 2017:140).

In Rochelongue however none of these forms have been identified. The only pieces that can be directly linked to metal vessel are the RCH1.2017.00755 and RCH1.2017.01041. The first is a vertical handle, for which parallels have been proposed in a bowl located in tomb 8 of the necropolis of Anglès (Girona). For the example from Catalonia, central European or Nordic origins were proposed (Pons and Pautreau 1994) although the closest models seem to be in central-Mediterranean zones (Bernardini and Botto 2015; Graells 2007). Other fragments from Rochelongue can also be interpreted as handles or hooks for metallic bowls (RCH1.2017.00589, RCH1.2017.00510).

The second fragment corresponds to a simple bowl edge without decoration (RCH1.2017.01041) that may be interpreted as the group of hemispheric cups in bronze that are relatively frequent in archaeological context at Languedoc for the LBA–EIA. These containers, defined as local productions (Gruat 2003; Verger and Pernet 2013:121–123)(Gruat 2009, Verger and Pernet 2013:121–123) have a diameter that does not exceed 20 cm and height 8 cm. They are either smooth or decorated concentric circles made to regrow from the outside. These are essentially discoveries

made in the funeral context mainly graves of eight or seven centuries B.C. J.C. In the context of Launacien there is an example (five fragments decorated three without decoration) in the depot of the Cross-of-Mus in the Herault (Soutou and Arnal 1963).

Other bronze fragments from Rochelongue may be linked to this type of metal vessel—although it cannot be assured. The number RCH1.2017.00829 and RCH1.2017.00830 perhaps belong to a 'simpulum' (ladle with a long handle) that appear frequently in the contexts of Languedoc and Catalonia for EIA. Finally, some objects as RCH1.2017.01404 and RCH1.2017.01054 can be interpreted as specific objects. The first one seems to be part of what could be a bronze top, the second one has been interpreted in some occasion as a handle (Guilaine et al. 2017:249 fig. 53, no. 7).

E. Raw Metal

E.1 Lead and tin

A relatively large number of fragments of lead and / or tin plates are associated with the material set of Rochelongue. However, they are not relevant enough to be considered as evidence of material exchange. Equally it is not expensive the ascription of many of these fragments with the archaeological context (LBA-EIA) that I cover in this study.

E.2 Plano-convex ingots

The so-called 'plano-convex' ingots generally have a circular or slightly oval shape; porosity can be low but usually very high (especially in the bigger examples). A large number of these ingots appears partially fragmented. Two types can be distinguished based on size for the period of LBA–EIA. Type 1 (big module) and Type 2 (small module) (**Figure 6.10**). The plano-convex ingots with big modularity are present in large number in the west of France presenting a morphology very similar to the found in England (Roberts and Veysey 2011). The smaller ones, however, seems to be more frequent in the area of the Iberian Peninsula (Montero Ruiz et al. 2011; Ramos 1993). The number of plano-convex ingots is higher in the west of France if we compare with the rest of the territory (Boulud and Fily 2009). south of France is an exception and fragments of

ingots are found in metal hoards (Gomez de Soto and Milcent 2000; Guilaine et al. 2017). The remains are concentrated in certain deposits such as Launac, Batares and Roque-Courbe (Guilaine et al., 2017:148) while most of the metal deposits do not show remains. Furthermore, ingots are inexistent in metal hoards in the north (Blanchet 1984) or very little in areas as Burgundy (Mordant 2001) or in the Alps (Fischer 2012).

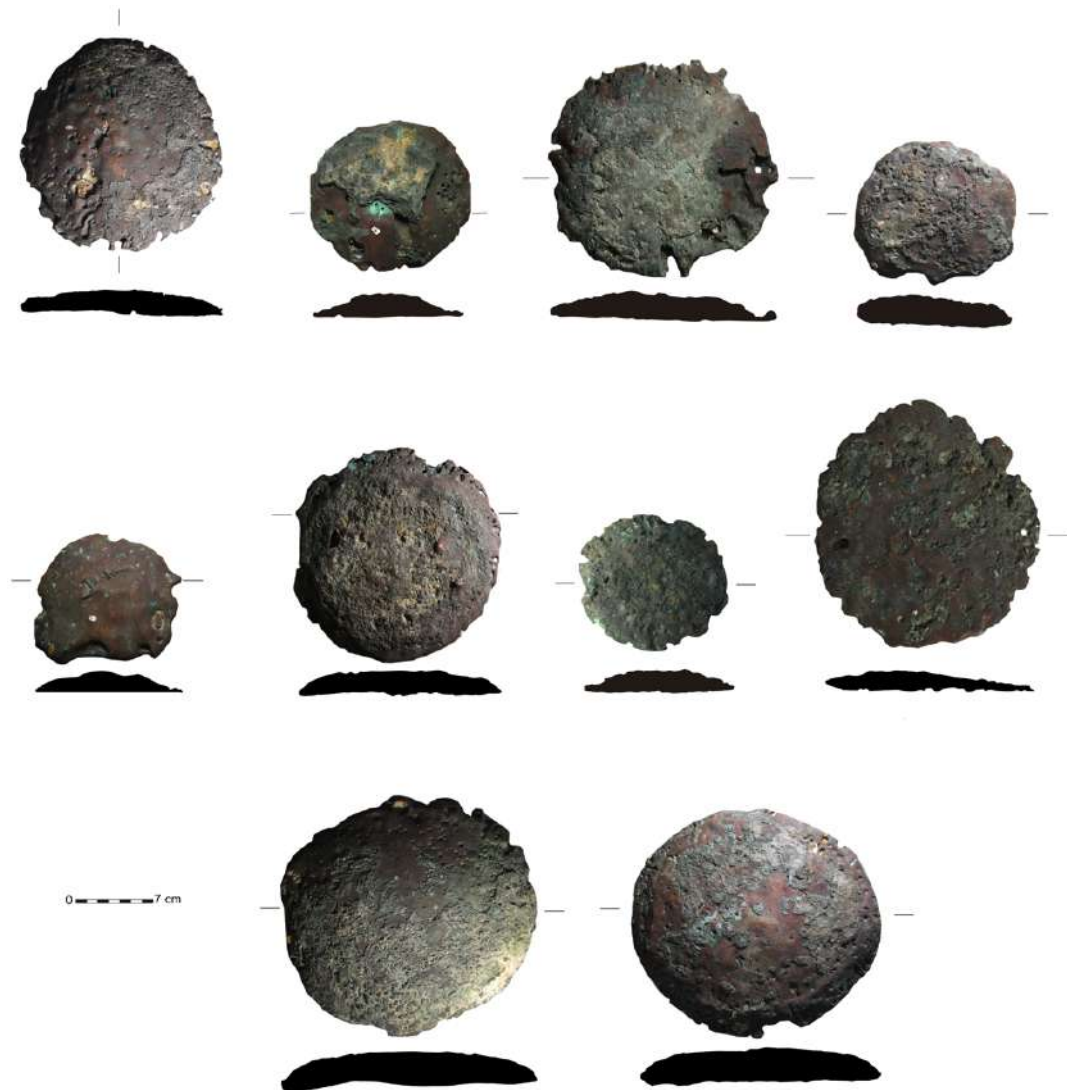


Figure 6.10. Examples of copper ingots from the Rochelongue underwater site showing size variations (photographs by author).

In Rochelongue a total of 112 plano-convex ingots and 2,961 fragments has been found, some of them were showing 'Y' mark (painted?) (RCH1.2017.00615) and graved

marks (**Figure 6.11**) (Garcia 2002:38). Unfortunately, these examples are only preserved in the pictures from field diaries. The ingots with the marks wasn't located in the assemblage. It can be considered the possibility that the marks have been affected by the corrosion of the object. In Launacien deposits another typology its usually identify 'bar ingots' (Guilaine et al. 2017:35) small fragments with 'D' section sometimes unclear to be considered even as 'ingot'. In Rochelongue these group are represented by a number of 17 in total (e.g. RCH1.2017.01027, RCH1.2017.01028, RCH1.2017. 01029, RCH1.2017.01031, RCH1.2017.01032). I will return to these objects later in this chapter since they have been the main object of the metal studies.

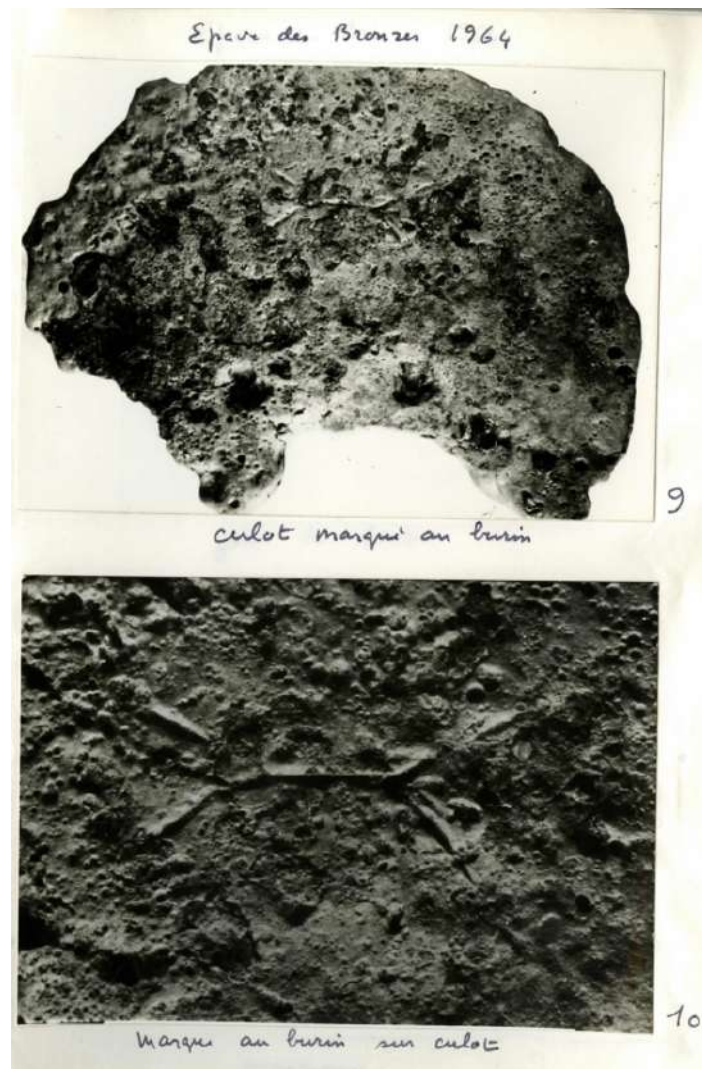


Figure 6.11. Marked ingots (from Bouscaras 1964 excavation report, DRASSM Archive)

E.3 Slags

Finally, a small number of objects that could be linked to foundry residues have been identified in Rochelongue (e.g. RCH1.2017.01049). The metal slags 'correspond to the excess metal remaining in the funnel above objects cast in a mould' (Le Carlier de Veslud et al. 2014:509). At Rochelongue a fragment of slags results from the melting of the axes. However, from the conserved photos of the field journals it can be identified that at least two other objects of this type existed in the assemblage.

6.2.2 Chronological considerations

As explained in chapter 2, the chronological framework of this work extends from the LBA to the EIA periods during which develops the societies that will ends in the so-called 'Launacien phenomenon'. In the case of metal hoards such as Rochelongue, establish an absolute chronology was not possible due to the lack of organic elements that allow us to obtain this kind of information. It is through the study of metal artefacts that a relative chronology can be established. Understanding the functionality and evolutions of various forms of artefacts, I have established a precise time range. Note that the system used is based on the chronology of the south of France in correlation with the Mediterranean (Chapter 2:17, fig.2.4). For Rochelongue assemblage, then the only option is to identify elements between well-studied archaeological contexts that permit better chronological definition (Guilaine et al. 2017). Overall, metal deposits contain three types of objects that can help us to clarify relative chronology: First, objects recognised in other assemblages in archaeological context along Languedoc (habitat or burial). In the second group we find some objects that are only known in Languedoc metal hoard context.

Finally, a third group is based on the absent objects, which will give us a limit in the time scope. All these three aspects will permit me properly define the chronological framework of the metal assemblage. For the first group the arrowheads can be taken into consideration. Examples discovered in the grave 142 of the necropole of the Moulin in Mailhac was dated at the beginning of the transition phase Bronze/Iron (Taffanel et al. 1998:305 fig.409). Another reference comes from the oppidum of Cayla,

where these types of artefacts have been dated in the LBA IIIb, between the ninth and eighth century B.C. (Taffanel et al. 1958:87 fig.57 no.5). Some examples, however, could be dated from the first quarter of the 7th century (Guilaine et al. 2017). On the other hand, fibulas have been the element frequently used for relative chronology. Double spring fibulae are documented in close context of the sixth century B.C. in the necropolis of La Pave (Taffanel et al. 1958:136-175)) and burials 34 et 293 of the necropolis of Moulin (Taffanel 1956) receiving a chronology ca. -775/-725. Some consider them with continuity until later fifth century B.C. (Argente Oliver 1994; Ruiz Zapatero 1985).

The pivot fibulas on the other hand, with examples in archaeological contexts such as Agullana or Can Piteu (Graells 2014b:251) expand their chronology between the end of eighth to the sixth centuries B.C. (López Cachero and Rovira 2012:44). Finally, the fibulae type 'sanguisuga' (RCH1.2017.00545) found in deposits as Carcassonne are very rare to find in Languedoc especially in closed contexts. A copy found in the grave 6 of the necropolis of Grand Bassin I has received a chronology of ca. 650 and 575 B.C. (Guilaine et al. 2017:352). The buckle belts type acebuchal found in burials in Agde (Nickels 1989), together with the Fleury type (Graells and Lorrio 2017) are datable between the end of the seventh and the beginning of the sixth centuries B.C. Although, as mentioned before, decorative elements (Figure 6.12) associated with belts buckles with application of decorative plate, seem to be chronologically restricted to the sixth century B.C. (Graells and Lorrio 2017). Also, some specific bracelets are a very important relative indicator for characterizing the chronology of the deposit. The Grand Bassin I bracelets (Type 4) are dated from the second half of the seventh and first quarter of the sixth centuries B.C. The open and decorated bracelets (Type 7 and 7.1) are also dated from the second half of the seventh and the first quarter of the sixth century B.C.

The average rings, generally known as parts of chains or clothes are well documented in burials since the LBA IIIb to the sixth century B.C. In the second group we find certain objects that are known in Languedoc only in the depot. This is the case with Launacien axes, for which we can retain a contemporary dating of the facies Grand Bassin I (ca.

725 and 575 B.C.). The terminal fin axes, very frequent not only in Launacien hoards but especially in the metal hoards from the central part of France, are dated Bronze Final III. A part, from the mentioned above most of the annular ornaments found in Rochelongue and in Launacien hoards are almost completely unknown in the western Languedoc archaeological contexts such as habitats or burials. The bracelets with bulbous decoration (Type 9, 10, 11 and variations) are numerous in central France where they are dated from middle of the seventh and beginning of the sixth centuries B.C. The bracelets, in particular the decorated pieces with triangular or circular section, are dated between 650 and 550 B.C. (Guilaine et al. 2017:352). Finally, besides the objects identified in the Launacien deposits, it is also necessary to reveal in a perspective of chronological seriation objects totally absent from these assemblages such as the 'Hispanic' annular fibula with a more recent dates, that according to the examples of the necropolis Grand Bassin II is having a chronology ca. 575 and 475 B.C. (Taffanel et al. 1958; Taffanel and Taffanel 1962). In this sense it is possible to argue that although some elements like the fin axes can have an extended chronology (LBA III / ca. 1000 B.C.) most of the elements that make up the material set of Rochelongue occupy relative chronological frame between 650 and 550 B.C. with a total absence of elements dated beyond the first half of the sixth century B.C.

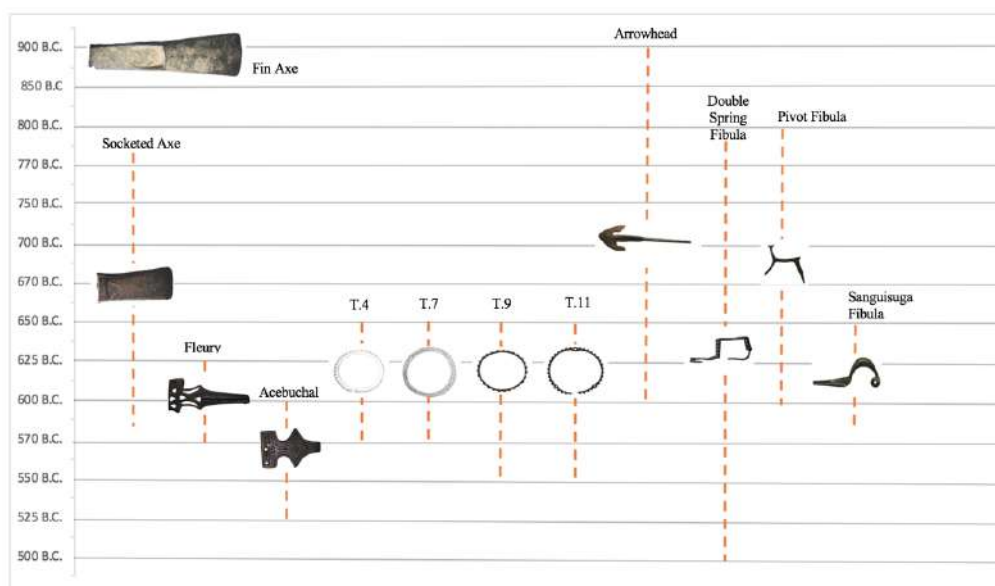


Figure 6.12. Chronological seriation of the Rochelongue artefacts.

6.3. Metallurgical analyses and applications

The Rochelongue assemblage, as we have seen, is connected to the deposition of metal hoards, a characteristic practice of the protohistoric period in southern France linked to the so-called Launacien phenomenon. The practice is an important source of archaeological documentation for EIA manufacture of copper-alloy objects, as well as a key factor in understanding the movement of metals and metal objects at various stages of their production cycle. One way to study these objects is to establish the provenance of their constituent materials for a better understanding of metals trading and circulation. The provenance study includes characterisation of the ore(s) from which the metal was extracted and refined (Pernicka 2014). The analytical method used in this study includes energy dispersive X-ray fluorescence (ED-XRF) for elemental compositional analysis, and inductively coupled plasma mass spectrometry (ICP-MS) for trace elemental analysis. The provenance study is completed by ‘fingerprinting’ the source ore(s) with lead isotope analysis using multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS).

6.3.1 Portable X-Ray Fluorescence (pXRF)

A portable XRF (pXRF) device was used in the present work to take advantage of its non-destructive character, speed, and portability (Shackley 2010, 2012). It is important to remember that this technique provides the elemental composition only of the artefact’s surface, so results can be influenced by possible environmental contaminants and corrosion products from the patina formed as a result of chemical interactions between the object’s surface material and the environmental conditions in which it was deposited (Rovira and Montero 2018:235). For many of the objects in the Rochelongue artefact assemblage, the patina has been removed during conservation treatments. Furthermore, to avoid any interference from the patina, a sampling protocol was chosen that prevents inclusion of the surface layer in the sample (see Chapter 5). The selection of manufactured objects for analysis focused on those object types represented in the collection whose dissemination was more external than local (Figure 6.13). Thus, for example, objects such as fibulae or belt buckles were prioritised over

socketed axes and weapons (Figure 6.14). Thirty-five items out of 90 ingots and manufactured objects were selected for lead isotope analysis.

The metal found in the Rochelongue underwater site is not limited to manufactured artefacts. In this sense an important part of the assemblage is composed by ingots, objects belonging to the category of semi-raw, or semi-processed, metal. The ingot represents a mass of metal destined for conversion to manufactured good through some process of fabrication. As such, it is an intermediate product in the *chaîne opératoire*, whose shape is linked to ease of transport, exchange, and storage (Montero Ruiz et al. 2011:99–100).

OBJECTS SELECTED FOR ELEMENTAL ANALYSIS (N=90)

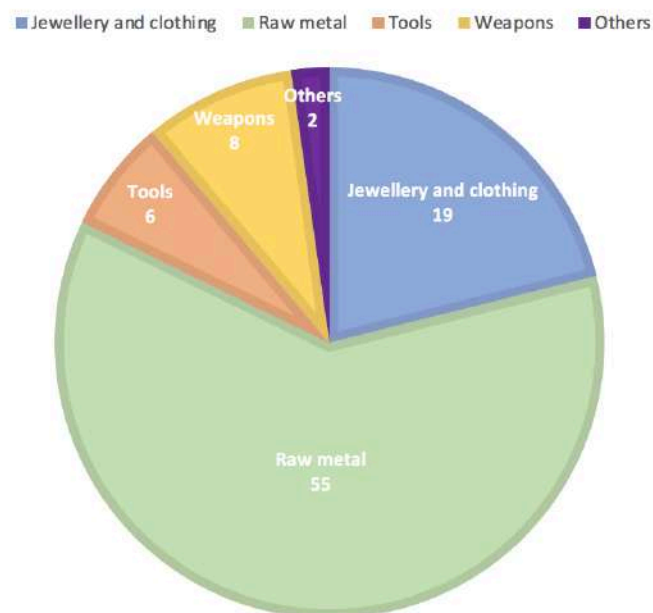


Figure 6.13. Samples (by type) selected for elemental analysis.

Traditionally, studies of Launacien material assemblages have recognised two distinct forms of ingots: the bar and plano-convex types. Both types are found in the Rochelongue assemblage, although the bar ingot is poorly represented and it is unclear in some cases whether the object is an ingot at all. On the other hand, plano-convex ingots make up a large percentage of the overall assemblage (see section 6.1 in this

chapter). For these reasons, the analysis concentrated on plano-convex ingots, with a total of 51 samples.

OBJECT SELECTED FOR LEAD ISOTOPE ANALYSIS (N=38)

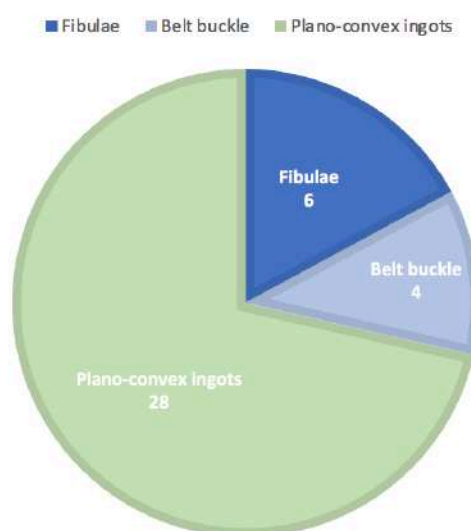


Figure 6.14. Samples (by type) selected for lead isotope analysis.

Additionally, a fragment of what originally was designated as galena (lead ore), but ultimately turned out to be hematite, was sampled for analysis (see Chapter 7 for discussion). Finally, two samples of metal slag were analysed, completing the selected set of 74 objects for elemental analysis by pXRF.

6.3.2 pXRF data reliability

Elemental analysis using pXRF was complemented by analysis using ICP-MS. The elementary detection limits of the latter technique are much lower, which it is used especially for trace elements detection (see Chapter 5). Comparison of these two analytical techniques for determining elemental composition of metals from the Rochelongue assemblage was achieved by laboratory work. Of the 74 samples (artefacts and ingots) selected from the collection, 20 were selected for ICP-MS analysis to validate p-XRF data. While ICP-MS has been commonly used as a reliable method for accurately determining low-level elemental concentrations (Griffith et al. 2009), it has

the disadvantage of requiring significant sample preparation, which pXRF does not. Previous studies indicate that the pXRF used in this study has a detection limit of 0.02 wt% (200 ppm) for most elements, except silver (Ag) and antimony (Sb), for which the limit of detection (LOD) is 0.15wt% (1,500 ppm) (Rovira and Montero 2018:226). The lead (Pb) concentration determined by pXRF correlated closely with the results from ICP-MS ($R^2=0.98$) (Figure 6.15). The plotted results indicate that pXRF has a tendency to overvalue the Pb content, but not significantly. In general, ICP-MS results corroborated the pXRF data for Pb composition and showed that pXRF was a reliable and more expedient method for determining the Pb levels in metals.

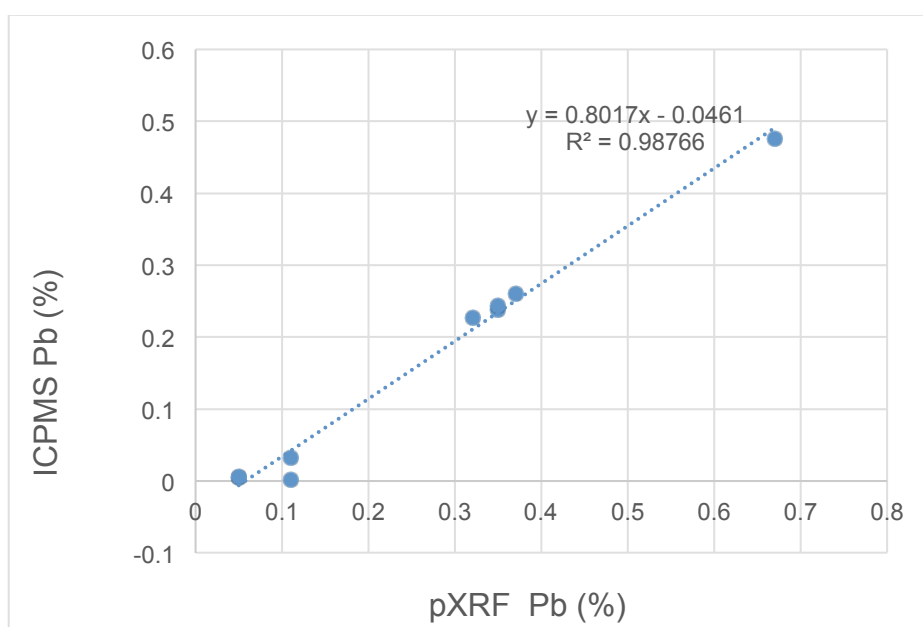


Figure 6.15. Comparative results of lead (Pb) analyses using pXRF and ICP-MS.

The pXRF technique also proved to be an appropriate technique to analyse for arsenic (As), Sb, Ag and nickel (Ni), being less expensive than traditional mass spectrometry requiring sample preparation using acidic digestion, while also allowing for much larger sampling regimes in relatively shorter times. The results of the statistical analysis performed for both pXRF and ICP-MS data sets ($n=20$) are reported in Appendix 2 and show no significant difference between the two methods.

6.3.3 Results of elemental analysis

The objects that make up the Rochelongue deposit are almost all binary bronzes, with tin as the only alloying element (of at least 5 wt%). The bronzes are plotted in Figure 6.16 grouped by tin content, with the largest group having tin levels between 8.8 and 13.2 wt%. Nevertheless, there is a relatively wide dispersion that needs to be examined in more detail.

In the case of lead, most of the artefacts contain less than 2% (Figure 6.18). Only four objects (S0002, S0006, S0037 and S0046) have lead levels greater than 3% and so can be categorised as leaded bronzes.

The raw metal category of objects is an important part of the Rochelongue metal assemblage. Plano-convex ingots make up the vast majority of this group, but it also includes metal scrap material resulting from foundry activities (e.g. RCH1.2017.01049). Since the ingots are only semi-processed, representing an intermediary—both product and feedstock—in the *chaîne opératoire*, they tend to be a single metal with only ‘natural’ impurities found in the source ore. Manufactured metal objects oftentimes comprise alloyed metals or mixed metals resulting from recycling. Thus, ingots lend themselves better to isotopic fingerprinting and provenance studies.

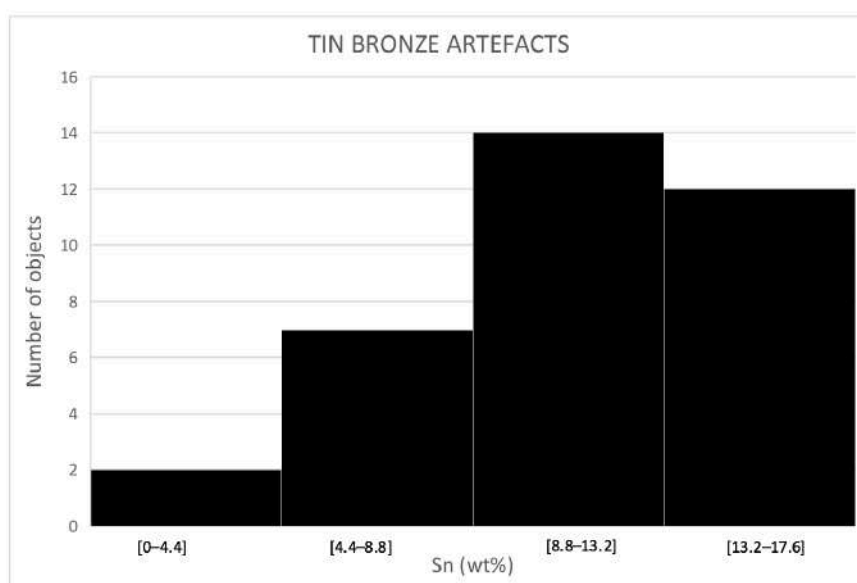


Figure 6.16. Distribution of bronze objects by tin content.

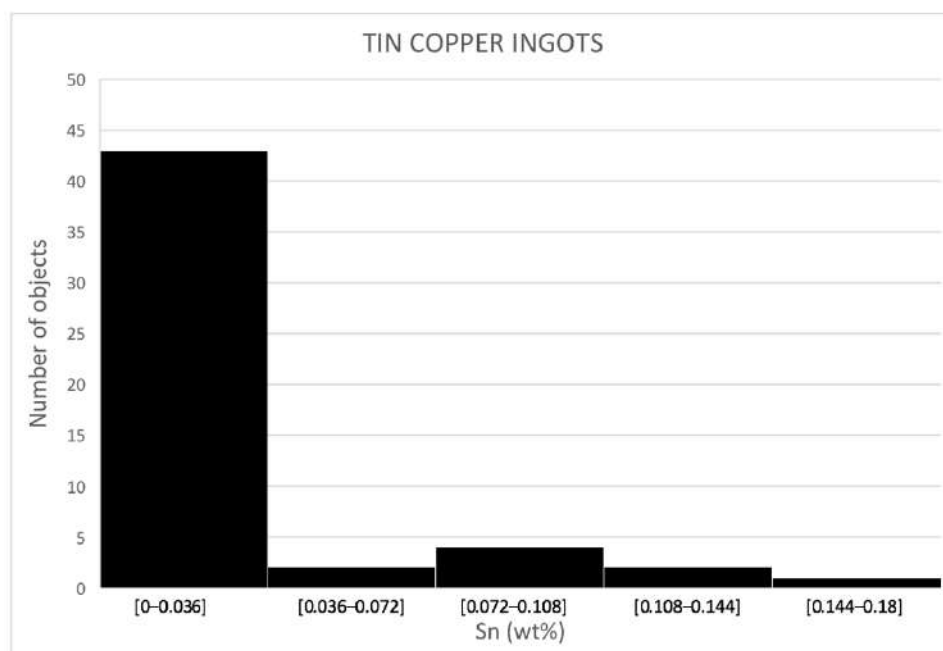


Figure 6.17. Distribution of copper ingots by tin content.

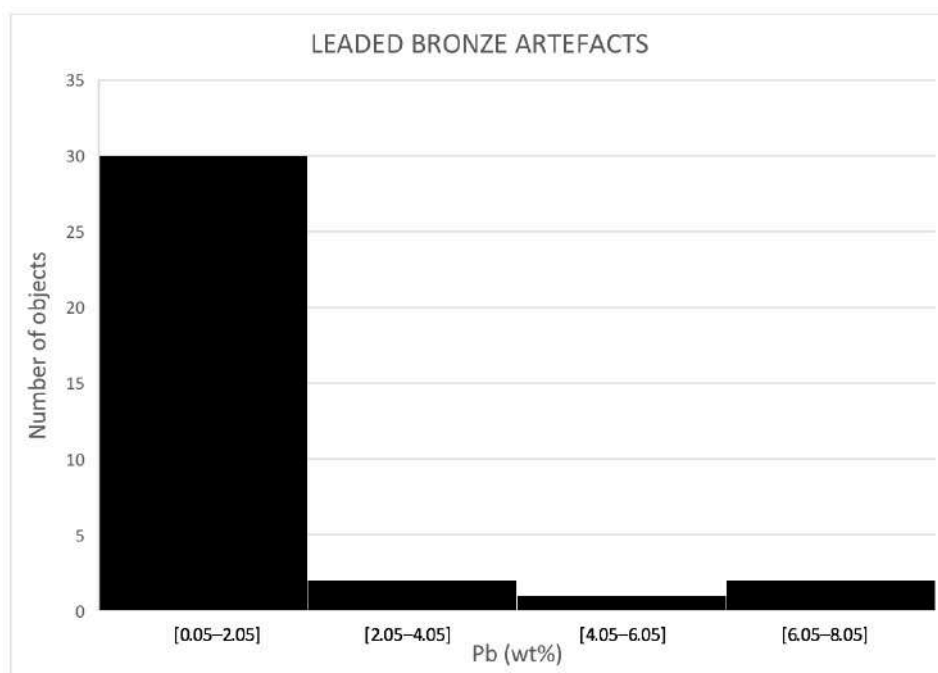


Figure 6.18. Distribution of bronze objects by lead content.

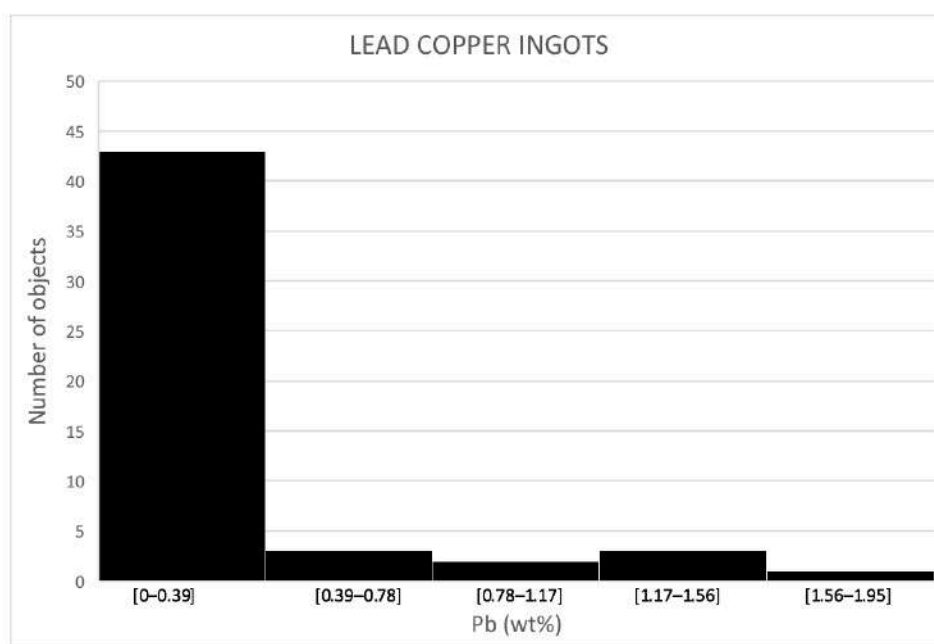


Figure 6.19. Distribution of copper ingots by lead content.

The elemental compositions of the plano-convex ingots from Rochelongue stand in stark contrast with those of the manufactured artefacts (Figure 6.16; Figure 6.17; Figure 6.18 and Figure 6.19). The results of the analyses show that all ingots are unalloyed copper, with the exception of the three lead ingots that were discarded from study (see Chapter 5). The tin and lead contents of a majority of the ingots are extremely low; less than 0.04 wt% or 400 ppm for tin (Figure 6.17) and 0.39 wt% for lead (Figure 6.19).

6.3.3 Cumulative rate of impurities

The materials of the Rochelongue assemblage contain very low levels of impurities, most being less than 0.02 wt% (200 ppm), which is the LOD for most elements using pXRF. To analyse these levels of impurities, the sampled ingots and manufactured objects are classified into copper groups (CG), following the methodology for interpreting chemical and isotopic data from archaeological copper alloys established by Oxford researchers (Bray et al. 2015:85–114; Pollard 2018:5). This method is based on a presence/absence classification system reporting the most common trace elements—As, Sb, Ag and Ni—and provides a means of identifying the dominant signals

running through the data (Bray et al. 2015:205). Using 16 groups, a simple binary YES/NO matrix is created based on the presence or absence of a trace element, which in this case is defined by the LOD for Ag and Sb: greater or less than 0.15 wt% (1500 ppm), respectively (Table 6.1; Table 6.2 and Table 6.3). It is important to note that the resultant groups do not necessarily correspond to specific source regions or sites, but simply are a general comparative characterisation of the metals that can be used to suggest possible source regions. Potentially, these groups can be used to analyse the sourcing and circulation of particular copper groups temporally and geographically (Bray et al. 2015:205).

Table 6.1. Definition of Copper Groups (from Bray et al. 2015:205, figure 1).*

Copper Category	Trace Elements Combination	Trace Element			
		As	Sb	Ag	Ni
1	None	no	no	no	no
2	As	YES	no	no	no
3	Sb	no	YES	no	no
4	Ag	no	no	YES	no
5	Ni	no	no	no	YES
6	As + Sb	YES	YES	no	no
7	Sb + Ag	no	YES	YES	no
8	Ag + Ni	no	no	YES	YES
9	As + Ag	YES	no	YES	no
10	Sb + Ni	no	YES	no	YES
11	As + Ni	YES	no	no	YES
12	As + Sb + Ag	YES	YES	YES	no
13	Sb + Ag + Ni	no	YES	YES	YES
14	As + Sb + Ni	YES	YES	no	YES
15	As + Ag + Ni	YES	no	YES	YES
16	As + Sb + Ag + Ni	YES	YES	YES	YES

* Presence is defined as greater than 0.15 wt% (1500 ppm).

The copper alloy objects of the assemblage are assigned to a particular CG based on the definitions given in **Table 6.1**. The 'ubiquity' of each CG then is determined, which

is the number of objects in each group expressed as a percentage of the total number of objects in the assemblage (Pollard 2018:89–90). Ubiquity in the Oxford Method is simply an ‘expression of how common a particular combination of trace elements is within a particular assemblage’ (Pollard 2018:104). It is a heuristic device that, among other things, allows one to detect variations between typological categories (see Pollard 2018:104–105).

Table 6.2. Allocation of the Rochelongue Assemblage Objects to Copper Groups.

CG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Ingots	22	5	0	3	5	0	0	0	1	0	1	0	0	0	0	0	37
Artefacts	11	10	2	0	3	1	0	0	1	0	5	0	0	0	0	0	33
Total	33	15	2	3	8	1	0	0	2	0	6	0	0	0	0	0	70

Table 6.3. Ubiquities (%) of Copper Groups for the Rochelongue Assemblage.

CG	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Ingots	59.5	13.5	0	0.1	13.5	0	0	0	2.7	0	2.7	0	0	0	0	0	100
Artefacts	33.3	30.3	6.1	0	9.1	3	0	0	3	0	15.2	0	0	0	0	0	100
Total	47.1	21.4	2.9	4.3	11.4	1.4	0	0	2.9	0	8.6	0	0	0	0	0	100

Figure 6.20 shows that all of the analysed materials have low levels of impurities. Impurity levels in only one sample each from the ingots and manufactured objects (S0X8 and S0X21, respectively) exceed 1 wt%. In both material groups, the main impurity is arsenic. This also is demonstrated by the predominance of copper groups 1 (pure Cu) and 2 (arsenic copper).

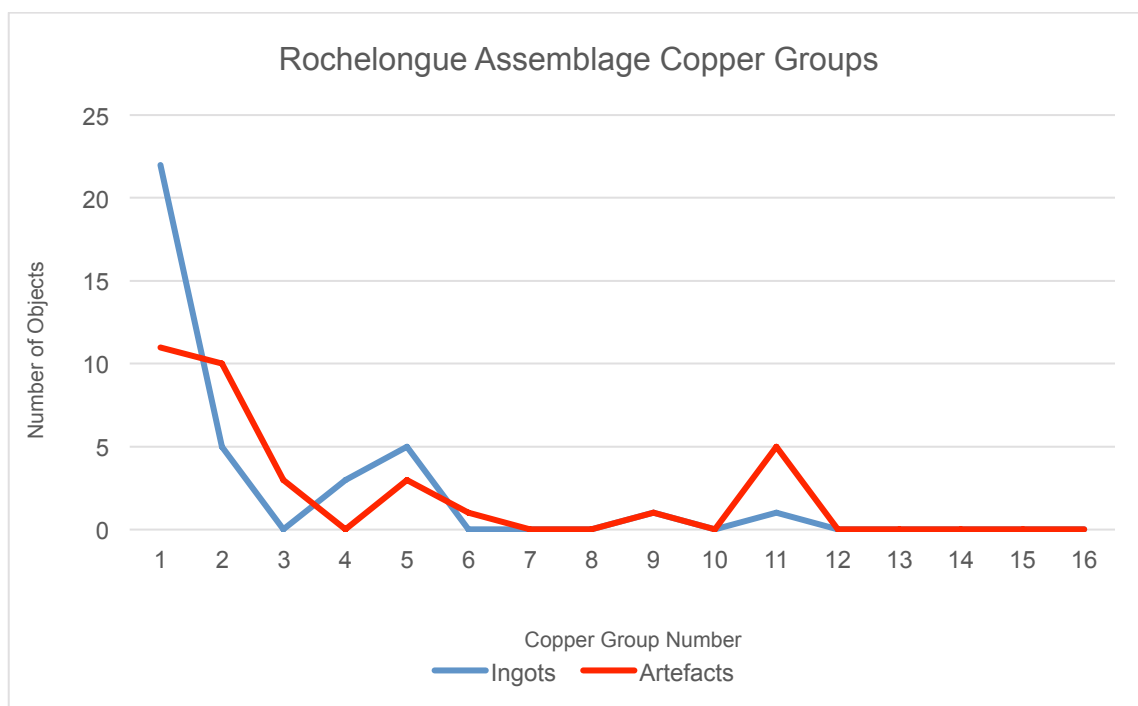


Figure 6.20. Allocation of Rochelongue materials to copper groups.

6.3.4 Lead Isotope Analysis

A selection of objects and ingots whose elemental composition was determined was preferred for lead isotope analysis. Plano-convex ingots are especially significant in this regard, since they represent unalloyed copper, which lends itself particularly well to provenance studies. Almost three quarters (25 of 35) of the plano-convex ingots were analysed, as well as a selection of 10 manufactured objects. Non-Launacien artefacts and objects with a wider (more foreign) distribution were selected preferentially over more locally distributed objects. Thus, for example, fibulae and belt buckles of various types were selected. Beyond object typology, particular attention was paid objects with higher lead contents; two fibulae (S0037 and S0046) and two belt buckles (S0002 and S0006) have a lead content greater than 3 wt%.

The LIA data from the Rochelongue assemblage were compared to that of a number of metalliferous regions in southern France and the Iberian Peninsula (Figure 6.21). The mining region of southern France (S. France) includes Cabrières, Cevènnnes and Montagne Noir (Ambert 1995; Ambert et al. 2001; Ambert et al. 2009; Guilaine et al.

2017; Verger and Pernet 2013). Those of the Iberian Peninsula are Molar-Bellmunt-Falset (MBF) in the Catalanian Coastal Ranges in the north-east; Linares, located in the Andalusian province of Jaén in south-central Spain; south-eastern Spain (SE) around Cartagena, Mazarrón and Almeria and the Ossa-Morena zone in south-western Spain (SW), which is sub-divided into the Arronches-Córdoba Belt (ACB) and the Evora-Aracena Belt (EAB). Much of the data from the Iberian Peninsula was generated by the research project Archeometalurgia de la Península Ibérica (1985–2017), under the direction of Salvador Rovira and Ignacio Montero (Montero Ruiz 2018), and supplemented with unpublished data generously provided by Ignacio Montero. These data correspond mainly to ingots from various EIA archaeological sites. From the Rochelongue LIA results (Table 6.4), it should be noted that at least 10 (S0055, S0056, S0071, S0072, S0076, S0080, S0084, S0088, S0094 and S0097) of the 25 plano-convex ingots analysed have the same isotopic signature.

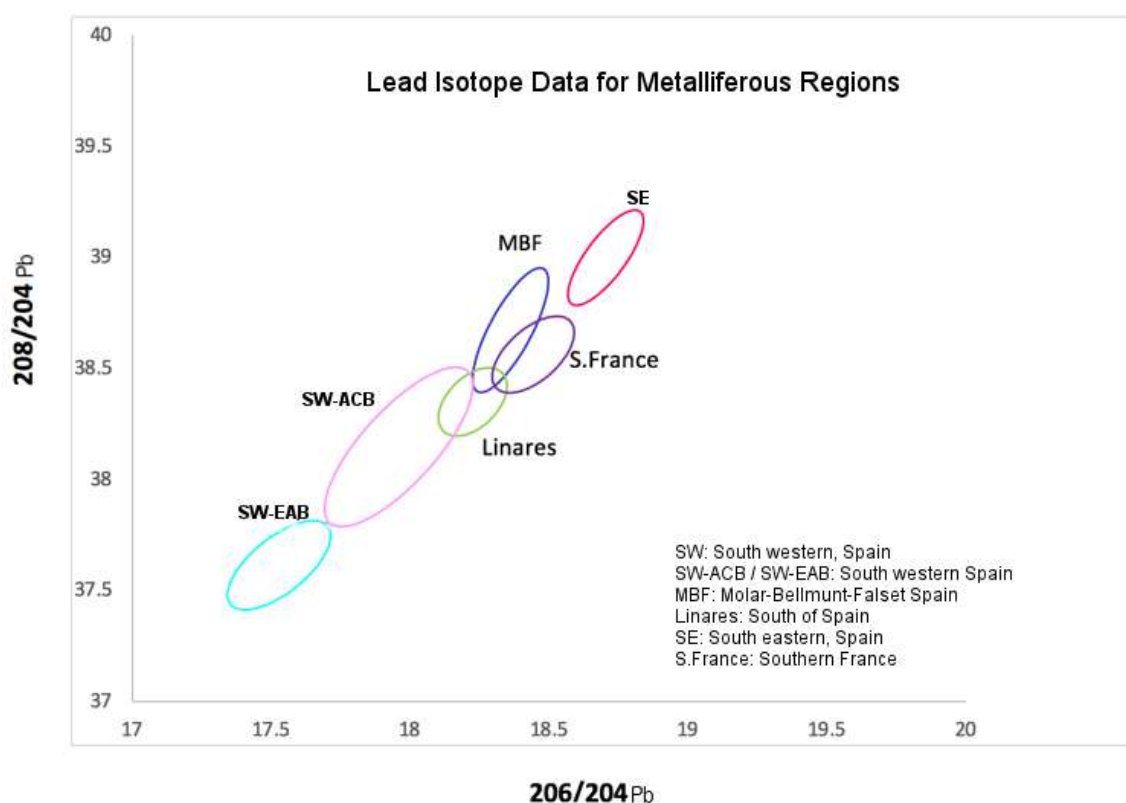


Figure 6.21. Ores from mining regions used for comparative LIA values (Ambert 1995; Ambert et al. 2001; Ambert et al. 2009; Guilaine 2017; Montero Ruiz 2018; Verger et al. 2013).

Table 6.4. Lead isotope analysis results (analyses by SGiker).*

ID	Sample	$^{206}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{206}\text{Pb}$	$^{207}\text{Pb}/^{206}\text{Pb}$
S 0044	Fibula (frag.)	18.2828	15.6446	38.4547	2.10333	0.85570
S 0046	Fibula (frag.)	18.2533	15.6375	38.4218	2.10493	0.85670
S 0037	Fibula	18.2536	15.6382	38.4244	2.10503	0.85672
S 0048	Fibula (frag.)	18.2199	15.6213	38.3708	2.10598	0.85737
S 0041	Fibula	18.2579	15.6422	38.4386	2.10532	0.85674
S 0006	Belt buckle	18.2517	15.6376	38.4186	2.10493	0.85678
S 0002	Belt buckle	18.5166	15.6587	38.5620	2.08256	0.84566
S 0001	Belt buckle	18.3364	15.6398	38.4600	2.09746	0.85294
S 0005	Belt buckle	18.1879	15.5917	38.1978	2.10017	0.85725
S 0036	Fibula	18.2520	15.6370	38.4234	2.10516	0.85673
S 0055*	Ingot	17.9923	15.5489	37.9316	2.10821	0.86419
S 0056*	Ingot	17.9840	15.5508	37.9370	2.10948	0.86470
S 0057	Ingot	18.2822	15.6305	38.3022	2.09505	0.85496
S 0059	Ingot	17.8025	15.5514	37.8772	2.12764	0.87355
S 0060	Ingot	18.5278	15.6573	38.6514	2.08613	0.84507
S 0062	Ingot	18.1006	15.5729	38.1080	2.10535	0.86035
S 0063	Ingot	19.1530	15.6989	38.6859	2.01984	0.81966
S 0066	Ingot	17.6815	15.5357	37.7914	2.13734	0.87864
S 0067	Ingot	19.1667	15.6587	39.6873	2.07064	0.81697
S 0068	Ingot	18.0498	15.5706	37.8712	2.09815	0.86264
S 0071*	Ingot	17.9777	15.5489	37.9316	2.10992	0.86490
S 0072*	Ingot	17.9815	15.5501	37.9386	2.10986	0.86478
S 0073	Ingot	17.4633	15.5068	37.5910	2.15257	0.88796
S 0076*	Ingot	18.0026	15.5542	37.9569	2.10841	0.86400
S 0078	Ingot	17.6949	15.5342	37.8149	2.13705	0.87789
S 0079	Ingot	17.4488	15.5032	37.5712	2.15322	0.88850
S 0080*	Ingot	17.9884	15.5510	37.9409	2.10918	0.86450
S 0081	Ingot	18.7225	15.6385	38.9601	2.08092	0.83527
S 0083	Ingot	18.3030	15.6481	38.3940	2.09770	0.85495
S 0084*	Ingot	17.9796	15.5505	37.9365	2.10997	0.86490
S 0087	Ingot	18.2170	15.5957	38.2200	2.09804	0.85611
S 0088*	Ingot	17.9772	15.5479	37.9280	2.10978	0.86486
S 0090	Ingot	19.1279	15.6918	38.9269	2.03509	0.82036
S 0094*	Ingot	17.9884	15.5486	37.9301	2.10859	0.86437
S 0096	Ingot	18.4019	15.6500	38.5245	2.09350	0.85045
S 0097*	Ingot	17.9799	15.5487	37.9306	2.10962	0.86478
S 0098	Ingot	18.4010	15.6496	38.5346	2.09415	0.85048
S 0099	Ingot	18.3985	15.6495	38.5244	2.09389	0.85059

* Ingots with the same isotopic signature.

A plot of the lead isotope data for the Rochelongue copper groups described above (Figure 6.22 and Figure 6.23) illustrates the wide dispersion of CG1 (pure copper), where $17.4 \leq {}^{206}\text{Pb}/{}^{204}\text{Pb} \leq 19.2$. This copper group has the highest ubiquity value in the Rochelongue assemblage, and the wide range of its isotopic ratios indicates that its constituent objects have the greatest relative number of possible source metal provenances. Categories CG2 and CG5 also have relatively wide lead isotope ratio distributions.

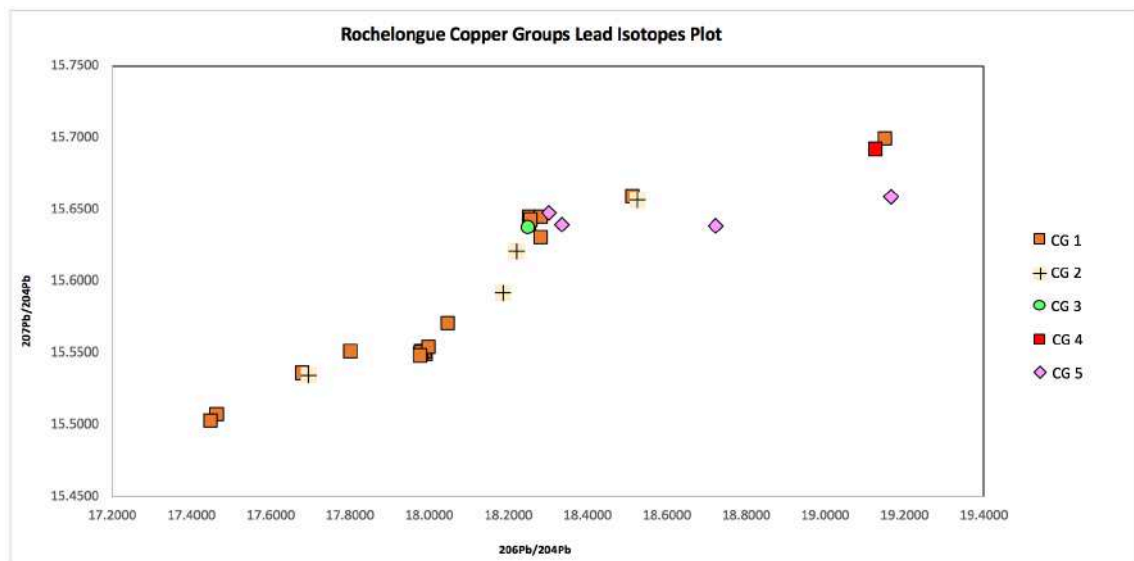


Figure 6.22. Lead isotopes plot for the Rochelongue copper groups.

Consequently, a first conclusion is that the metal makeup of the Rochelongue assemblage is not a good criterion for establishing provenance. When the lead isotope ratios are plotted separately for ingots, artefacts with high lead content and those with low lead contents (Figure 6.24), it is clear that the isotope ratios of artefacts, regardless of lead content, are more tightly grouped than are those of ingots. It can be concluded then that the metal for the manufactured objects was sourced from a specific area, and that the objects themselves can be considered as part of one group. Two ingots (S.0044 and S.0041) also have this same isotopic signature, so they can be assigned to that group as well. Similarly, the group of ten ingots that share an isotopic signature represent a second common provenance. Finally, the rest of the ingots have widely

dispersed lead isotopic signatures suggesting a diversity of provenances. Comparing Figures 6.24 and 6.25, however, it is evident how objects analysed in Rochelongue correlate with the MBF isotopic field. This field also presents some areas of overlap between the ores of Linares (Jaén) and those of southern France ($18.3 < 206\text{Pb}/204\text{Pb} < 18.4$). However, bivariate comparisons of lead ratios represented in Figure 6.24 make it clear that most of the objects (such as S0036, S0041 and S0044) correlate best with ores from the MBF and Linares regions. It is worth noting that objects that correlate to ores from southern France have high lead content. When comparing Rochelongue artefacts with objects from Launacien contexts (Figure 6.25), it is clear that only one Rochelongue sample (S0002) of a leaded bronze correlates to the Launac group. The lead isotope data for the rest of the Rochelongue objects are more dispersed and their ore provenances lie outside of the metalliferous regions discussed here (MBF, Linares or southern France). For now, the source metals for these objects remain undefined, and the objects themselves may have been fabricated from a mixture of metals from various sources.

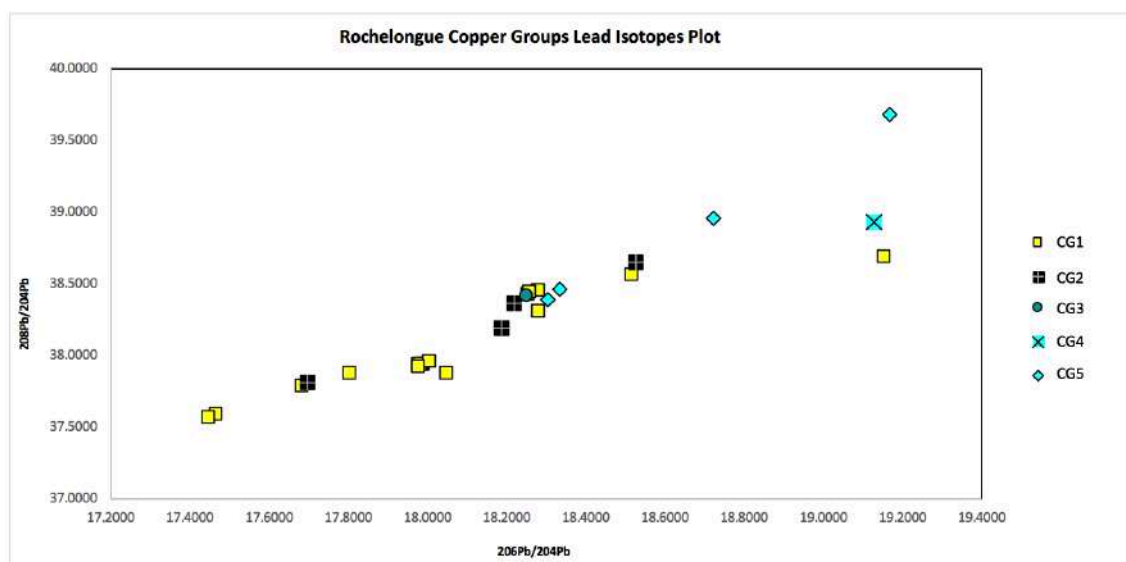


Figure 6.23. Lead isotopes plot for the Rochelongue copper groups.

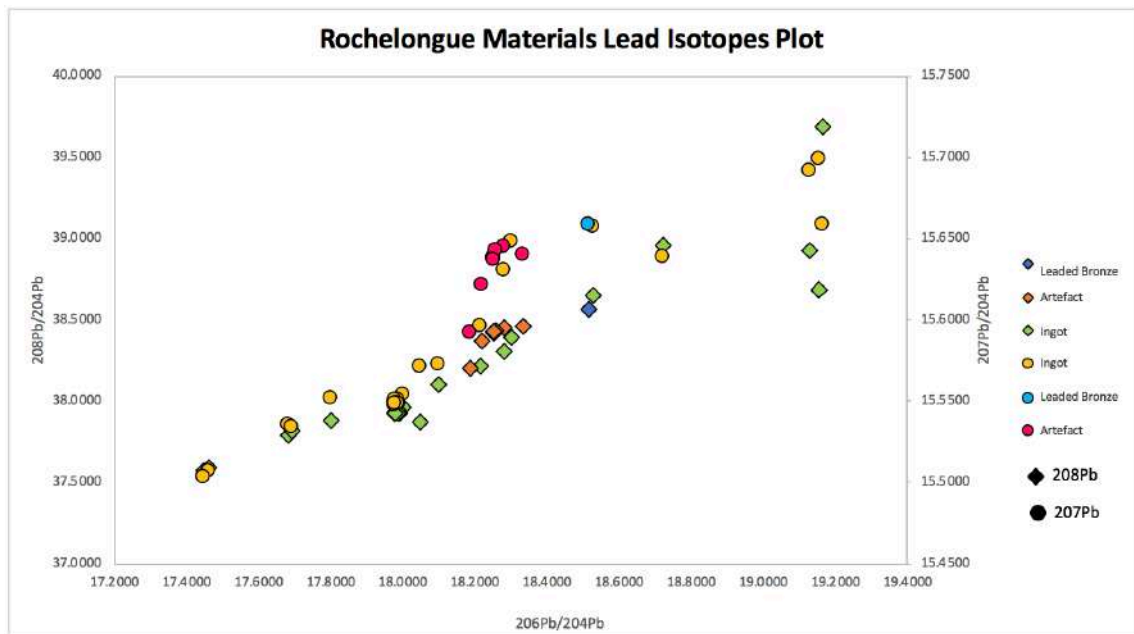


Figure 6.24. Lead isotopes plot for Rochelongue copper alloy materials.

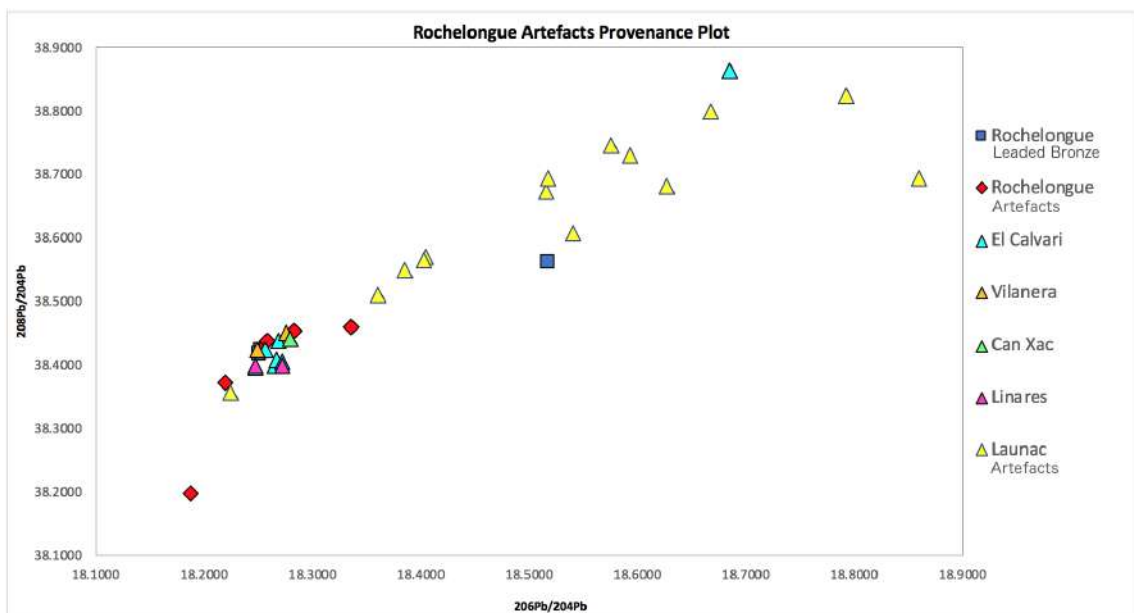


Figure 6.25. Comparison of lead isotope data for Rochelongue artefacts and various metalliferous sites.

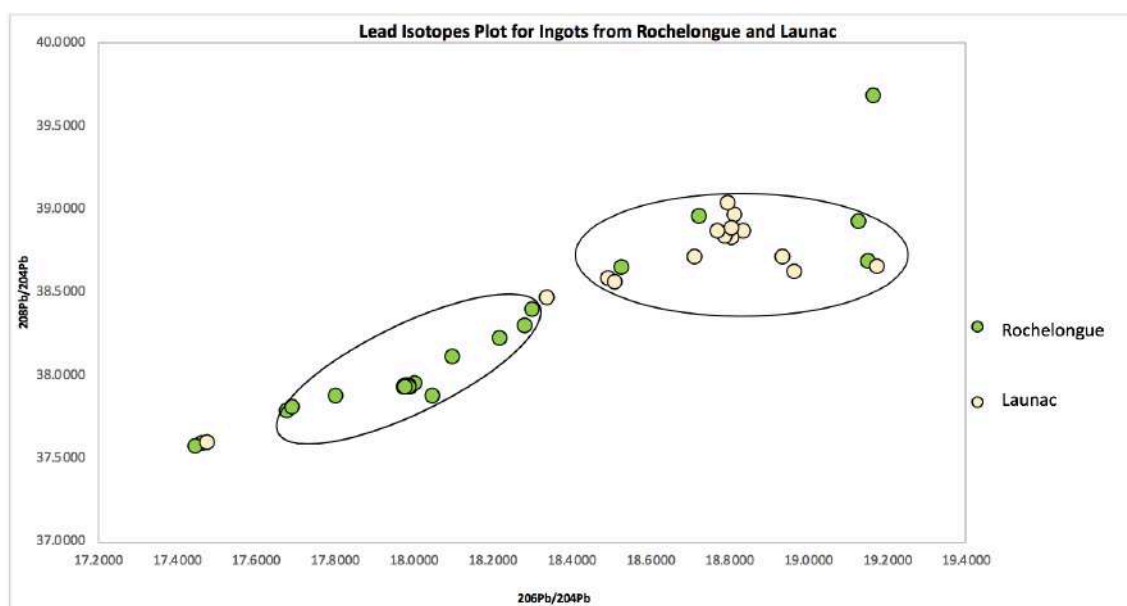


Figure 6.26. Correlation of lead isotope data for ingots from Rochelongue and Launac.

Taking a closer look at the ingots, a comparison of the lead isotope data for those from Rochelongue with that for examples from the Launac deposits (Figure 6.26) shows that the majority of the ingots do not correlate. Only four ingots from Rochelongue share the Launac signature, while the ten Rochelongue ingots that have the same isotopic signature correlate with the southwest Iberian metalliferous region (SW-EAB), while those with $^{206}\text{Pb}/^{204}\text{Pb}$ ratios lower than 18.0 can be ascribed to the south-west Iberian Peninsula as well, but in this case to the SW-ACB region. At least three ingots from the Rochelongue assemblage have an isotopic signature matching the Linares mining region. It is interesting, therefore, that a large number of ingots can be ascribed to the Iberian Peninsula. Comparing lead isotope signatures of these to various copper ingots from EIA sites on the Iberian Peninsula (Figure 6.27), it appears that the Rochelongue site has links to San Martin de Ampurias (Girona) and Turo de la Font de la Canya (Tarragona) in north-eastern Iberia, to El Risco (Caceres) in the western centre of the Peninsula and to La Fonteta (Alicante) on the Peninsula's eastern Mediterranean coast.

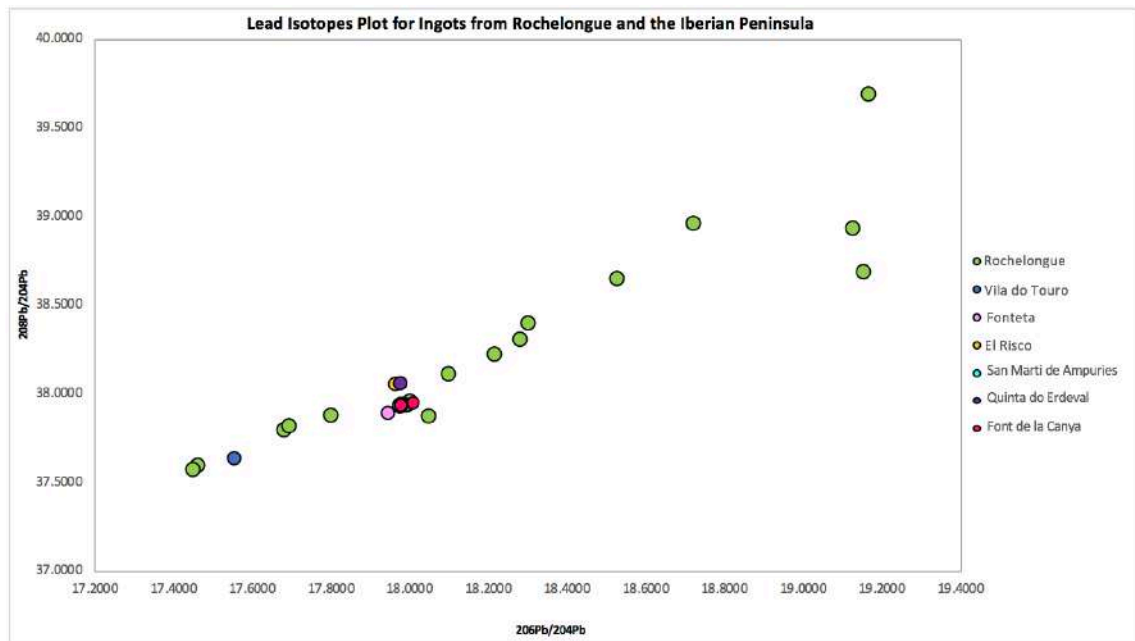


Figure 6.27. Lead isotopes plot for ingots from Rochelongue and Iberian Peninsula sites.

In conclusion, more than half of the sampled ingots from Rochelongue can be traced to the southwestern Iberian Peninsula (Figure 6.28), marking a clear distinction from typical Launacien metal deposits. As for the manufactured objects in the assemblage, their isotopic signatures match artefacts found at sites in the northeast of the Iberian Peninsula, such as El Calvari (Tarragona). Studies have shown that the metal for these objects likely was sourced from mines in the Linares region in northern Andalusia (Montero Ruiz et al. 2012a). At least three ingots in the Rochelongue assemblage have isotopic signatures that correlate to the Linares region as well, suggesting an interesting movement of both raw metal and manufactured object between these three regions—Linares, northwest Iberia and southern France. Nevertheless, the role of Linares is relatively limited according to the number of ingots involved, less than six percent (three out of 51) of the total. These data still are relevant considering that the ingots (raw material) represents 61% of the Rochelongue assemblage, set against the remaining 39% of objects, which can be divided into local productions eminently attached to the Launacien culture, such as the talons Launaciens, and foreign objects such as the belt buckles and fibulae. These results then have direct implications for the interpretation of the Rochelongue assemblage, as is discussed in chapter 7.



Figure 6.28. Sites and Mining areas mentioned in the text (map by author).

6.4. The Maritime Connectivity Model (MCM)

In this section, MCM is applied to the assembly artefacts in order to explore connectivity within sea and coastal spaces using social network analysis (SNA) based on artefact contexts and GIS transportation and navigational modelling. The SNA utilises two-mode and Ego networks to analyse the ‘export’ of Launacien artefacts (predominantly bracelets) (Figure 6.29). These are applied to visualise trade interactions through local and inter-regional exchanges. The resultant matrix of connectivity will be compared with networks for secondary artefacts, such as belt buckles and fibulae, having a hypothetical provenance in southern France and NE Iberia (see section 6.2). This will assist in revealing participants and mechanisms of exchange within complementary economic spheres.

The second step uses environmental and technological mobility constraints to create maps and a navigational model for the LBA–EIA based on current knowledge of nautical technology for that period. The results show costs and navigation times, which ultimately will help provide answers to the questions exposed by this research. The

navigational model is based on sea conditions, in particular wave action (height) and wind (speed and orientation). Besides inherent errors due to the interpolation of data and the scale of the study, there is an underlying presumption that current environmental conditions are similar to those in antiquity and, therefore, can be used to model palaeoclimatic conditions (Murray 1987). Both models then are used to create a maritime network model based on the 'coefficient of difficulty in navigation', which ultimately allows the influence of different actors to be assessed. These actors potentially are intervening in the process of cultural interaction that defines the characteristics of the contact zone in western Languedoc from a maritime perspective.

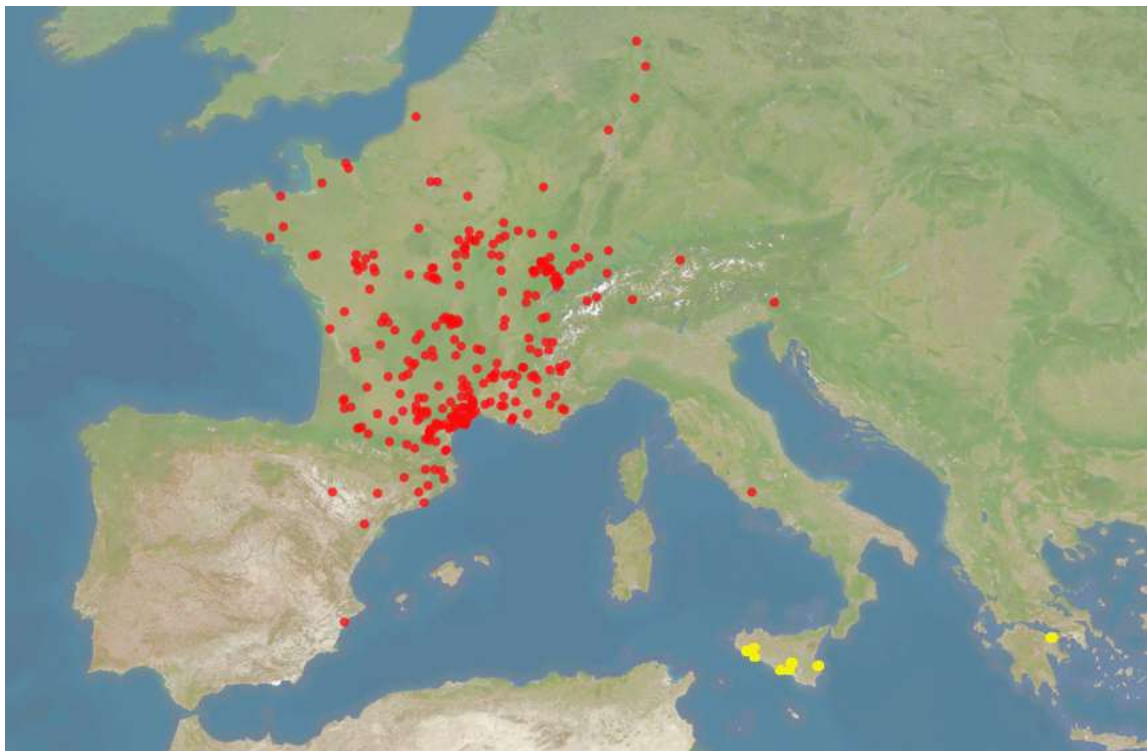


Figure 6.29. Locations of other archaeological sites where Launacien artefact types represented in the Rochelongue assemblage have been found. Yellow mark indicates Greek context (map by author, based on data from Guilaïne et al. 2017)

6.3.1 Two-mode network

Like the Launacien deposits, the Rochelongue assemblage comprises objects of diverse provenance, including from Brittany and the Atlantic façade (socketed axes), central

Europe and Hallstattian culture (bracelets) and the northeastern Iberian Peninsula (belt buckles and fibulae). These cultural links and associated trade connections are similarly reflected in the find spots of the various Launacien hoards, including along the Atlantic tin route and throughout central and southern France, with important inroads further north and eastward towards the Hallstatt core (Guilaine 1972; Soutou and Arnal 1963). Some of the object types present in the Rochelongue and Launacien assemblages recently have been connected to the Greek colonial domain through votive offerings of metal objects found at Archaic Mediterranean shrines (Verger 2005).

Some of these objects are Gallic, with possible origins in the northern regions of France, but they are found alongside typically Languedoc products (talons), indicating that Languedoc served as a corridor for trade flows between the continental interior and the Greek Mediterranean (Guilaine et al. 2017:353). While the Atlantic and continental find spots could represent a riverine dispersion of terrestrial metal sources (Dedet and Marchand 2015; Ropiot 2007), the links to Greek colonies in Sicily obviously were dependent upon maritime transport. The cultural and typological diversity of these elements are the attributes that will be examined in the MCM using both social and geographical approaches.

Rochelongue is the Ego, or central node, of the social model. The connections between Rochelongue and other sites (the alters) are analysed to understand the mobility of objects and people and, consequently, to reveal evidence of connectivity. The key so-called 'inside-out' concept used in this model defines the duality of connectivity based on material culture. Thus, 'turning [a network] inside-out' defines pairs of groups as actors/sites connected by the artefact(s) which belongs to both groups in the pair (Horden and Purcell 2000:133; Knappett and Nikolakopoulou 2014). Graphically, a two-mode network is used to define which site is affiliated to one specific type or another and how; they are two-moded because the ties are between nodes of two different types (Mills 2017:383). In (Figure 6.30), the first mode of nodes represents sites and the second mode Launacien type artefacts that appear both in the Rochelongue assemblage and other archaeological contexts. Links are the affiliation between these

The analysis in this model is based on two basic concepts within network analysis: centrality and degree of centrality. Centrality is defined as a family of measures of a node's position within the network, which represents a ranking of nodes (Collar et al. 2015:11). Degree centrality, also known as the centrality of a node, is based on the number of edges incident to a node (Collar et al. 2015:11). In social science, these concepts are directly related to the power of actors (nodes) in a network. According to the degree of centrality measure, a node is important, or prominent, if it has edges to a high number of other nodes. Actors who have more ties to other actors may hold advantaged positions. A higher number of ties may represent an advantage for one actor over others, as, for example, one holding a privilege position as middleman and controlling exchanges among others. Again, from a social science perspective, an actor receiving many ties often is said to be prominent or to have high prestige, recognising that many other actors seek to direct ties to them as an indication of their importance (Hanneman and Riddle 2005a).

Object types (Table 6.5) that have higher degrees of centrality are bracelets with solid section (types 5 and 9), measuring 6.5 and 4.7 degrees, respectively. The sites with the highest degree of centrality (

Table 6.6), apart from Rochelongue (the Ego), are Vias (1.10 degrees), Launac (1.28 degrees), and Carcassonne (1.39 degrees). These values attest to the local proximity of these sites. Turning to external connections, on the other hand, the most central sites are Sciacca (Sicily) and Gela (Sicily), both having 0.81 degrees of centrality, which is higher even than most of the local deposits (**Figure 6.31**). The object types with the highest connectivity with respect to these external actors are rings with hollow sections (type 7), bracelets with solid sections (type 10) and Launacien talons. Another interesting object type is the open disc, which, at 3.3 degrees, has a high degree of centrality and connects areas as disparate as central Europe (Germany–Switzerland area), Rochelongue and Perachora in Greece.

Table 6.5. Degree of Centrality for Rochelongue artefacts.

Artefact Type	Degree of Centrality (%)
Bracelet with Solid Section (Type 5)	6.5
Bracelet with Solid Section (Type 9)	4.7
Wheel Pendant	3.3
Open Disc	3.3
Ring with Hollow Section (Type 6)	3.2
Triangular Pendant	3.1
Bracelet with Solid Section (Type 1 decorated)	3.1
Axe, Launacien, type (undecorated)	3.0
Axe, Rochelongue type (undecorated)	2.9
Launacien Talon	2.7
Bracelet with Solid Section (Type 10)	2.5
Axe, Launacien type (decorated)	2.0
Arrow	1.3
Ring with Hollow Section (Type 7)	1.3
Bracelet with Solid Section (Type 1 undecorated)	1.2
Ring with Hollow Section (Type 1)	1.2
Adzes	0.5
Axe, Rochelongue type (decorated)	0.5

Table 6.6. Degree of centrality for sites yielding Launacien artefacts.

Site	Degree of Centrality (%)
Rochelongue	2.21
Carcassone	1.39
Launac	1.28
Saint-Saturnin	1.16
Vias	1.10
Montpellier	0.93
Sciacca	0.81
Gela	0.81
Murviel-les-Beziers	0.81
Peret	0.69
Esperaza	0.58
Mailhac	0.58
Selinunte	0.46
Puy-de-Dome	0.46
Cazeville	0.46
Ternay	0.35
Rieux-Minervois	0.35

Megara Hyblaea	0.35
Durban	0.35
Albi	0.23

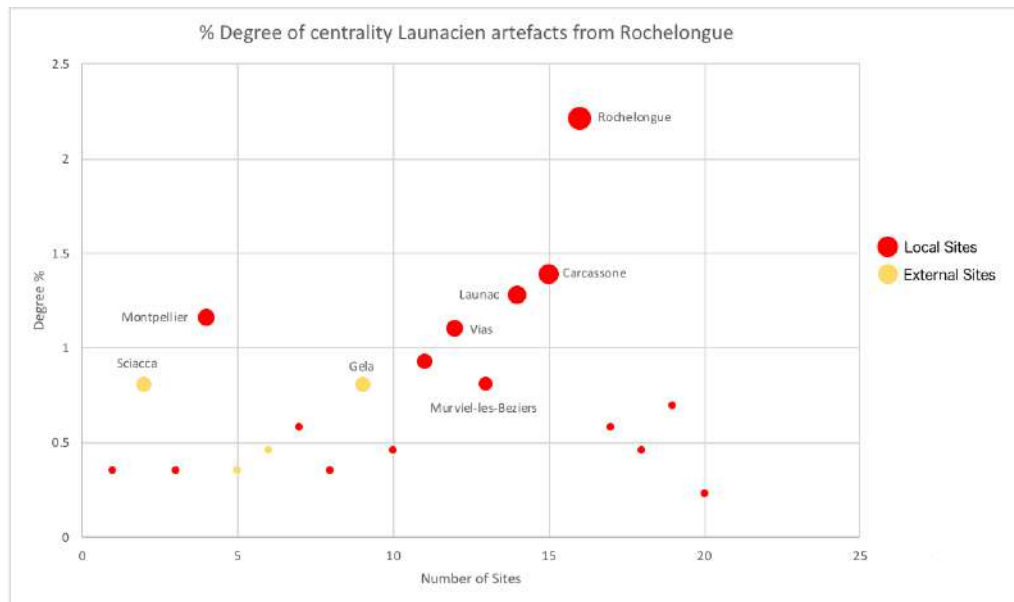


Figure 6.31. Relative connectivity of sites containing similar Launacien artefacts as the Rochelongue assemblage.

6.3.1.2 Ego network

Now that the two-mode network has established the diversity of connections and identified those sites and object types with the highest connectivity, the model is simplified to an Ego network by affiliation to highlight specific relationships in the network. This is done also so as to explore the type characterisation of the Rochelongue site with respect to external actors. This provides a window onto the socio-cultural dynamics of a society acting in a contact zone. Thus, whereas the two-mode network can be viewed more as a regional network, the Ego network is focussed on identifying external and, by extension, maritime connectivity.

Figure 6.32 shows the graphical results of the Ego network for Rochelongue, in which each node corresponds to a site with a higher degree of centrality (between 0.35 and 2.21 degrees), while edges between nodes represent the co-presence of Launacien artefacts. The ranking of sites (node size) is based on betweenness (see Appendix 5:

Glossary for definition), which provides a visual indication of the relevance of specific sites within a network. For links, the weighting factor is the number of shared artefacts, which shows the strength of the relationship between sites. In this case, the Ego network graph is directed, meaning the relationships between pairs of actors, or dyads, are not necessarily equivalent. In this case, the Ego network graph is directed, meaning the relationships between pairs of actors, or dyads, are not necessarily equivalent. The two-mode network revealed who was connected to whom, but it did not necessarily reflect the level of reciprocity in the relationships. The Ego network, on the other hand, is directed; each pair of nodes is connected by two opposing links that reflect different levels of exchange. This allows a site's degree of centrality to be characterised as degrees out (the total outward flow of exchange goods from the site) and degrees in (the total intake of goods exchanged from other sites). Table 6.7 lists the degree of centrality in and out for sites in the Rochelongue Ego network. The average degree out is 2.9, which means that each node on average has outward connections to 2.9 other nodes; the average degree in is 2.7. Similar degrees in and out can be indicative of a strongly connected network, but a third measure, betweenness, provides an even better indication of this.

In network theory, a node's betweenness is defined as 'the fraction of the number of geodesics passing through this node over the number of geodesics between all pairs of nodes in the network' (Collar et al. 2015:1–32). This gives actors positioned 'between'

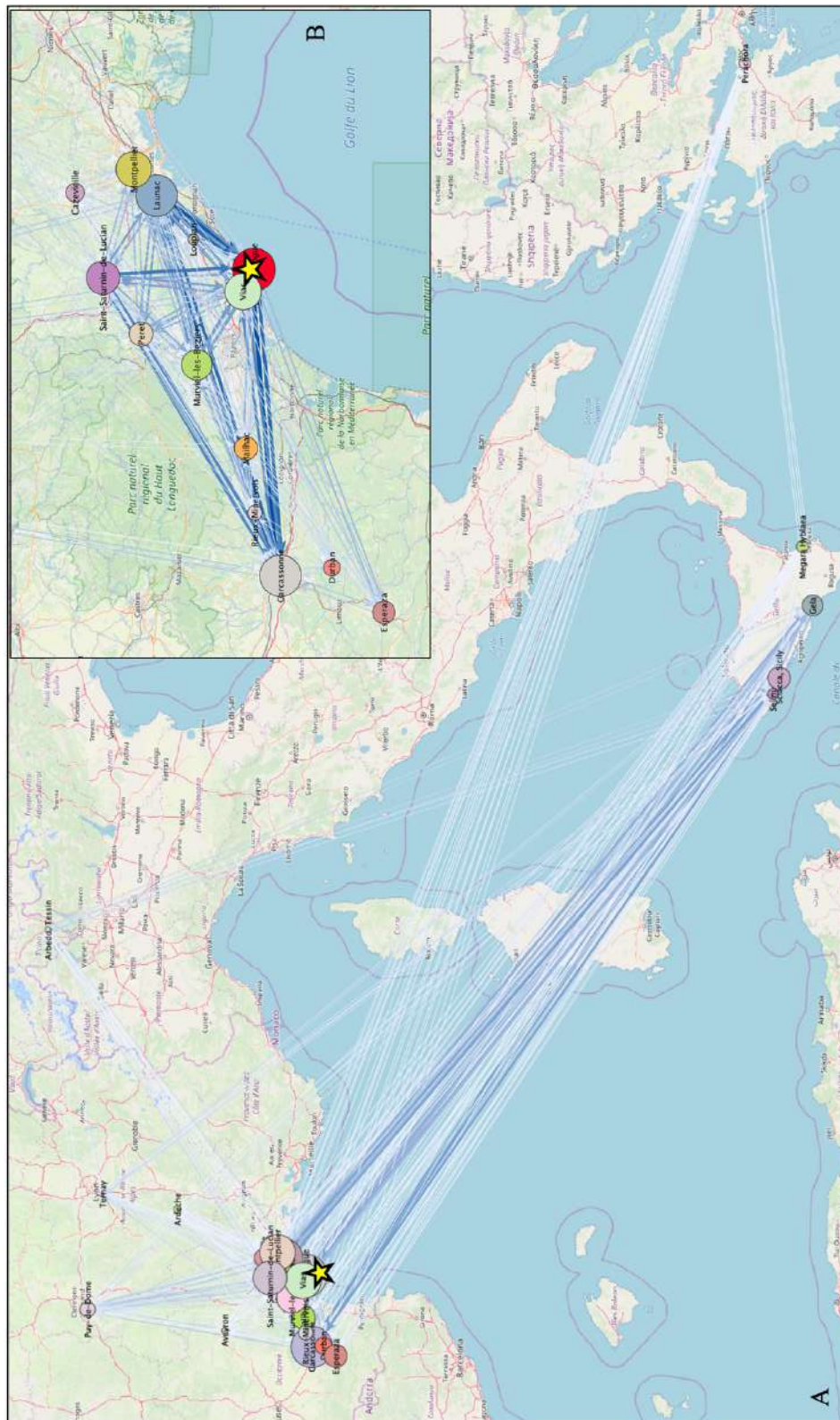


Figure 6.32. A) The Rochelongue Ego network, mapping connectivity with external actors (Rochelongue site marked with a star); B) detail of local connectivity. Nodes (circles) are sites and links represent the co-presence of artefact types between sites. Site ranking (circle size) is based on percent betweenness and link ranking (line darkness) on number of artefact types shared between sites.

other unconnected actors power or influence over the others' transactions and their status in the network. Thus, the more embedded an actor is within a network, that is to say, the more connected they are between other actors in the network, the more those other actors are dependent upon them for information and material, the more they can control exchanges within the network and the more they are able to profit from their position. The Rochelongue assemblage, at 12.28% centrality, and metal hoards such as at Launac or Carcassonne, both at 11.25% centrality, point to this type of control or position, known as brokerage, and represent the strongest actors at the local level.

Table 6.7. Degrees of centrality in and out for sites in the Rochelongue Ego network.

Site	In-degree (%)	Out-degree (%)	Betweenness (%)
Rochelongue	4.35	4.13	12.28
Carcassonne	4.24	4.35	11.25
Launac	4.24	4.35	11.25
Vias	3.92	4.24	8.71
Montpellier	3.92	3.92	8.38
Saint-Saturnin-de-Lucian	3.81	4.24	7.52
Murviel-lès-Béziers	3.70	3.92	6.24
Péret	3.15	3.26	3.76
Mailhac	3.15	3.37	3.61
Espéraza	2.94	3.15	3.41
Sciacca	3.15	3.37	3.32
Gela	3.05	3.05	2.81
Cazevieille	2.72	2.83	2.31
Durban	2.61	2.83	1.85
Puy-de-Dôme	2.72	2.39	1.51
Rieux-Minervois	2.61	2.83	1.36
Megara Hyblaea	1.96	2.07	0.94
Perachora	1.85	2.07	0.84
Loupian	2.28	2.28	0.75
Selinunte	2.17	2.17	0.70
Aveyron	2.07	0.87	0.21

Simplified network models' also lend themselves to comparative evaluations of the network as a whole, and provide visualisations of network characteristics, such as density (**Figure 6.33**). This metric is the ratio of the number of ties found in a network to the total possible number of ties (Mol 2014:94). It is expressed as a coefficient between 0 and 1, where 0 indicates a network with no connected nodes and 1 indicates a network in which all nodes are connected to all other nodes. For Rochelongue, the network density for Launacien objects is 0.7. The connectivity evidenced in the Rochelongue material is focused more locally than externally (i.e., the local connections are more intense than the external ones).

This changes somewhat when considering other elements of greater regional diffusion, such as belt buckles or double-spring fibulae, and the intensity of external connectivity increases. Objects such as buckle belts and double-spring fibulae, distributed mostly across the Iberian Peninsula, have a network density of 0.8 and 1, respectively (based on Graells 2014b for fibulae; Graells and Lorrio 2017 for belt buckles). These objects tend to have greater densities than Launacien objects (with densities around 0.7), and are more disseminated in the central Mediterranean. Nevertheless, the different models verify that, although contact may be less dense in that region, it is more direct for Launacien objects, whereas belt buckles and fibulas require the intervention of multiple actors in their trading.

6.3.2 Geo-referential Information System applied to Maritime Model.

The MCM is completed using least cost path analysis based on time, distance and ease of navigation. The model is calibrated to small coastal vessels adjusted to coastal sailing; that is to say, coastal visibility (Figure 6.34, A). This navigation model applies the minimum nautical technological capabilities appropriate for the seventh–sixth centuries B.C. Mediterranean in order to identify geographical features with which to define coastal navigation and its cost (required effort).

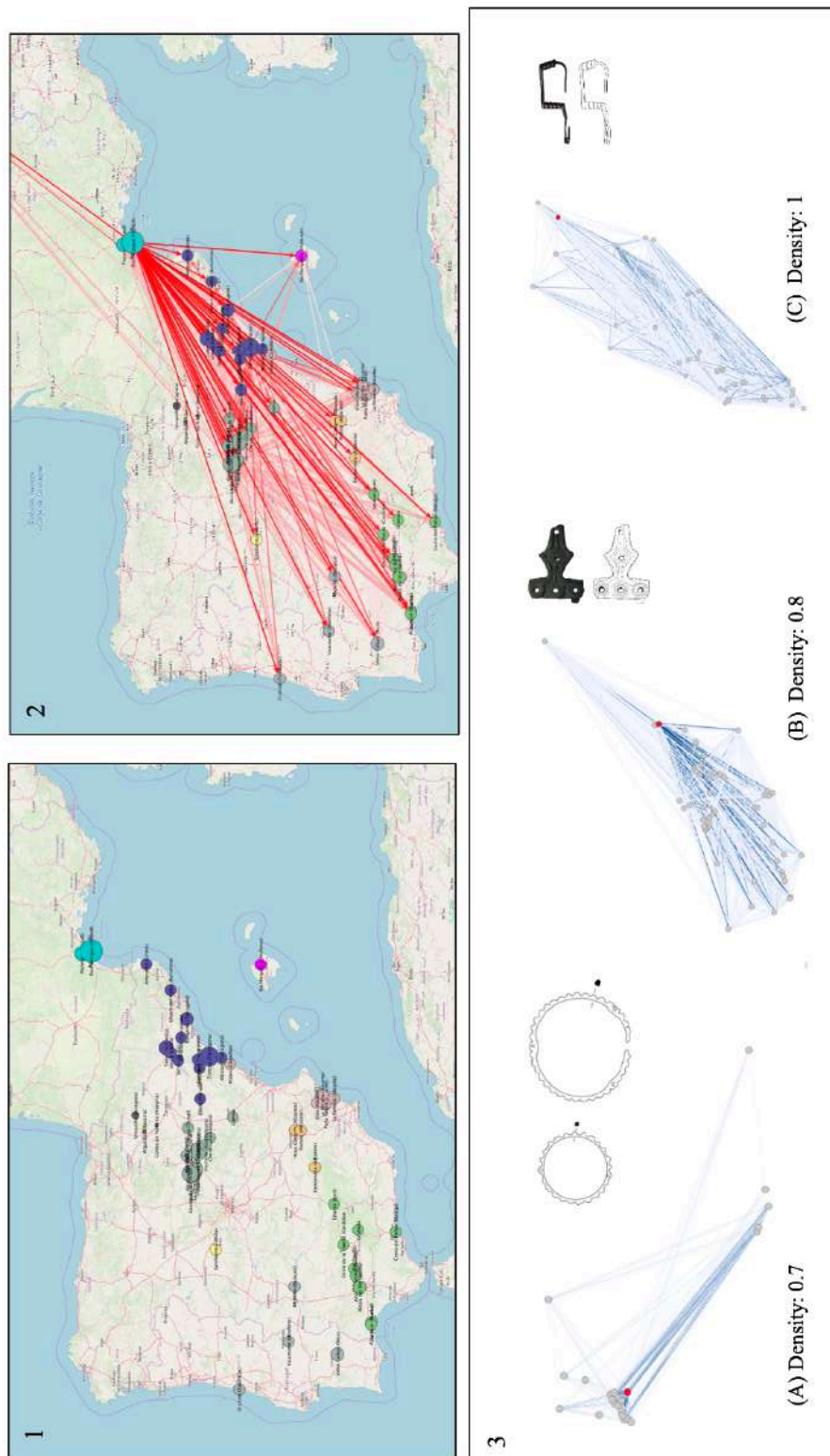


Figure 6.33. 1. Distribution of belt buckle types represented in the Rochelongue assemblage; 2. Visualisation of the network analysis of belt buckle types represented in the Rochelongue assemblage; 3. Comparative network densities for dispersion of A) Launacien bracelets, B) belt buckles, and C) double-spring fibulae (red circle marks the Rochelongue site).

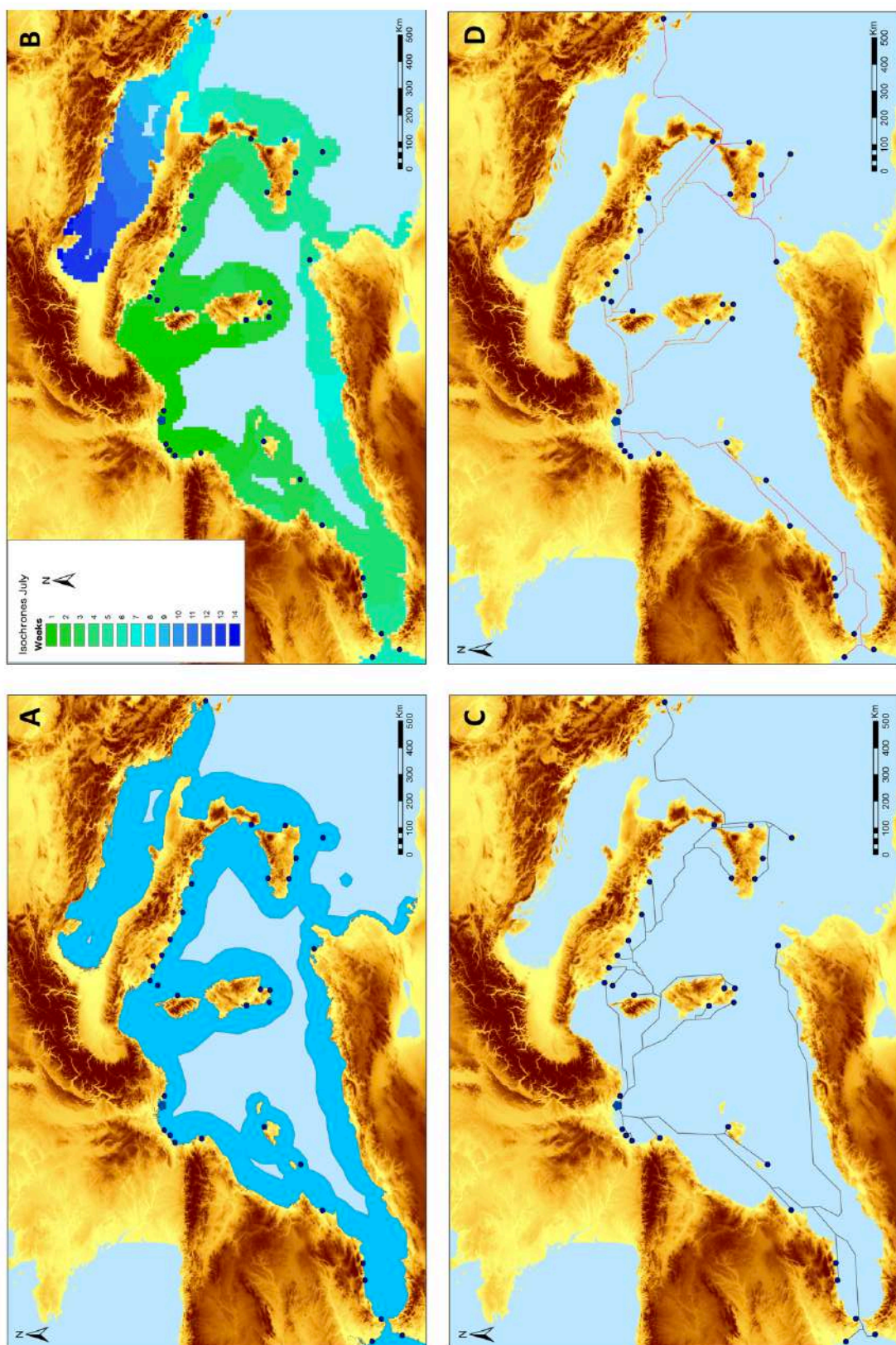


Figure 6.34. A) Coastal visibility in the central Mediterranean (dark blue colour indicates areas of the sea in which a coast is visible); B) Experimental time/distance map for coastal navigation from Rochelongue; C) Comparative least-cost-path for January; D) Comparative least-cost-path for April.

As discussed in Chapter 5, there are pros and cons to such a model, which is why it is used only as a complementary step in the SNA (Herzog 2012; Rivers et al. 2011, 2013). Although there is archaeological evidence for larger vessels with perhaps greater nautical capabilities for this period (e.g., the shipwrecks reviewed in Chapter 5), based on the tonnage represented by the Rochelongue assemblage, the Jules-Verne 7 vessel and the capabilities demonstrated during sailing trials of its replica, *Gyptis* (Pomey and Poveda 2018; 2019), provided the baseline performance (Figure 6.34, B, C and D) used to construct the maritime model. The coastal sites included in the model were determined by SNA, and were supplemented with additional coastal settlements relevant to the seventh and sixth centuries B.C. in order to create a broader comparative context.

As shown in Figure 6.34, B, the isochrones represent the navigation calculations in weeks, taking as a point of reference the Rochelongue site and the locations of its proposed connections, mostly in the Gulf of Lion and central Mediterranean regions. In Figure 6.34, C and D, trip distances are expressed in days, so as to subdivide navigation times into short, medium and long distances. Taking summertime (the season with most favourable conditions) sailing then as an example, destinations in the long-distance zone (30–43 days of navigation) include Gadir and Huelva to the west, on the southern Atlantic coast of Spain, and Perachora to the east, on the Corinthian Gulf in Greece. These sites are accessible only from successive navigation scales (zones). Sites such as La Fonteta (Alicante, Spain), Ischia (Italy) and Nora (Sardinia) occupy the medium-distance zone (20–30 days of navigation), while the short-distance zone (10 days of navigation or less) includes the near coasts of France (Massalia, Marseille) and Catalonia (Emporion, Ampurias), as well as Etruscan ports like Vulci and Populonia. Sardinia also lies mostly within the short-distance zone; Tharros, for example, is an 8-days sail away, while Sulcis is 11 days.

Least-cost-path (LCP) calculations then were made on the basis of these zones and variables affecting navigation; namely, wind direction and force and corresponding wave direction and height, as detailed in Chapter 5. Using the model, it is possible to compare months and the most likely routes that a boat with the considered

characteristics would follow from Rochelongue. By comparing months with opposite extreme values, such as January, with the worst navigation conditions, and April, with consistently average values that allow for easy navigability, it is possible to visualise the variation in possible routes (Figure 6.34, C and D). The results of such an examination show that the LCPs for traveling from the Rochelongue area to all the other sites change only very slightly during the different seasons. The coefficient of navigation (actually, the difficulty of navigation), then, can be calculated using the average cost value for all months of the year and the accumulated cost.

The coefficient of navigation ranges from 0 to 400 and can be seen as a measure of similarity, where a lower value represents a strong relationship between nodes. Conversely, the higher the coefficient of navigation, the greater the distance between two nodes and the less similar they are (Figure 6.35). The resultant MCM, then, is the navigational model embedded with data from the SNA.

The final results show sites forming clusters (Figure 6.36) based on their maritime connectivity (degree of similarity). Clustering in network analysis usually means the grouping of nodes based on the network structure, such that there are many links within a group (high cohesion) and only few links between it and other groups (low coupling) (Brughmans 2010:15). The final picture presented by the MCM for Rochelongue can be interpreted almost as a 'small world' structure; that is, 'a type of network where most links are shared between small, proximate groups of nodes, and these groups are linked together by less frequent, yet important, ties' (Knodell 2013:4). The result is a multi-scalar network in which habitual interactions within small worlds are predominant, but are informed by the weak ties to, or less frequent interactions with, external networks.

This model highlights the fact that maritime connectivity in the EIA western Mediterranean is defined by well-connected hubs with weak ties between them that conform a context of structural holes. A structural hole is defined as a gap or absence of nodes between clusters within a network (Burt 2001). In a network with structural holes, nodes/actors frequently acts as brokers or middle persons that serve to bridge one or more such holes (Crossley et al. 2015:36).

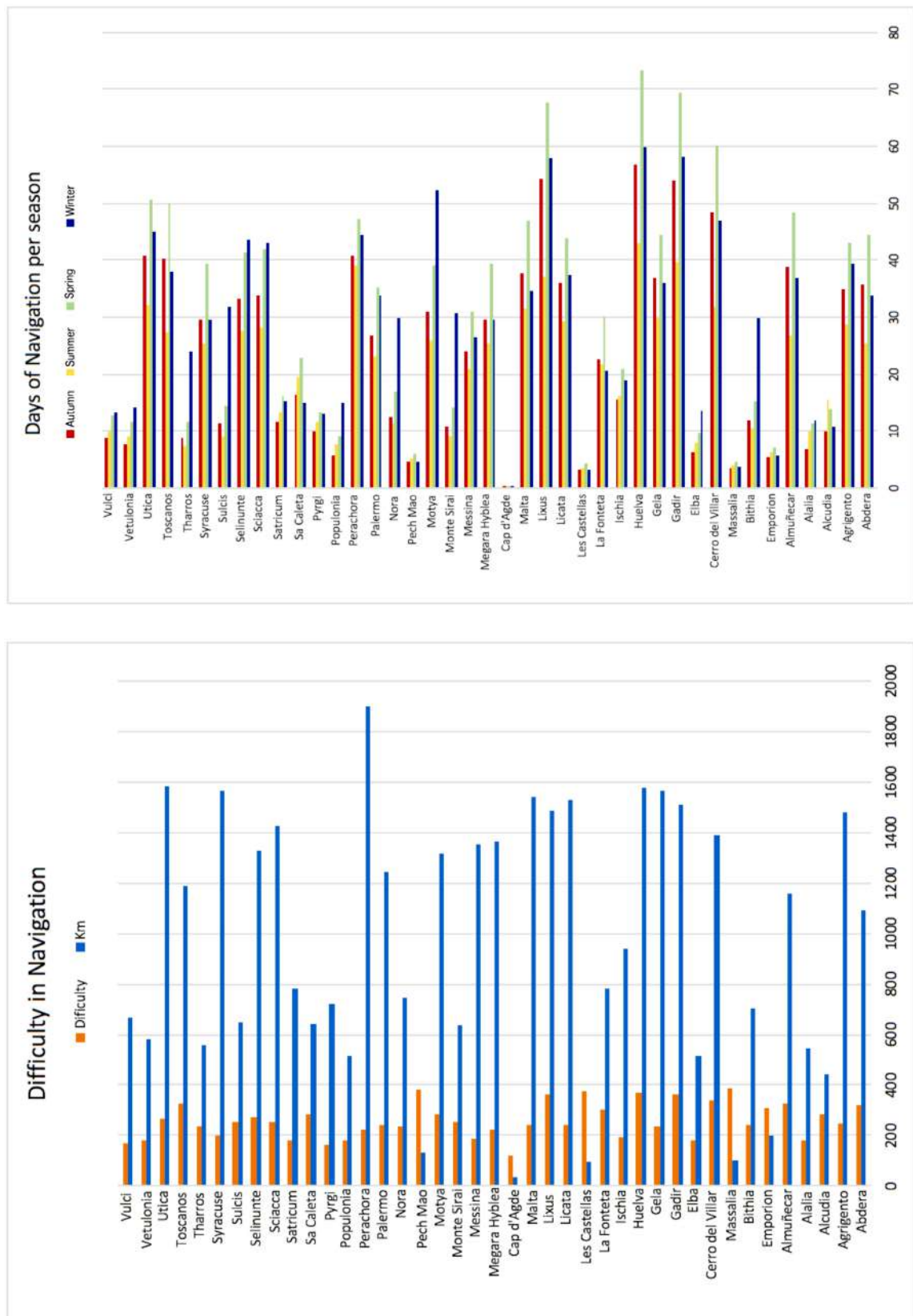


Figure 6.35. Upper: sites included in the MCM; Lower: coefficient of navigation for sailing from Rochelongue to the sites.

6.5. Conclusion

This chapter has presented the results of the multiple analyses undertaken as part of this research, comprising (1) an archaeological investigation of the Rochelongue artefacts at the Ephebe Museum at Cap d'Agde; (2) elemental and isotopic characterisation of metals to shed light on provenance, sourcing and technological processes; and (3) a geospatial and social assessment of the assemblage. The artefact recording was based on contextual, manufacturing/forming, stylistic and technological features as well as identification of artefacts by type categories and MNI. This analysis has provided a characterisation of the Rochelongue assemblage with which to proceed now to a comparative evaluation (discussed further in the next chapter).

The results of the pXRF elemental analysis showed that almost all of the manufactured pieces in the Rochelongue assemblage are binary bronzes, with tin as the only alloying element with a relatively wide dispersion, while the ingots are almost all unalloyed copper with extremely low lead content. The analysis of cumulative impurities in the manufactured objects identified a predominance of copper groups 1 (pure Cu) and 2 (arsenic copper). On the other hand, LIA of these pieces revealed a relatively wide distribution of isotopic ratios within the copper groups, and so the latter could not be used as criteria for establishing provenance. On the other hand, comparison of the lead isotope data for the artefacts and ingots with local and external sources of mineral ores did provide some interesting results. Over half of the analysed samples appear to have a provenance in the southwestern Iberian Peninsula. Within this group, it is noticeable that ten ingots have an identical isotopic fingerprint. These data, together with some interesting details of artefacts, are highly relevant to better understanding the Rochelongue site and its context. Finally, a maritime connectivity model was constructed using GIS data and information from SNA, from which it is possible infer processes of change and continuity resulting from cultural interactions over time. Moreover, the results reflect evidence for local community agency and external influences throughout these processes, all of which is explored in the following chapter.

CHAPTER 7. DISCUSSION

7.1 Introduction

This chapter explore the results, and provides archaeological interpretation of the data produced by the research in relation to existing comparative data. To interpret, discuss and critique a MCM can reveal attitudes to cultural interaction and colonialism, and their articulation within the broader site context. The context of metal use and cross-cultural interpretation will be useful to understand the identity, functionality, and significance of the Rochelongue underwater site, as well as cultural influence and interaction on the west Languedoc coast of France during the pre-colonial period (seventh–sixth centuries B.C.).

It is pertinent, first, to return to the primary research question set out at the beginning of this thesis. The overall goal of this work was to investigate if and how a research framework using multiple methods of analysis can provide a new and more in-depth approach to theorising and interpreting evidence derived from the metal assemblage of the Rochelongue underwater archaeological site in order to better understand the dynamics of cultural interaction in the western Mediterranean during the LBA–EIA. In addressing this question, this thesis investigates the raw material supply, trade, and working of metals within a framework of maritime connectivity to identify local agency versus external influence and cultural interactions in west Languedoc during this time.

This research also provided a unique opportunity to generate a complete catalogue of the collection and reinterpret the site and its material from a multi-methodological approach to better understand their relevance in their historical-archaeological contexts. Considering the significance of this research, a number of sub-questions are addressed to better answer the main research question:

1. How does the Rochelongue metal assemblage compare with other metal hoards of this period found in terrestrial archaeological contexts?
2. Do the characteristics of these assemblages reflect the social and cultural logic of indigenous societies and their institutions, cosmologies and structures and, if

so, how can their analysis contribute to a better understanding of these assemblages?

3. How can an interpretation based on the concept of 'contact zone' allow us to contextualise locally the initial phase of colonial encounters in southern France?

7.2. Defining Rochelongue

Early in this thesis there was a review of the previous research into this site, and its cultural material, and much critical discussion of the traditional debate around which this research was focussed—namely, the nature of the site. The present study employs a new methodological approach in an attempt to move beyond traditional interpretive debates on whether the site is a shipwreck or some type of inundated terrestrial deposit.

The goal here is to find ways to extract more informative and generalised socio-economic or cultural meaning from the material that can shed light on this dynamic and formative period in the south of France. Nevertheless, after such an investment in documenting and re-evaluating the site, its excavation and recovered material, it would be remiss not to first summarise the results of this research

As mentioned in Chapter 3, this question has been controversial almost since the site was first discovered. As early as 1964, the site's discoverer, Bouscaras, suggested in his initial report on the excavation two possible interpretations: it was either a terrestrial site now submerged as a consequence of sea level change; or it was the wreck of a tramper carrying an itinerant metalworker looking for scrap metal and trading opportunistically. Neither interpretation seems valid. The first was rejected almost immediately by the author himself, since palaeo-environmental research shows that the sea level has not changed significantly since the period in question (LBA–EIA). This fact has been corroborated by recent studies that show insufficient sea-level change (only ± 2 m) for the site seabed ever to have been dry land in the past three millennia (Ambert 2001). The palaeo-landscape in the Rochelongue environs has been reconstructed as a space dominated by marshes and a palaeo-bay at the mouth of the river Herault (Devillers et al. 2019), which only would have made it more conducive to

the interaction of local communities in a coastal environment. The second hypothesis, on the other hand, has been maintained since its proposal and adopted frequently by subsequent authors (Abdelhamid 2015; Bouscaras 1964a; Bouscaras and Hugues 1972; Garcia 2002; Hugues 1965).

The evidence used to support this hypothesis is based on the important presence of raw material (ingots), tools such as hammers and chisels and the abundance of fragmented materials believed to have resulted from 'scrapping activity'. Despite this conclusion, the lack of any evidence for the remains of a ship and its equipment works directly against this theory.

Indeed, the lack of any actual boat remains, pottery or ballast is one of the main arguments against the possibility that the assemblage came from a shipwreck. But precisely what types of remains should be expected of a genuine shipwreck? Leaving aside remnants of the ship's wooden hull (since there are none at Rochelongue) and attending instead to other evidence, the excavated assemblages of all other contemporary shipwrecks in the western Mediterranean, such as at Bajo de la Campana, Giglio, Mazarrón or Xlendi Bay, include ship equipment and crew possessions, as well as assorted materials of trade (cargo) and the containers in which they were shipped (Bound 1991; Gambin et al. 2018; Negueruela 2004; Negueruela et al. 2000; Polzer 2014).

Xlendi Bay Shipwreck (Gambin 2018)

This ship, linked to Phoenician merchants, sank off the coast of Malta in deep water (110 m), which largely is responsible for its good state of preservation. Unfortunately, due to the great depth of the site, no small finds have been recovered. The general organisation of the ship's lading is readily discernible. The ship's stone (volcanic basalt) cargo was split between the fore and aft extremities of the hold, while the central portion was filled with mostly amphoras, but also other ceramics (Figure 7.1). Although the existence of the ship's wooden hull has not been evidenced, it is more than probable that such remains are preserved under the cargo.



Figure 7.1. The Xlendi Bay shipwreck: the stone cargo can be seen grouped at either extremity, with amphorae and other ceramics lying in between (from Gambin et al. 2018:78 fig. 10).

Bajo de la Campana (Polzer 2014)

Located on the east coast of the Iberian Peninsula, this wreck is identified as being of Phoenician origin and transporting cargo composed of amphorae (likely carrying wine and fish products) from Andalusia and the central Mediterranean, elephant tusks, copper and tin ingots and galena, a common mineral ore of lead. Along with these, more exotic items such as a stone altar, boxwood combs, and bronze furniture elements complete the products of the cargo. A small group of elements can be assigned to the crew (Figure 7.2), such as a group of cylindrical whetstones probably used to sharpen bronze and iron implements, a collection of bronze and lead pan-balance weights and a ceramic oil lamp.

Giglio (Bound 1991)

Situated in the Tyrrhenian Sea off the coast of the small island of Giglio, this shipwreck yielded mainly Greek and Etruscan, but also some Phoenician amphorae, along with copper and tin ingots. The recovered finds also included rigging toggles (Polzer

2008:225), lead brail rings (Figure 7.3) and a stone anchor stock, as well as flutes, a writing tablet, the leg of a couch, 30 arrow points and a helmet.



Figure 7.2. Whetstones and pan-balance weights from the Bajo de la Campana shipwreck (left courtesy of ARQUA; right from Polzer 2014:233 figures. 123 a–d).

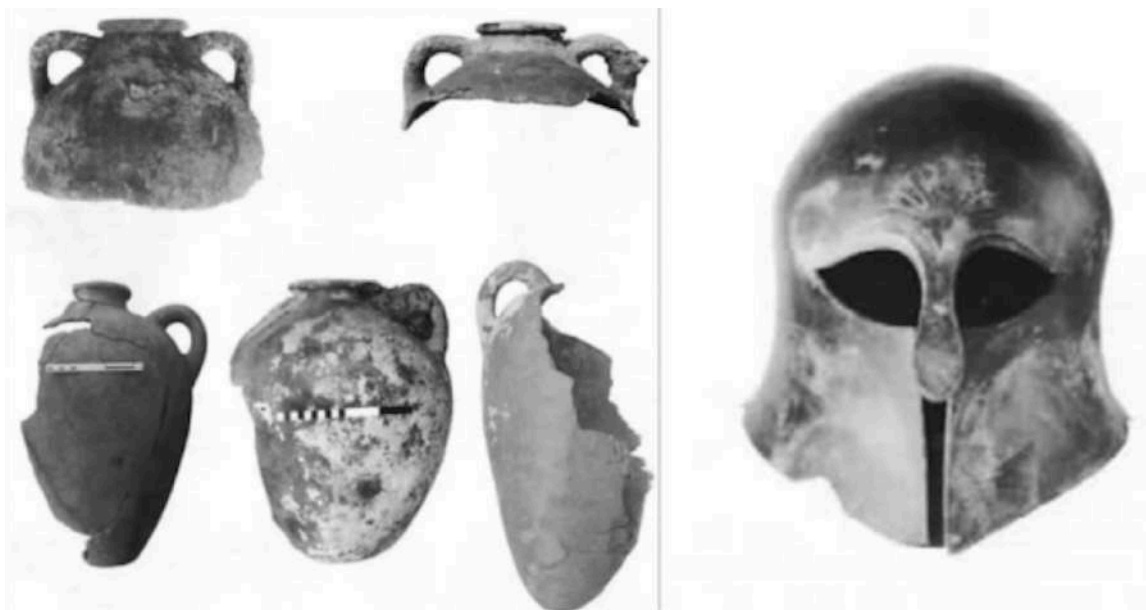


Figure 7.3. Cargo amphorae and Corinthian helmet from the Giglio shipwreck (from Bound 1991:10 figure. 9).

Mazarrón 2 (Negueruela 2000; Negueruela et al. 2004)

This wreck, along with another less well preserved (Mazarrón 1), was located on the southeastern coast of the Iberian Peninsula. The vessel's main cargo of 2.8 tons of litharge (lead oxide) in ingot form was distributed in the central part of the hull (Figure

7.4). Other items included an Andalusian amphora, found in the central part of the ship with marks indicating that it had been tied, a granite hand mill and a basket with a wooden handle. In addition, a wooden anchor with a lead stock was found still tied with its rope. No similar evidence of possessions or specialised maritime objects is found in the Rochelongue assemblage. The only element that perhaps could be considered as such is a stone anchor; however, as mentioned already, this object was not registered during the original excavation and, therefore, cannot be assigned to the assemblage.



Figure 7.4. A litharge ingot and amphora from the Mazarrón 2 shipwreck (photographs courtesy of ARQUA).

On the other hand, the underwater sites in the UK that were discussed in Chapter 3, such as Salcombe and Moore Sand and Langdom Bay (Muckelroy 1980; Muckelroy and Baker 1980; Needham et al. 2013), demonstrate an archaeological fingerprint that is strikingly similar (Figure 7.5). Despite the obvious chronological difference (the latter wrecks dating to the MBA), these archaeological contexts present the same interpretative problem as the Rochelongue material and also suffer the same lack of any boat remains, pottery or ballast (Needham et al. 2013). Here, it has been argued convincingly that any boats involved in such deposits would have been dugouts or similar types, which would not be expected to leave any archaeological signature

unless deposited in a more protective environment or otherwise buried quickly. Similarly, such craft—without sail and sporting low freeboard—would have no need for purposeful ballast (Needham et al. 2013:150–155).



Figure 7.5. Archaeological material from Salcombe, Devon. (Wang et al. 2016:81 figure. 2; Wang et al. 2018:114 figure. 12)

Such arguments are perfectly applicable to the Rochelongue situation. The shallow depth and strong currents impacting the site provide adverse conditions for the preservation of any wooden remains; indeed, evidence of erosion can be seen even on many of the pieces of the assemblage made from much more durable materials. As for the lack of ballast (presumably stone) at Rochelongue, the metals cargo likely would negate the need for such and, in fact, the raw metals in particular may well have served this function. It also should be pointed out that, in the case of Rochelongue, the rocky nature of the coast and seabed makes it more difficult to recognise intrusive stone. The reef of Rochelongue largely is volcanic basalt, which, from at least the sixth century B.C., was exploited and transported to nearby settlements, such as the oppidum of Montlaurés at Narbonne, Aude (Reille 2001).

Any evaluation of a possible shipwreck site must take into account the distribution of artefacts on the seabed. Based on the Rochelongue site plan (Figure 7.6), there seems to be four accumulations of material: in grid sectors E4-F4-G4; E4-J5-K6; K4-L4 and M2-M3-N2-N3, respectively. The most spatially diagnostic objects are the ingots and galena, the size and shape of which make them likely to have remained in their original

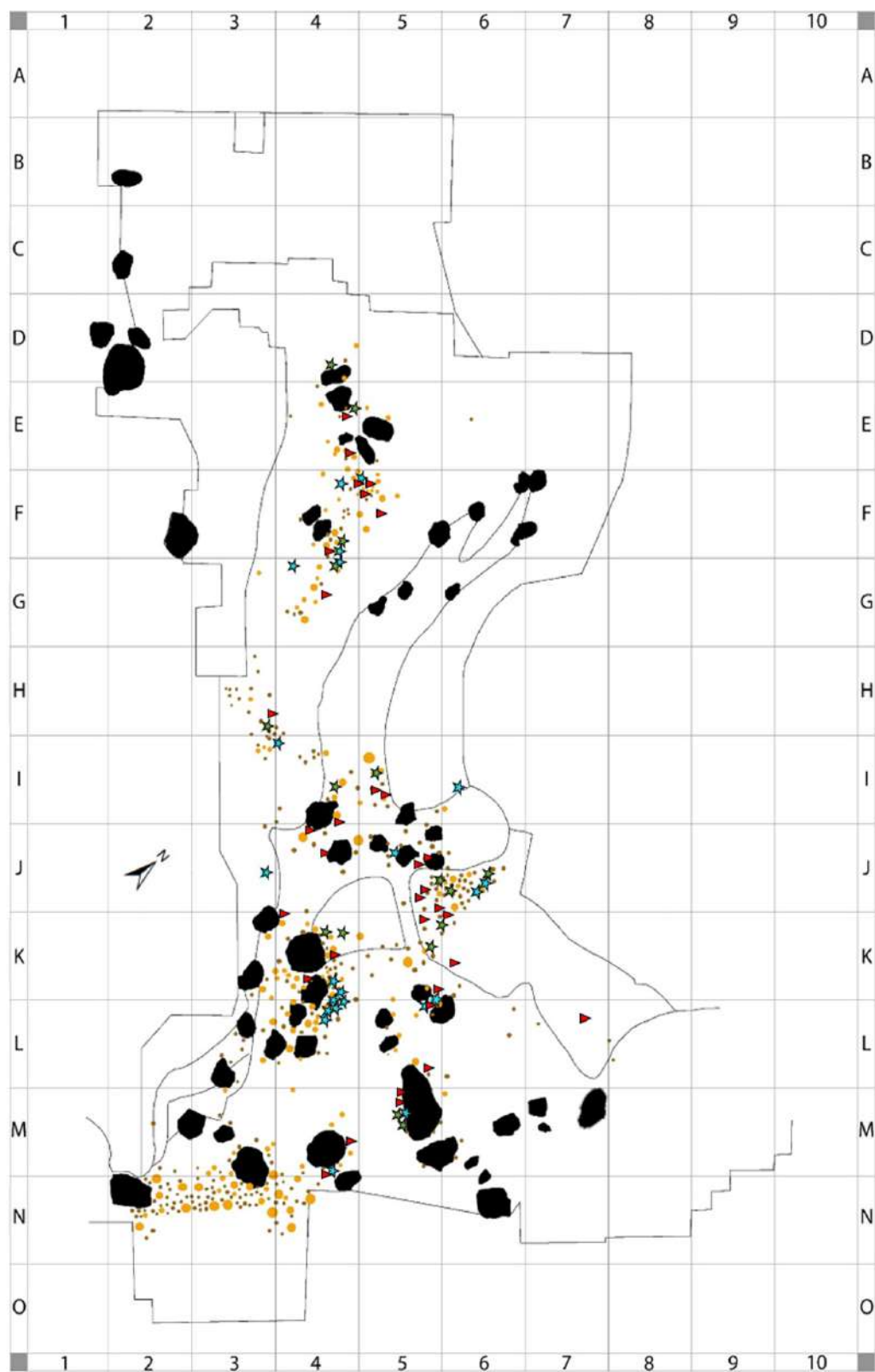


Figure 7.6. Rochelongue site map based on Bouscaras' excavation reports from 1964–1970: natural basalt rocks (black shapes) and ingots (yellow circles) are representative of their individual size, while hammers (blue stars), belt buckles (green stars) and weapons (red triangles) show only location/distribution.

position after being deposited on the seabed. Grid areas B3-B4-C3-C4-D3-D4 and K6-K7-L6-L7]-M6-M7 contain other significant accumulations of objects; however, the majority of these are small items, such as pins and buttons, which are more easily displaced by water movement, so it cannot be assumed that their find positions are representative of their original deposition on the sea floor, or of their original lading on the ship. The distribution—and, thus, implied stowage—of the raw metal and ingot cargo does not make sense if attributed to a single vessel. The large gaps between material groupings would need to have been filled originally with some type of cargo. The most obvious candidate is an organic cargo, such as grain, wool or other agricultural produce, packed in baskets or sacks, all of which was washed away during the wrecking or failed to survive the centuries of submersion and water action. Although such a possibility cannot be discarded out of hand, but it is telling that there is not even a hint of any such cargo.

A more plausible explanation for the spacing of archaeological assemblages (and one that does not rely on negative evidence) is that they were deposited separately, presumably by different small boats, rather than in the wrecking event of a single vessel.

Examination of other items in the assemblage that potentially could represent personal possessions of the crew, such as weapons, ornaments, tools and implements, can provide additional testimony with regards to this hypothesis. The axe heads, for one, while technically tools/weapons, should be consider as cargo, since it has been well established that these objects served as a type of coinage in the pre-monetary exchange economy of the time (Bats 2011). The large number of these items and the fact that many of the examples have casting burrs and show no signs of preparation to be used functionally only validate this categorisation. As for the other tools in the assemblage, such as the hammers and chisels, the question that arises is whether they are carpentry or metalworking equipment of a ship's company, scrap collected for recycling or some other type of representational deposit?

Turning back to the western Mediterranean shipwreck context discussed above, these types of tools have not been preserved; they are, however, recorded in the Salcombe

and Moore Sand and Langdon Bay deposits (Needham et al. 2013, Muckelroy 1980). Then again, the Rochelongue assemblage includes 23 such items, compared to only four examples for the Langdon Bay site (Needham et al. 2013:70 fig. 3.11). If the distributions of the Rochelongue tools are viewed under the assumption of multiple deposits, based on the groupings of ingots (Figure 7.7), then each would contain between 2 (Group 4) and 9 (Group 3) examples (Table 7.1). Indeed, the distributions of weapons and tools, as well as belt buckles, all show that these objects are not dispersed randomly, but have a similar spatial orientation as the ingots, one that is best explained by multiple depositional events.

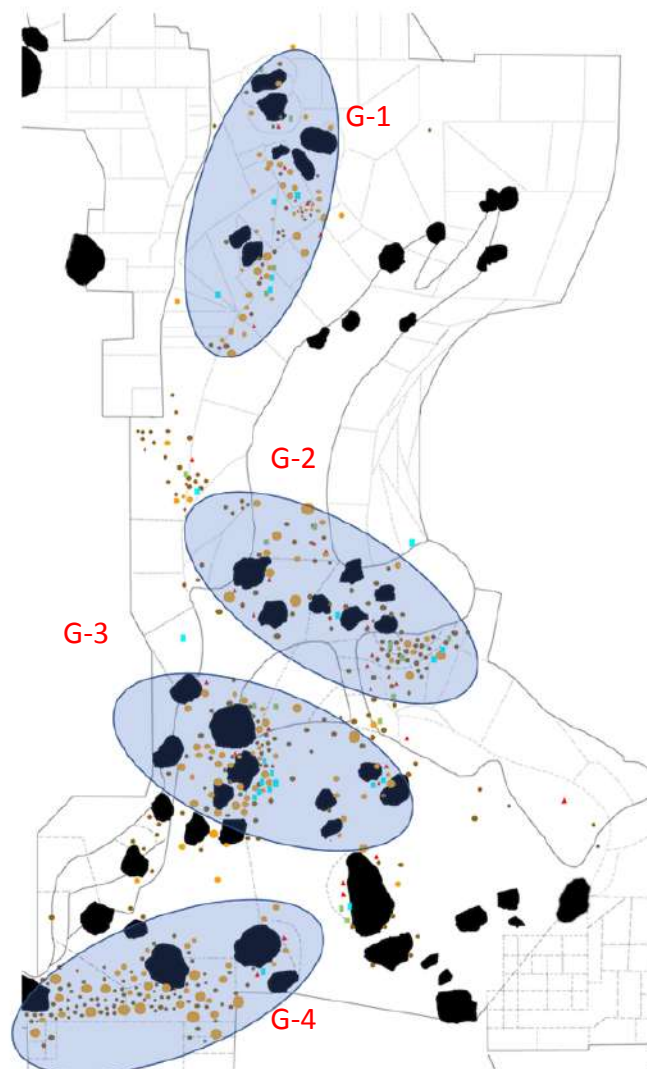


Figure 7.7. Rochelongue site map showing artefact grouping.

Table 7.1. Number of artefacts per grouping.

Group	Whole ingots	Hammers	Weapons	Belt buckles
1	43	5	8	4
2	20	6	13	7
3	51	9	5	3
4	39	2	5	2

In his description of the site, Bouscaras mentioned that:

‘moreover, objects are found very often grouped. When one is found, there almost certainly will be others of the same series in the immediate vicinity’. He interpreted this as signifying ‘that the objects originally had been categorised and held in containers—likely bags or baskets—that did not survive to the present’ (Bouscaras 1964:14).

Alternatively, what is proposed here is that the accumulation of groups of the same types of objects is indicative of separate deposits from different boats. Based on the results of the lead isotope analysis of the copper ingots, which yielded identical isotopic signatures, and the fact that these ingots come from multiple groups, the most plausible explanation is that the deposits represent the cargoes of a number of boats travelling together that were caught in a storm off Rochelongue and swamped or capsized, dumping their contents onto the seabed. The number of wrecks in the area (Chapter 3, Figure 3.4) testifies to the hazards of navigating in these waters, as does the historical as well:

Agde (Hérault), 3 January. — During heavy south-easterly weather, with very bad sea, the Norwegian three-masted *Garibaldi*, with eleven crew, having lost her rudder and driven by the current, was lost at about one o'clock in the afternoon on Rochelongue Point located two miles to the east of the mouth of the Herault [Société Centrale de Sauvetage des Naufragés 1888 (translation from the original French by author)].¹⁵

The boats themselves, likely some type of dugout or expanded dugout, would have been washed away without leaving a trace. Such boats from the MBA/LBA are found

¹⁵ Agde (Hérault), 3 Janvier. — Par une grosse tempe de sud-est, mer très mauvaise, le trois-mâts norvégien *Garibaldi*, avec onze hommes d'équipage, ayant perdu son gouvernail et drosse par le courant, alla se perdre vers une heure de l'après-midi sur la pointe de la Rochelongue située à deux milles dans l'est de l'embouchure de l'Hérault.

not infrequently in the British Isles (Berry et al. 2019) and have come to light also in France. Excavations at Sanguinet, Bordeaux, for example, have yielded at least nine specimens dated to the LBA/EIA (Dubos 2006:8–24) (Figure 7.8).

It is not surprising that a society that traditionally lived by the coast or a river, as evidenced by the site of La Motte (Moyat et al. 2010; Verger et al. 2007), would develop a close relationship with its environment in terms of transportation, trade and exploitation of resources (Graells 2010). Especially interesting in this regard is a fifth-century B.C. lead tablet from the indigenous fortified site of Pech Maho, a so-called *oppidum*, located in west Languedoc (Gailledrat et al. 2012:32). The tablet bears an inscription that, despite its later date, is pertinent to the context here. The inscribed text describes a local group in the Languedoc buying or hiring a boat (ακατιον)¹⁶ from Greek traders from Emporion (Lejeune 1991; Lejeune et al. 1988:22).

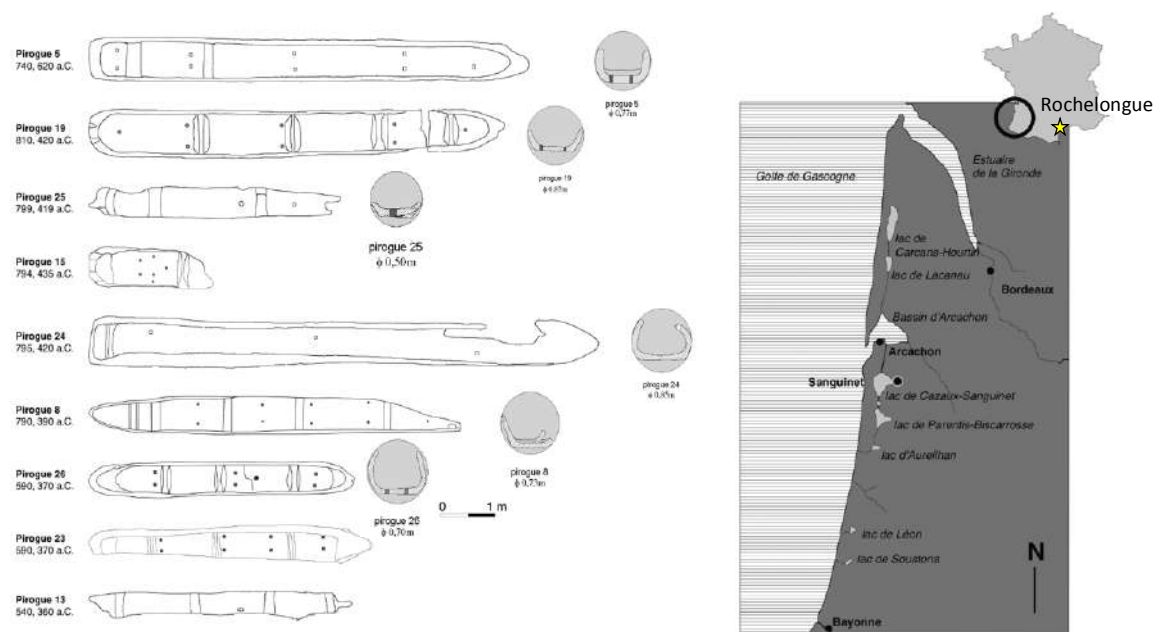


Figure 7.8. Dugouts uncovered at the Sanguinet archaeological site (from Dubos 2006:8–24).

¹⁶ This type of boat had a flat bottom and is described as a barge used for lightering ‘between the coast and larger boats anchored at some distance’, but also ‘capable of keeping to the sea and cabotage’ (Lejeune 1991:321).

This find is significant, as it highlights the local population's active role in seafaring and trade, at least along the rivers and nearby coasts. Additionally, it reveals another interesting point, which is the setting where the transaction takes place: the meeting between Greek merchants and local buyers occurs 'on the river' (Lejeune 1988:22). What *a priori* may be obvious—that the purchase of a boat would happen on or near the water—in fact instructs us about the context wherein the encounter occurs: the 'multiethnic middle ground' that some authors describe (Greene 2018:137; Malkin 2011:166).

As already discussed, it was common in pre-classical exchange systems for inland trading to occur at neutral places dedicated to trade, especially at crossroads (Ruiz-Gálvez 1999:53–56). The coastal equivalent would be river estuaries, coastal promontories or nearby islets (Delgado 2010; Guerrero Ayuso 2008a; Guerrero Ayuso et al. 2017). Oftentimes, submerged objects marked such locales, which represented neutral or even sacred spaces of mutual trust (De Sousa and Sousa 2018; Dedet and Marchand 2015; Huth 2017). Some classical authors describe coastal emplacements utilised as centres of exchange between socially differentiated communities. Pseudo-Scylax (112), for example, describes this type of activity at Kerné Island, where Phoenician merchants would set up camp to trade with Mauritanian Libyans. Thucydides (IV, 53, 3) gives another example, wherein Greeks would meet with Egyptians and Libyans coming by boat on the island of Cythera (modern Kíthira) to trade goods. Such practices have been identified at least since the end of the Bronze Age (Guerrero 2008; Guerrero et al. 2017), and some of these encounter spots ultimately became the origin (*palaipolis*) of important colonies.

In light of such practices, interpretations of the Rochelongue site as a ritual deposit at sea, such as espoused by Jean Gascò, cannot be discarded out of hand. Gascó (2012:235) cites the presence of Launacien objects left as offerings in Greek sanctuaries as supporting evidence for his argument. Although on the surface both practices are forms of ritual deposition, the former served as ritual demarcation—and perhaps dedication—of a special space, whereas the latter was votive in purpose, serving to plead or thank in perpetuity a deity for some favour desired or granted. Nevertheless,

it is important to note that scrap metal deposits also are associated with a number of sanctuaries connected to the Greek colonial world in the western Mediterranean (Baitinger 2016), especially in Sicily, where 31 scrap metal hoards were excavated at the Bitalemi shrine, near Gela; some also containing Launacien elements (Orlandini 1965; Pace and Verger 2012; Tarditi 2015, 2016; Verger 2003; Verger 2006; Verger 2011; Verger and Pernet 2013). Another important example is the site of Santa Anna, also in Sicily, where 150 kg of bronze and copper, mostly ingot fragments, but also scrap metal, were found inside a large pithos; however, in this case, most of the objects were of Greek or Sicilian origin (Baitinger 2016:116). Doubtlessly, there was an important link in the colonies of the west to the dedication of scrap metal at sanctuaries. This activity also has been identified at sacred sites on mainland Greece, such as Olympia and Delphi, where fragments of weapons and armour were dedicated (Baitinger 2018). The importance of such martial offerings to the gods concerns not only Greece, but also a broad swath of early southeastern, central and western European cultures (Baitinger 2018:15).

Although the practice represented by these examples may seem, at least superficially, akin to the Rochelongue assemblage as ritual deposit, its true relevance to the is suspect. Two distinctions of the sanctuary deposits in particular draw attention: namely, the fragmentary nature of all of the constituent elements (some spearheads, although otherwise whole, have purpose made cuts in their edges) and the vast majority of Greek elements in the assemblages. The occasional presence of Launacien artefacts in these sanctuary contexts is merely evidence of contact, whether direct or indirectly, and the attribution of the same sacral use or meaning of such deposits to both cultures—Indigenous and Greek—is too simplistic and convenient. Moreover, one must consider that the types of objects deposited, even if the same or similar, might well reflect different social perspectives and symbolic values, depending on who deposited the material, who produced it and who used or consumed it.

At Rochelongue, there certainly is a significant number of fragmentary elements, denoted by breaks, cuts or other intentional deformations, that could signify ritual destruction; however, the much larger number of complete objects and especially the

overwhelming amount of raw metals make it difficult not to see an economic motivation behind the whole. Regardless, as argued already, it is difficult to separate the profane and sacred spheres. The co-presence of trade goods and possible ritual objects is linked closely to the perception of the maritime interface and interaction zones—contact zones.

Some ritual element should be expected, and some type of offering might reflect the occasion that was being marked, as, for example, celebrating a successful transaction, an auspicious homecoming or safe arrival. We cannot forget that a maritime interaction zone, with respect to the inhabitants of the associated hinterland, represents an area of interface between their own land and the sea—and the unknown lands and peoples beyond. Such zones were thresholds that had special social regulations for the conduct of maritime interactions (Needham et al. 2013:149), or for the consideration of ritual landscapes closely linked to the social context of seafaring in western European Bronze Age traditions (Chapman and Gearey 2004; Van de Noort 2004). Thus, some ritual aspect cannot be ruled out due to the special cultural norms associated with thresholds or contact zones, and to the Bronze Age cosmological meanings attached to prominent features in the maritime landscape that go beyond their utilitarian use as navigational markers.

The archaeological evidence from the site, including the find location of the assemblage and the presence of trade goods (ingots) and whole objects (bracelets, belt buckles, fibulae) from the Iberian Peninsula, does not fit well with an interpretation of ritual deposition; rather, it more strongly points to a shipwrecking event. Independent of this conclusion, the lack of any evidence of watercraft prevents us from knowing the type of vessel or the type of navigation or seafaring involved. In the end, though, the specific nature of the deposit matters little if the assemblage is interpreted within a contact zone context. Examining the archaeological material using a variety of methods (in this case, archaeological, analytical and network connectivity) within this interpretive framework provides greater opportunity for generalising conclusions as to the societies and cultural norms responsible for the deposit, in keeping with Muckelroy's (1978:4) pronouncement:

Above all, it should be noted that the primary object of study is man...[sic] and not the ships, cargoes, fittings or instruments with which the researcher is immediately confronted. Archaeology is not the study of objects simply for themselves, but rather for the insight they give into people who made or used them...maritime archaeology is concerned with all aspects of maritime culture; not just technical matters, but also social, economic, political, religious and a host of other aspects.

The study approach adopted for this thesis is more likely to engage in broad discussion with the material assemblage from Rochelongue, not only about those responsible for its deposition, whether intentional or not, but also about those who mined, manufactured, used, and traded its constituent materials, and the partners—foreign or local—with whom they interacted. Importantly, it moves the discussion of the Rochelongue site beyond the binary model of colonialist and colonised that traditionally has dominated scholarship on the archaeology of ancient colonisation (Dietler 2010:26). A more comprehensive vision of these contacts should therefore consider the complexity that cultural connectivity reveals.

7.3. Cultural Connectivity: The Contact Zone

When this research began, the archaeological analysis of the Rochelongue assemblage focused on comparable Launacien metal deposits and the connectivity via sea trade with Mediterranean cultures that the contents of these deposits manifested. The typical hypothesis explaining the cultural motivations of the Launacien phenomenon has centred on the role of Etruscan or Greek actors. More recently, some scholars have put forward contacts with Greek colonies in Sicily and southern Italy as a probable rationale (Verger 2003; Verger and Pernet 2013; see Chapter 2). Others have concurred; arguing that Sicily's influence during the Archaic period has been underestimated (Guilaine et al. 2017). Certainly, recent data has supplemented significantly the Sicilian record (Bouffier and Garcia 2017). The seventh-century B.C. 'Greek' vases (cups and *skyphoi*) discovered in southern Gaul (at Mahilac and Montlaures, in the Aude, and at Agde, in the Herault), traditionally attributed to Etruscans (Gras 2000:233), potentially can be assigned now to Sicily (Guilaine et al. 2017:360). Similarly, the so-called Ionio-Massalian wine amphoras found at EIA sites in

southern France are attributed now to Magna Graecia (Abbas 1999). Conversely, it has been outlined previously in this thesis that objects found in southern France from the seventh and early sixth centuries B.C., comprising principally bronze artefacts, have also been identified in Sicily, in specific contexts at sites such as Bitalemi and Sciacca (Baitinger 2016, 2018). These circumstances reflect at the least direct contact between these locales, if not more involved commercial entanglements. The circulation of objects from southern France, reaching such far-flung regions as the Iberian Peninsula (Graells 2013a), Italy, and mainland Greece (See Chapter 6 p.183 Figure 6.29) (Verger 2000; Verger and Pernet 2013), testifies to a dynamic mechanism involving social relations and mobility that relates directly to the discussion of Rochelongue.

The Rochelongue assemblage reflects these relationships in different ways. Diverse types of ornamental elements, such as bracelets, represent one of the most common categories connecting sites, not only regionally, but foreign as well. As seen in the previous chapter, the bracelets with the greatest degree of centrality, which can be interpreted as being most in demand, are those with a solid section, namely Types 5 (6.5) and 9 (4.7). These forms originate from continental France (Verger and Pernet 2013:234). Considering sites, on the other hand, those (other than Rochelongue) with the highest degree of centrality (Ego) are Vias (1.10), Launac (1.28) and Carcassonne (1.39). These values attest to the proximity of these locales to major waterways (rivers or coast) and demonstrate the primacy of local actors in moving products from the coast to the interior and vice versa.

With respect to external connections, the two most central sites are Sciacca and Gela, both in Sicily, which at 0.81 have higher degrees of centrality than many of the local deposits. The objects with greatest connectivity with respect to external actors are bracelet types 7 (decorated penannular bracelet) and 10 (leg ring with high reliefs) and the Launacien talons. Another object type of interest is the disc with central bulge (type C.4.3), which has a high degree of centrality (3.3) and connects areas as far-flung as central Europe (Switzerland-southern Germany-Austria), southern France (Rochelongue) and Greece (Perachora).

On the other hand, it seems clear that Rochelongue acted as a broker of sorts, since the proportion of ornaments originating from the central France and Launacien deposits is significant, and the existence of fragments of these same elements in several Greek cities on the south coast of Sicily also is noticeable. Furthermore, Rochelongue occupies a central position in the framework of long-distance circulation of raw metals between the Hallstattian domain, Catalonia-Languedoc and the central Mediterranean. It can be argued therefore that the Rochelongue assemblage co-exists in this broad context of early Mediterraneanisation of southern France (Gaul) before the foundation of Marsala (Garcia and Sourisseau 2017:82; Morris 2003). The SNA map shows a strong and direct link between west Languedoc and Sicily (see Chapter 6 p. 191, Figure 6.32), one that is corroborated by the Maritime Model of Connectivity and the LPC. Considering sailing months with opposite extreme conditions, such as January (with the worst conditions) and April (with constant average values that allow easy navigation), it is apparent that the best maritime route between southern France and Sicily goes via the Tyrrhenian Sea. The Giglio shipwreck may be indicative of this route at the inception of the sixth century, but could not the Rochelongue assemblage be as well?

Attending more closely to the artefacts from Rochelongue, objects exported to other areas of the Mediterranean (whether to fulfil an economic or ritual function), such as bracelets, are well represented in the assemblage. However, as discussed previously, there is no material culture in the Rochelongue assemblage that can be associated with the Greek colonies of Sicily. In fact, the only elements that could be considered foreign are assigned to the Etruscan and Phoenician cultural spheres. This would be the case as well for some fibulae, belt buckles, metal vessels, and the copper ingots, although this evidence requires a deeper discussion, which follows. Indeed, from the end of the seventh century, Provence and Languedoc (Garrigues and Rhone Valley) constituted the privileged areas for diffusion of Etruscan products (Dedet and Py 2006:121). The artefacts linked to Etruscan culture are wine amphoras, fibulae, metal vessels with pearled rims, and the conic metal vases called *situlae*. Amongst the Rochelongue materials, two fibulas (RCH1.2017.00544 and RCH1.2017.00545) have been identified as northern Italian, and several fragments of copper that have been linked to *situlae*

(Garcia 1987). In addition, a possible cauldron handle (RCH1.2017.00755) also has been assigned an Etruscan origin, although its most direct parallels have been found in the central Mediterranean, especially Sardinia (Bernardini and Botto 2015; Graells 2010). Regarding situlae and metal vessels with pearled rims, of which there are no examples in Rochelongue, recent research has shown that they contain a number of metal impurities and a high tin content (9%) similar to Launacien bronzes (Guilaine et al. 2017). This has led to the hypothesis that they are local copies of Etruscan models. Fibulae, on the other hand, have been cited as indicators of direct pre-colonial contact with Etruscan Italy, rather than with indigenous Italic populations (Dedet and Py 2006). Along similar lines, it has been suggested that certain Italic products are the result of indigenous trade routes that are independent of the Greek, Etruscan or Phoenician involvement (Graells 2013a:734). These few materials would take advantage of a local exchange and communication networks that spanned the entire Gulf of León during LBA–EIA (Graells 2013:734). Similarly, although the westward limit of distribution of Etruscan material culture typically is seen as the Aude River, where only one example of bucchero nero and a fragment of an Etrusco-Corinthian oenochoe have been found at Ruscino (Perpignan) (Guilaine et al. 2017:358), the remains of EIA Etruscan forms are known also in the northeastern Iberian Peninsula, at sites such as the indigenous settlement of San Martí d'Empúries (Aquilué et al. 2008).

Likewise, some authors (Graells 2013) see a fluid exchange of metal objects between Catalonia and southwestern France. Launacien artefacts have been documented along the eastern coast of the Iberian Peninsula, in areas such as La Escudilla, Aldovesta, Empúries and Turó de la Font de la Canya (Graells 2013:728). Along with this, the archaeological record shows that, from the end of the seventh century B.C., prestige objects of Italic production were used by local elites to enhance their social standing (Graells 2013:730). Thus, the flow of materials and influences circulated bi-directionally between Italy and the Iberian Peninsula via southern France, which seems to have acted as a bridge between the two regions (Graells 2013:733).

Supporting this commercial dynamic are other objects that fed the flow of local exchange stimulated by the Mediterranean contacts. Rafel and colleagues have

investigated a group of objects as evidences, for the existence of local workshops in the area of Languedoc and Catalonia (Rafel et al. 2010a). The production of such objects continues a bronze metalworking tradition of Sardinian influence that is manifested in decorative elements, such as rope motifs, spirals, and hollowed rings (Figure 7.9). The most characteristic object of this tradition is the offering-stand, the most representative of which, for the Iberian northwest, come from the necropolis of Les Ferreres Calaceite (Armada and Rovira 2011; Graells and Armada 2011), and, for west Languedoc, from Coufoulens (Aude) and Saint-Julien (Pezenas, Herault) (Verger and Pernet 2013:66–67). All of these finds date to the first half of the sixth century B.C., and the burials are interpreted as aristocratic, since elements linked to war (armour and weapons) and banqueting (ceramic and metal dishes) are typical indicators of elevated status.

The bronze offering-stands are manufactured objects of technological complexity that testify to local adaptation of a foreign object or long-standing stylistic tradition in the Mediterranean. Examples from Calaceite, Couffoulens, and Pézenas do not constitute an isolated phenomenon; rather, they share stylistic and decorative features with other less elaborated artefacts, such as decorated pendants and chains (Figure 7.10) (Armada et al. 2008:498–501; Graells and Sardà 2007; Rafel 1997). These artefacts are commonly found in metal hoards in Catalonia, Aragon (Armada et al. 2008), and the Balearic Islands (Guerrero Ayuso 2008a). The type of decoration, the relative chronological uniformity and area of distribution of this type of objects has led some authors to interpret them as a late production that assimilates earlier ornamental and morpho-technological Cypro-Sardinian stylistic traditions (Armada et al. 2008:478). The so-called La Clota tripod, found in an aristocratic burial like the offering-stands, is a good example of the phenomena (Lo Schiavo 2008; Rafel 2002). The object stylistically approaches Cypro-Sardinian models; however, recent LIA evidences has indicated a likely provenance on the Iberian Peninsula (Rafel et al. 2010). Sardinian and Cypriot influence is a consequence of a tradition of contact inherited from the Bronze Age (Armada et al. 2008; Rafel et al. 2008). This interpretation is not inconsistent if we take into account various findings that highlight both maritime and terrestrial contact

between the central Mediterranean and Atlantic zone through the southern coast of France during the Bronze Age. Among the most characteristic finds that exemplify this contact are the oxhide ingot found on the Languedoc coast near Sète, Hérault (Domergue and Rico 2002). Needham and Giardino (2008) also have proposed southern France as the conduit for central Mediterranean influence on some LBA metallic productions in the British Islands.

Such statements are not contradicted by the evidence from the Rochelongue assemblage, as some of the objects from the site bear the same type of decoration manifest in the offering-stands from Calaceite, Couffoulens and Pézenas. Additionally, some pieces find similarity with decorated pendants, marking direct parallels from the Balearics and Iberian northeast, including its interior (Figure 7.9 and Figure 7.10) (Graells 2013). A possible Sardinian influence cannot be excluded, since the few remains of metallic vessels in the Rochelongue assemblage share some common decorative elements as examples of cauldrons and metal bowls found in Sardinia (Bernardini and Botto 2015:336).

Rochelongue object RCH1.2017.00755 (Figure 7.11 A) is a handle with similar features as the metal bowl found at Monte Sa Idda, Sardinia (Figure 7.11 B) (Matthäus 2001:154–165 figure 6). Bowls with so-called ‘figure-of-eight handle supports’ present handles crowned by a lotus flower (Bernardini and Botto 2015:345). In the case of Rochelongue, part of what appears to be a lotus flower decoration was found on a handle fragment RCH1.2017.01382, which invites comparison with Sardinian models, although the poor state of preservation of this fragment prevents a definitive identification. The models found in Sardinia are directly connected to Cypriot prototypes produced by Phoenician workshops during the eighth century B.C. Again, in the case of Rochelongue, we find a local adaptation of older models that had great proliferation throughout the Mediterranean. Recent studies have concluded that the circulation of cauldrons with lotus flower handles was much wider than it is possible to document today because (Bernardini and Botto 2015:348).

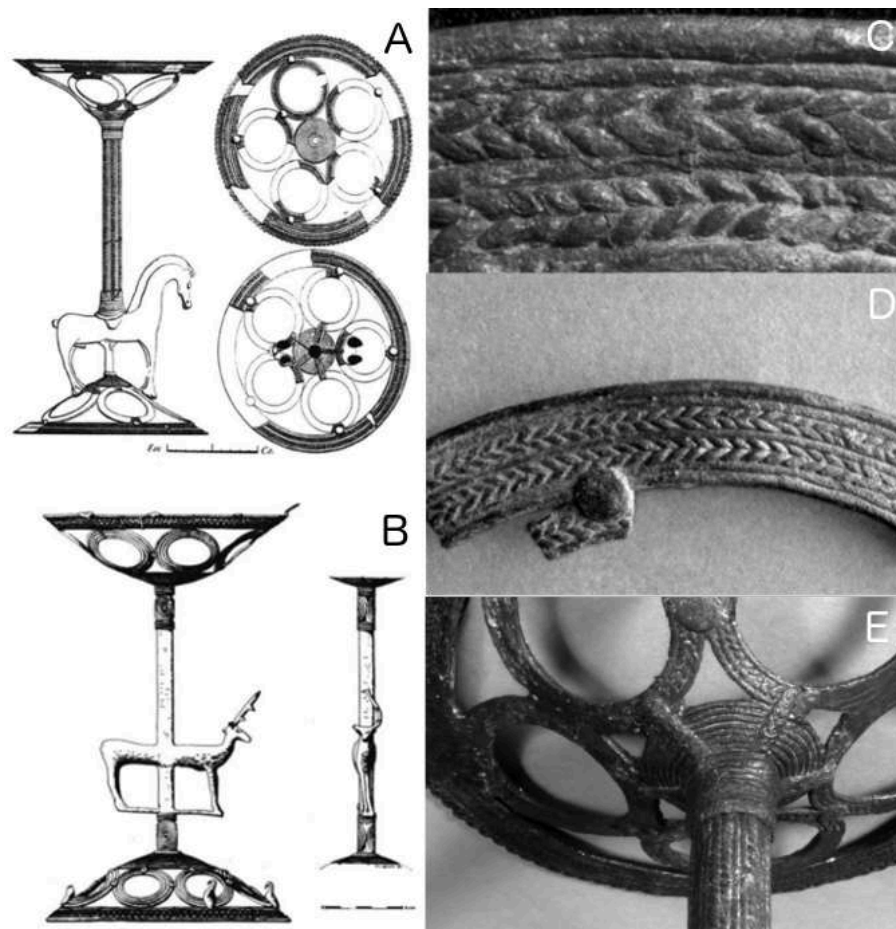


Figure 7.9. Offering-stands from A) Calaceite, with details shown in C–E; and B) Couffoulens (from Armada et al. 2008:496 figs 15:2–3; Armada and Rovira 2011:19–25 figs 7, 8 and 13).

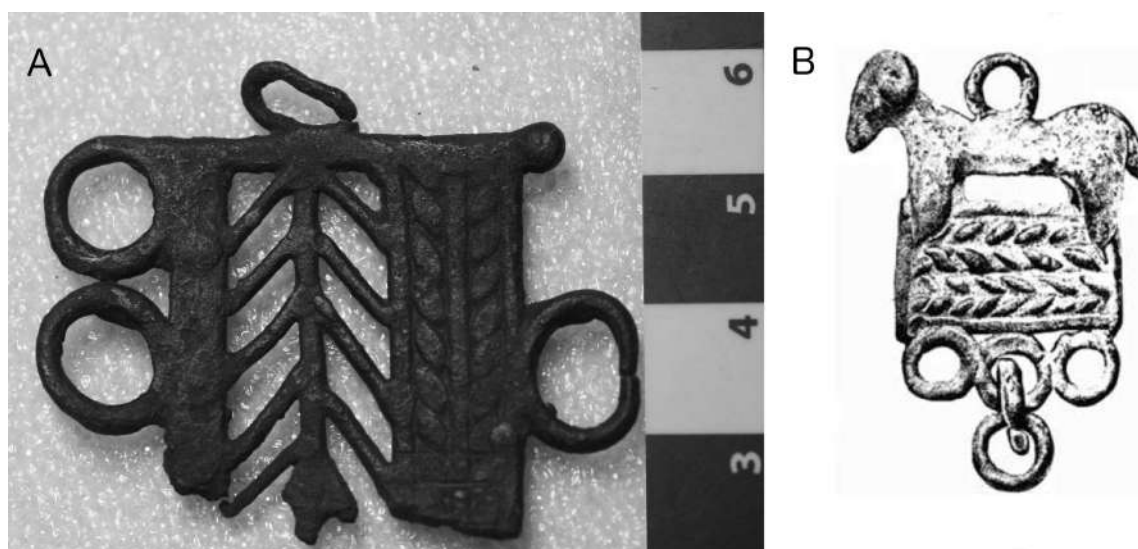


Figure 7.10. A) Object RCH1.2017.00522 from Rochelongue with decorative rope motif; B) zoomorphic pendant from Torre de Monfort, Catalonia (from Armada et al. 2008:500 fig. 18).

In the Iberian Peninsula, two figure-of-eight handle attachments from cauldrons dated to the eighth century B.C. have been found at Nora Velha (Ourique, Beja) and Casa del Carpio (Belvís de La Jara, Toledo) and interpreted as Cypriot imports (Armada 2006:274–279, fig. 5:1–2; Avila 2002:152–153; Bernardini and Botto 2015:348). In addition, two examples of imitation productions come from Castulo (Jaén). These rectangular handles with lotus flower appendices, dated to the seventh century B.C., are interpreted as being inspired by eastern Mediterranean models (Armada 2006:274–279, fig. 5:3; Avila 2002:153; Bernardini and Botto 2015:348; Matthäus 2001:165)



Figure 7.11. Handles of bronze cooking pots from A) Rochelongue (RCH1.2017.00755) and B) Monte Sa Idda, Cagliari (Bernardini and Botto 2015:343 fig. 47:2); C) whole cauldron with lotus flower handles, from Sardara (National Archaeological Museum, Cagliari; Bernardini and Botto 2015:339 fig. 44).

Such evidence requires a re-examination of certain objects in the Rochelongue assemblage (e.g., RCH1.2017.00980 and RCH1.2017.01001) that *a priori* might fall into the ‘indeterminate’ category, but in fact may correspond to components of similar

metal tableware. These elements, together with the aforementioned *situlae*, constitute objects of local origin linked to social practices of hero-warrior burials and banquets that begin to appear at the end of the 7th century and culminate in the second half of 6th century B.C. (Graells 2013; Graells and Armada 2011).

In light of these observations, the material culture of Rochelongue, which traditionally has been ascribed to Etruscan and Greek milieus, expresses a network dynamic that in most occasions is best characterised as indigenous. This network encompasses the entire Gulf of Leon in a much broader conceptualisation than typically has been acknowledged. These 'local' contacts are more expansive, comprising the interactions between the LBA–EIA societies of the greater Catalonia–Languedoc region. Furthermore, this dynamic exhibits a quality that is not only terrestrial, but also maritime, as shown by the close relationship with the central Mediterranean islands.

Certainly, together with the aforementioned Tyrrhenian Sea route, the material culture so far analysed shows two additional circuits evidenced by the MCM: one across to Sardinia and Corsica (connecting to Sicily), and the other along the Languedoc–Catalonian coast. Destinations such as Tharros, Sulcis, Nora, and Monte Sirai in Sardinia represent nine days of cabotage navigation. Recall that the model considers only coastal navigation (in constant view and proximity to the coast), which in turn facilitated occasional stops. Corsica and the Strait of Bonifacio also likely played important roles in the Sardinian route (Broodbank 2013:495), as the Phocaeen foundation of Alalia in ca. 535 B.C. confirmed (Broodbank 2013:550)

A third lowest-cost-path route runs west along the southern coast of France and south to the coast of Catalonia, then from there to the Balearic Islands. Coastal settlements such as Emporion would have been only a six-days sail from west Languedoc, making it much more accessible to transport large cargoes by sea than over land across the Pyrenees (Carreras et al. 2019). The Balearic Sea is somewhat farther away, with establishments such as Alcudia (Mallorca) or Sa Caleta (Ibiza) representing 16 and 19 days travel by sea, respectively, from the west Languedoc coast. Such areas would be more easily accessible via the Catalonian coast than by open-sea voyaging directly from the Languedoc coast. Sailing directly from Corsica or Sardinia to the Balearic Islands

would require open-sea voyaging as well (see Chapter 6 p.197 Figure 6.34); the sea extending between these two island groups being one of the largest ‘visual deserts’ in the Mediterranean (Guerrero Ayuso 2006:90–91). On the other hand, a coastal route from Sardinia to the Balearics would proceed counter-clockwise along the French then Catalanian coasts, almost as far south as Cap de la Nau (to present day Dénia), before heading due east for some 50 nautical miles (93 km) across to Ibiza.

Despite the problems and limitations inherent in this method of maritime connectivity (see Chapter 5), it is interesting nevertheless to highlight the indicative values that this model represents based on the coefficient of navigation. Clusters show that the best-connected area is the Tyrrhenian Sea, linking southern France with Sicily, Sardinia and the northeastern coast of the Iberian Peninsula. This is the decisive maritime context of the Rochelongue site and, consequently, the encompassing primary contact zone.

At this point, then, it must be asked if the cultural context of the Rochelongue material can still be considered entirely within the Launacien phenomenon, or does it represent a different reality? Is it really representative of direct interactions with colonial Mediterranean spheres, or should it be understood as a maritime extension of a long established network of local connections, influenced by foreign elements, but independent of them? To answer these questions, an assessment of the similarities and differences between the Rochelongue and Launacien deposits is required.

Identification of the Rochelongue assemblage as a Launacien deposit in recent decades is based on the presence of particular objects—Launacien talons and other ornamental elements—linked directly to this phenomenon. Furthermore, as seen in Chapter 6, in the absence of any absolute dating for the assemblage, the relative chronology of certain pieces, such as the Fleury type belt buckle and the so-called ‘belt buckle with decorative applique’, date the assemblage to the end of the seventh or beginning of the sixth centuries B.C. Thus, chronologically, the assemblage and hoard materials are concurrent. The constituent materials of the deposits also have a shared cultural heterogeneity. Indeed, like the Rochelongue assemblage, the Launacien metal hoards contain foreign elements from the Burgundy region of eastern France and neighbouring canton Jura of northwestern Switzerland (Guilaine et al. 2017; Millotte 1963a, 1963b),

from the Atlantic zone as well as from other continental cultures (Soutou and Arnal 1963).

Nevertheless, there also are important differences between the Launacien and Rochelongue deposits. The first and most obvious is the maritime environment in which the Rochelongue material singularly was found, but there are also dissimilarities in the nature of the materials. A majority of the Rochelongue artefacts are complete pieces and there is a significant presence of both crafted and semi-processed elements from the Iberian Peninsula. This contrasts with the typical Launacien hoard wherein most of the pieces are fragmented (Guilaine et al. 2017) and objects of Iberian origin are limited.

The products that most closely link Rochelongue to the Iberian world are the double-spring fibulas and belt buckles. As seen in Chapter six, these products are widely distributed along the eastern coast of the Iberian Peninsula, as well as along several corridors inland that connect the coast to the Bajo Aragon and La Meseta regions and Andalusia (Figure 7.12). Although traditionally the double-spring fibula has been ascribed to Phoenician manufacture, Graells (2014b:249) more recently has suggested that it is an indigenous production that originated in the Peninsula's eastern coastal region. Similarly, the types of belt buckles found in Rochelongue may be mainly productions from west Languedoc or northeastern Iberia (Graells and Lorrio 2017).

At this point in the discussion, a recent and relevant find needs to be mentioned. Archaeological excavations at Turó de la Font de la Canya, in the Priorat region of Catalonia (Province of Tarragona), uncovered a metal deposit comprising whole bronze ornamental objects and copper ingots. The deposit is well dated stratigraphically to the end of the seventh or beginning of the sixth centuries B.C. (Graells 2013b:215). The objects are clear parallels to those found at Rochelongue and in the Launacien deposits, such as bracelets (e.g., type 11) and pendants. The importance of this deposit is that it requires an historico-archaeological analysis of the Launacien phenomenon to incorporate the northeastern Iberian Peninsula into what is considered 'local' and, more broadly speaking, to consider as well the margins of the Gulf of Lion when

evaluating the web of exchanges between southern France and the western Mediterranean.

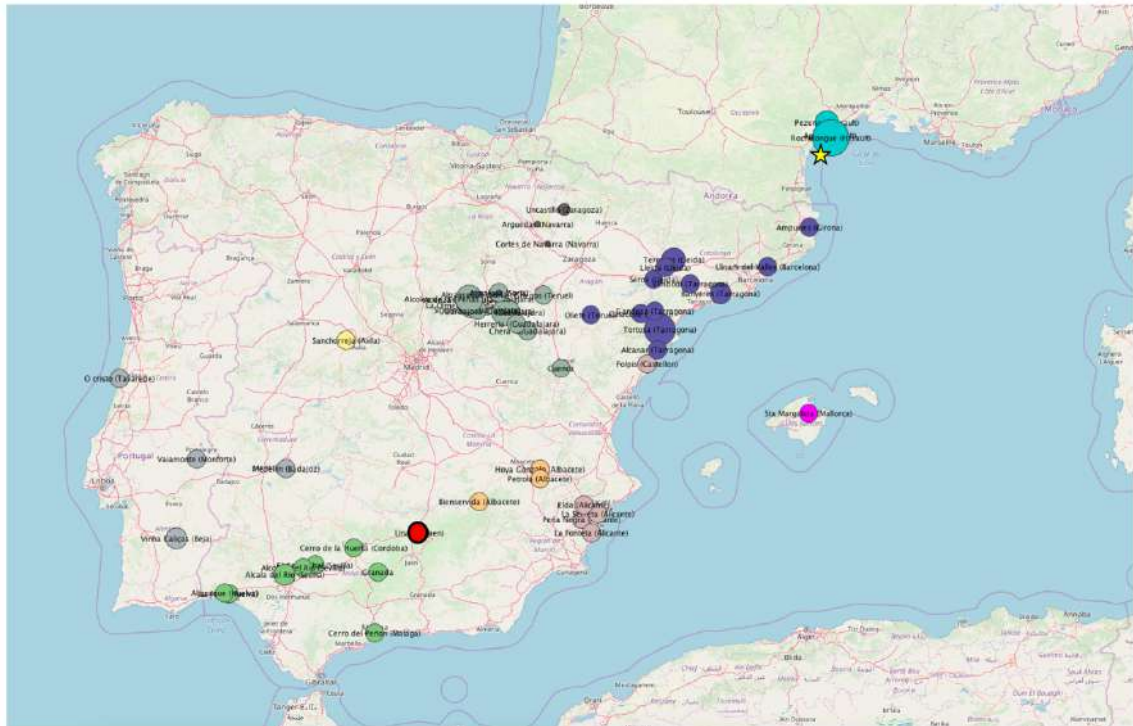


Figure 7.12. Distribution of belt buckle finds (based on Graells and Lorrio 2017). Circles indicate find spots, their size reflecting the number of buckles found and their colour indicating the area of distribution. Rochelongue site is marked with a yellow star and Linares is marked with a red circle.

In this respect, recent studies have shown a clear exchange between the south of France and northeast Iberia, as evidenced by Launac-type objects (Figure 7.13) that then were re-distributed along the southeastern and southern coasts of the Peninsula and across the interior (Graells 2013). The focus of this exchange seems to have been bronze items of adornment, especially belt buckles and fibulae (double spring and pivot types), examples of which are found also in the Rochelongue assemblage (Graells 2014: 250–251).

This relationship is reinforced by the metallographic and isotopic analyses of the Rochelongue materials. The leaded bronzes in the Rochelongue assemblage correspond most closely to local mineral sources, such as Cevennes, where the copper

mineralisation includes a high percentage of lead (Ambert 1995; Ambert et al. 2009). However, such objects are few in number, whereas the majority of analysed artefacts from Rochelongue have a low lead content. Thus, even though there are readily accessible local sources of ore, most of the metal for the Rochelongue material seems to have been sourced farther afield. While some of the Rochelongue objects can be linked to Linares, only one of the ingots can be assigned to this source. Thus, the possibilities arise that either the metal arrived in the form of manufactured objects, or it resulted from recycling material representing a variety of sources.



Figure 7.13. Metal hoard from Turó de la Font de la Canya in Priorat, Province of Tarragona, Catalonia (from Graells 2013b:215).

Ignacio Montero and colleagues have documented a similar situation at sites such as Can Xac and El Calvari in the Iberian northeast (Montero Ruiz et al. 2012a). Although these sites are located within the Molar-Bellmunt-Falset mining district with ready access to non-argentiferous galena (lead) and copper ores, none of the copper-based objects they analysed could be related to the use of local minerals (Montero et al.

2012:167–184). Instead, they concluded that most of the metal was sourced from the mining area of Linares.

Looking specifically at ingots, those from Rochelongue have a totally different isotopic distribution than the Launac examples; only five have an isotopic signature that is coincident with the Launac group (see Chapter 6, p.179 Figure 6.26). Although it is possible that some of the Rochelongue objects were made with the ingot metal from Linares, none of the other copper ingots is an isotopic match for any artefact. Therefore, Linares has a limited role in the Rochelongue material and it is more probable that some objects were made from recycled metal. Identification of mineral and raw metal circulation and concomitant metal recycling exchange circuits is undoubtedly a complex problem that requires specific investigation. Such an examination is beyond the present study.

On the other hand, the ten ingots from Rochelongue with virtually identical isotopic signatures correlate with ingots from San Martín de Ampurias and Turo Font de la Canya (Tarragona), as well as some from El Risco (Caceres) and La Fonteta (Alicante) (see Chapter 6). The closest mineral area is the ACB region of the Ossa Morena, while other ingots, with $^{206}\text{Pb}/^{204}\text{Pb}$ isotopic ratios as low as 17.40 (Chapter 6 p.179 Figure 6.27), correlate only with the EAB zone of the Ossa Morena. Thus, more than half of the Rochelongue ingots analysed can be linked to the southwest of the Iberian Peninsula.

The circulation of metal, whether in ingot form or as finished products, invites reflection on the role played by each of the parties participating in this trade. Recent research investigated the circulation of metal from the southern areas of the Iberian Peninsula to the northeast and revealed strong interactions between Phoenician and indigenous populations (Montero et al. 2012). These interactions articulate an important exchange network for raw materials that encompassed almost the entire Peninsula (Murillo-Barroso et al. 2016:75).

The Phoenician presence—indeed, close relations with local communities—in northeastern Iberia has become increasingly evident as a result of recent research initiatives in Catalonia (see Rafel 2013: for synthesis). This situation is demonstrated by

the presence of Phoenician ceramics in indigenous areas such as Ampurias (Girona), both in the necropolis of Vilanera (Aquilue et al. 2008) and the habitation site of San Marti d'Empuries (Castanyer et al. 2016). Both of these sites are dated from the end of the seventh to the first decade of the sixth centuries B.C., just prior to the Greek foundation of Emporion (Agustí et al. 2000:105–112; Aquilué et al. 2008:174). The latter also is where an ingot was found with an isotopic signature that matches some of the Rochelongue material. Pottery finds include pithoi and amphorae produced in Phoenician factories in Andalusia, the Balearic Islands, and central Mediterranean locales.

Such sites demonstrate the important presence of imported ceramic materials or local imitations of Phoenician models in funerary contexts, although not just in areas with an established Phoenician presence, but also in sites further north, such as at Anglés and Agullana (Graells 2004; Pons and Pautreau 1994; Toledo i Mur and De Palol 2006) and at Can Piteu-Can Roqueta al Vallès (Marlasca et al. 2005). Some scholars argue that the distribution of such products, especially wine and prestigious goods, through exchange networks established by Phoenicians along the peninsular coastline is a phenomenon closely linked to processes of differentiation and consolidation on the part of indigenous elites for social and economic control (Aubert 2001; Sanmartí 2005; Vives Ferrandiz 2006).

This situation can be extended to west Languedoc, where the large number of Launacien objects in the Iberian Peninsula links the Rochelongue assemblage to necropoleis such as Agullana (De Palol 1958), Mas des Mussols (Maluquer de Motes 1984), Can Piteu (Astiz et al. 2002) and other (see Graells 2013a). These links are reinforced by the presence of Phoenician material or local copies in necropoleis in the vicinity of Agde, such as at Peyrou (Nickels et al. 1989), Mailhac (Taffanel 1958) or Le Bousquet (Gailledrat 2006:167). It is important to note that, for example, the roughly 200 tombs in the necropolis of Peyrou have yielded only four Greek and 14 'pseudo-Phoenician' objects. Thus, while overall such foreign elements are rare, Phoenician objects are at least three times more numerous than Greek ones (Ugolini 2010:230). This data reinforces the close cultural connection between the Rochelongue site and

Iberian Peninsula, especially the Catalanian region, and the exchange networks marked by such objects as double-spring fibulae and belt buckles. When viewed through the connectivity model (Chapter 6 p. 192 Figure 6.33.3) created for these two artefact types, there is an obviously important mesh of interaction that prioritises local exchange networks, but which influences and unifies long-distance behaviour patterns as well.

The mesh density for the Rochelongue-northeast Iberia network (See Chapter 6 p.192 Figure 6.33) indicates the involvement of a large number of actors, presumably indigenous. By contrast, the foreign (long-distance) connections revealed in the Rochelongue material, such as with Sicily, are much more direct and involve fewer intermediaries. Looking again at the presence of Phoenician and Greek ceramics, the type of contact may be reflected in the fact that while the number of 'Phoenician' vessels is greater, most of these are imitations and the actual Phoenician productions are fewer in number than the Greek. As a result, the Phoenician interaction might better be understood as a residual (indirect) influence filtered through indigenous exchange circuits, whereas Greek dealings are more direct. Nevertheless, the local interactions represented in the Rochelongue material are more numerous and much stronger than the foreign ones, as shown by the micro-network connections between the Launacien hoards with the underwater assemblage (See Chapter 6:192 Figure 6.33).

Returning to the main question of this research: how can a research framework using multiple methods of analysis provide a more in-depth approach to theorising and interpreting evidence derived from the metal assemblage of the Rochelongue underwater archaeological site in order to better understand the dynamics of cultural interaction in the LBA–EIA western Mediterranean? It has been shown that the use of a research framework applying multiple methods of analysis is better able to expose the dynamics of cultural interactions behind the cultural material in the assemblage, as well as facilitate study on varying scales: local, regional and long distance.

Perhaps the truest test of this approach is that it generated more questions than answers. As a result of the evidence uncovered by this research, should the Rochelongue site be interpreted as a middle-step episode; that is to say, an intended

direct encounter with an external actor that ultimately never fully materialised due to unfortunate circumstances? Would this direct contact have been contact with the Greek sphere in Sicily, or perhaps somewhere else along the southern coast of France? Was the interaction between inter-regional actors exchanging products in a symbolic emplacement? What factors motivated the importation of raw copper to an area—west of Languedoc—that was rich in such ore deposits? All of these questions are intriguing and were prompted by the different analyses conducted for this research. Unfortunately, the available archaeological data does not yet allow for reliable answers. Future research is needed to properly address these and other questions, along with a framework best suited to consider local trade networks, inter-cultural connectivity, and native seafaring capabilities.

After having considered the nature of the underwater site at Rochelongue, this research applied a new analytical framework to more thoroughly assess the site assemblage and extract relevant data to address more generalising questions of socio-economic and cultural import. Scrutinising the resultant data through the lens of ‘contact zones’ has produced a more flexible discussion of concepts such as colonisation and culture contact based on mobility, connectivity, and flow (as defined in Chapter 1). It also has served to better visualise the types of encounters that took place within the inter-tidal areas of southwestern France. The native societies there were entwined through a common cosmology in a complex relationship circumscribed by natural border spaces, such as seacoasts and river estuaries, transformed into sacred landscapes that served as backdrops for profane encounters.

Foreign actors, but especially those from across the sea, have long been credited with playing a pivotal role in the mobilisation of materials—in this case, metals. The metals trade and foreign mariner-merchants, therefore, typically are seen as the mechanism and agents of the initial Mediterraneanisation of the southern French coast and Languedoc region during the LBA–EIA. This also has been the contextual paradigm through which scholars have approached the Rochelongue material assemblage. What the present research has highlighted is that local connectivity is what made this social and cultural transformation—this Mediterraneanisation—possible. The results of the

present analysis of the Rochelongue deposit testify to a local enterprise, whether for ritual or commercial purpose, to move metals inter-regionally by sea. The archaeological record points to a strong affinity and close cultural ties between indigenous societies in Catalonia and Languedoc, on either side of the Pyrenees. As a result, Rochelongue cannot be ascribed entirely to the Launacien phenomenon, but instead must be seen as part of a wider inter-regional episode during which societies within the greater Catalonio-Languedocian region transitioned from the Bronze to Iron Age. Foreign—mostly Phoenician, at least initially—influence certainly was not absent, but impacted the Iberian side of the Pyrenees more directly. From there, it flowed through to Languedoc along with the metals, material culture, and socio-economic interactions that moved through the complex of regional networks, both overland and, according to Rochelongue site, by sea.

This transition witnessed the rise of ‘Big Man’ societies characterised by the presence of aristocratic warriors (see Chapter 3) who accumulated wealth as a sign of power. Long-distance trade provided local elites with opportunities to consolidate social inequalities, a situation that was fully manifested in the second half of the sixth century B.C. (Sanmartí 2014:460). The hierarchical factor, therefore, was paramount, and was articulated particularly through the role of women, especially in marriage as a means of maintaining the primacy of elite families and consummating alliances between different groups (Dietler 2010). It is not happenstance that at least 16 per cent of the Rochelongue assemblage comprise objects of personal—most likely feminine—adornment. The female role is fundamental to understanding these early encounters, whether in cementing treatise and alliances within local societies or in ritualistic practices of foreign cultures (Verger 2011).

The other element indicative of these societies is the rising figure of the warrior, represented in the archaeological record by elaborate mortuary customs that included feasts and burial with weapons and other prestige furnishings. These also have been interpreted as the demonstration of mobility of people and ideas (Graells 2013; Verger and Pernet 2013). The warrior burials too are symptomatic of the accumulation of wealth and display of power that culminated in the second quarter of the sixth century

B.C. and resulted in increased competition between 'Big Men', violence and social inequality (Sanmarti 2014). These socio-cultural manifestations have been seen as 'an affirmation of military aristocracies and heroisation of specific personalities' (Graells and Armada 2011: 34). The dichotomy of the role of foreign stimuli in the underlying causation has been interpreted as a 'representative process of resistance to Mediterranean stimuli, but also an evidence of their assimilation and transformation of indigenous societies' (Graells and Armada 2011: 34).

Taking all of this into account through the theoretical framework of network analysis, the final picture of the MCM for Rochelongue can be seen as a 'small world' structure. Small world defines 'a type of network where most links are shared between small, proximate groups of nodes, and these groups are linked together by less frequent, yet important, ties' (Knodell 2013:4). In this way, at the micro-regional level, Rochelongue is representative of the role played by the south of France in its opening up to the Mediterranean. The region acted as a bridge, connecting regional actors in the interior and Atlantic facade through 'weak ties' with long-distance actors from the central Mediterranean that provided artefacts of novelty. The result was a multi-scalar network in which customary interactions within small worlds were essential, yet structured by less frequent interactions, 'weak ties', with external networks. With respect to other contemporary shipwrecks in the western Mediterranean, Rochelongue appears exceptional in this network structure. The site is connected somewhat tenuously to Greek settlements through elements of Launacien material culture, but for the most part it reflects a local (regional), or more specific, network within the Catalonia-Languedoc region, wherein the copper ingots represent the main link with other clusters. This is in contrast to shipwreck sites such as Giglio or Bajo de la Campana, which are immersed in wider networks dominated by Mediterranean seafaring cultures—Phoenician, Greek, and Etruscan.

Attending to the coefficient of navigability (see Chapter 6 p.199 Figure 6.36) this model highlights the fact that maritime connectivity in the EIA western Mediterranean was defined by well-connected hubs with weak ties between them that creates the context of structural holes (refer to Chapters 4 and 6 and the Glossary in Appendix 5 for

definitions). In a network with structural holes, nodes/actors frequently act as brokers, or go-betweens, that bridge one or more such hubs (Crossley et al. 2015:36). In this case, the Rochelongue site is representative of local actors mediating between the interior and the coast. At the end of the seventh and beginning of the sixth centuries B.C., Phoenician, Greek, and Etruscan actors increasingly took advantage of the structural holes as maritime connectivity increased between the continental and Mediterranean worlds. This is especially evident from the second half of the sixth century B.C. on by the increase of Etruscan products in southern France and the establishment of Phocaeen colonies at Massalia, Emporion and elsewhere, announcing a new period in the transformation of the western Mediterranean basin.

7.4 Conclusion

The results of this research confirm that primarily the copper ingots (raw metal) represent the primary foreign element in the Rochelongue assemblage. Metal analyses have demonstrated a significant diversity of provenances for this copper, including a likely origin in the Iberian Peninsula. The catalogue also has shown an important presence of local (Launacien) elements, and specific types, such as fibulae and belt buckles, that are dispersed along the Mediterranean coast and interior of the Iberian Peninsula. This dynamic is supported by strong, but indirect, connectivity via overland routes versus weaker, but more direct, contact by sea. In terms of network characterisation, Rochelongue can be defined as a nodal point whereat foreign products from long-distance exchanges intersect with more local goods moving through regional networks. Nevertheless, the site is more than simply a point of redistribution, as the research has highlighted the coexistence of local and long-distance interactions, along with the primary role of local actors within the greater Catalonia-Languedoc region. Other areas implicated in maritime connectivity during the LBA–EIA are the Balearic Islands, Corsica, and Sardinia. These connections were continuations of a tradition of exchange that extended back into the Bronze Age and that intensified until the first half of the sixth century B.C. Additionally, the Maritime Network Model shows that direct sea routes connected the south coast of France to Greek colonies in southern Italy and Sicily, whereas Phoenician and Etruscan contacts

were indirect and facilitated mostly by local actors. These commercial links forecast the trade that will grow to prominence from the second half of the sixth century B.C. on, with Phocaeen Greeks taking the lead from those of Magna Graecia.

CHAPTER 8. CONCLUSION

Maritime activity in the western Mediterranean experienced significant growth from the late eighth through to the sixth centuries B.C. This growth impacted the mobility of various agents, both local and foreign, and resulted in direct interactions between disparate cultures and subsequent social, economic and cultural upheavals. A direct consequence of this increased mobility was the introduction of new social structures and the intensification of the accumulation of metal resources in response to the increased demands of foreign agents. Maritime transport offered advantages by optimising costs across both time and distance, which was to play a pivotal and more evident role from the fifth century B.C. onwards.

The underwater archaeological site of Rochelongue, discovered in the 1960s off Cap d'Agde in southern France, produced a unique material assemblage from this period. Dated to the end of the seventh or first quarter of the sixth centuries B.C., the site reveals a short, but relevant, episode in cultural interaction from the time. The 70–80 years window it represents provides an opportunity to analyse the Launacien phenomenon through the initiative of local agents in collecting metal goods to service foreign demands. It is representative of the earliest instances of sustained interaction between indigenous peoples of southern France and foreign seafaring cultures of the Mediterranean. Examined at a micro-spatial level, this dynamic contact with Phoenician, Greek or Etruscan cultures led to a transformation of native socio-economic structures. From a more global viewpoint, this incident is representative of the countless similar interactions that led eventually to the material interconnectedness of the whole Mediterranean basin and Mediterraneanisation of the resident indigenous inhabitants—and inexorably to the creation of pan-Mediterranean identity (Broodbank 2013:348).

The results of this study contribute new information about the material culture that defines the Rochelongue site and its historical context. Not only does this thesis research represent the first comprehensive archaeological synthesis of the site, but it also utilised a novel research framework incorporating multiple analytical methodologies within an overarching conceptualisation of contact zones linked to

maritime connectivity. This research approach provided a wider perspective for extracting information from the material remains that ultimately yielded more generalising interpretations, new questions, and new avenues of future inquiry.

Utilising the metric of connectivity, the extent to which the components (nodes) of a network are connected to one another, this thesis has sought to identify cultural contacts and the dynamics of material and human mobility by sea at different scales in the western Mediterranean. The research approached maritime connectivity from a social, material, and geographical perspective, which allowed for an in-depth analysis of questions regarding cultural interaction and its socioeconomic repercussions. The design of this research framework is based on the vision of Braudel (1972) and many subsequent authors (Horden and Purcell 2000), which conceives of the Mediterranean as a whole, but comprised of numerous micro-regions connected to each other through interactions. In order to fully understand this dynamic, the opposite side of this interpretation needs to be examined. This thesis, therefore, considers the Mediterranean as a fragmented, but closely interconnected space, with each fragment having a social, material, and geographic nature. In order to expose and evaluate the connection between one fragment and another, the analysis must be made across multiple natures, rather than by any single one. Therefore, this research has analysed connectivity on local and regional levels through social and material data extracted from the artefacts, before then considering the assemblage in a broader context.

A micro-regional context has been useful in understanding the Launacien phenomenon and other local embeddedness of the Rochelongue material. This and the identification of relevant external actors has enabled the characterisation of different roles in the interactions manifested by the material culture. The scholarship of the ancient world tends to subdivide the Mediterranean into sub-regions, running from east to west, and analyse each sub-region individually; however, the reality is that different actors interact across sub-regions in varying ways due largely to maritime connectedness, and these dynamics change over time. The questions of concern here, then, are what actors were operating when the Rochelongue assemblage was deposited; where and in what way did they interact; and what were the cultural and commercial motives that drove

such engagements? These questions underlie the analysis undertaken throughout the chapters of this thesis. Although the micro-region of focus is west Languedoc, interactions and connections distilled from the Rochelongue material assemblage speak to mostly local, but also inter-regional and longer-distance networks that link a number of geographical regions from the Atlantic façade to northern Italy and from the Iberian Peninsula to the central Mediterranean, all of which converge on the Mediterranean shores of southern France.

The Languedoc and Provencal coast, centrally located on the Gulf of Leon, served as a meeting place—a contact zone—for peoples and goods from these disparate locales, some of which were already engaged since the MBA–LBA. These networks intensified and expanded to include new connections during the EIA, when external agents introduced new cultural materials and practices that intensified the frequency and dynamics of the exchanges. These encounters, however, did not occur spontaneously; rather, the archaeological record shows that some sites, such as La Motte, were already engaged in inter-regional and long-distance contacts in the MBA–LBA. Likewise, maritime finds off the Languedoc coast, such as oxhide ingots related to the Sardinian/Cypriot trading sphere, demonstrate that this area was already immersed in a paleo-network that only intensified during the EIA.

Rochelongue can be situated in this LBA–EIA transition and exemplifies the structural changes both at an economic and social level. The first foreign contacts are a consequence of Greek and Phoenician colonisation and the rise of an Etruscan civilisation that saw in the Tyrrhenian sea an opportunity for trading. The local Gand Bassin I populations of southwestern France, whose origins trace back to the late Neolithic, were active participants in Bronze Age exchange networks, but experienced a structural change at the beginning of the EIA. Changes in the burial practices of these societies (at least in their upper echelons) denoting increased hierarchy coincide with the first imports of Phoenician and Greek material culture in the second half of the seventh century B.C. Excavations of burials from this time have uncovered a small number of individuals who were buried with numerous grave goods, including imported items, in contrast to the majority that still were entombed in simple graves.

Evidence for new ritual burial practices, such as Oriental style feasting, further points to foreign cultural influences.

Even so, the encounters that take place during the seventh, and especially through the sixth and fifth centuries B.C., would never have been possible without a local population embedded in well-established exchange networks and possessed of the social complexity and organisational capability necessary for mobilising productive work forces and maintaining conditions conducive to material exchange. The LBA societies in western Languedoc must be viewed from a more nuanced perspective than traditionally has been the case. Despite the semi-nomadic nature of these societies, some archaeological contexts show signs of proto-urbanisation, such as at Ruscino, Carsac and Mailhac in Roussillon and west Languedoc and Sextantio, Roque-de-Viou and Le Marduel in east Languedoc.

The archaeological record also shows signs of social and economic changes as these societies transitioned technologically from the LBA to EIA and socially from egalitarian with strong matriarchal tendencies (the female figure is strongly linked to the sacred, as evidenced in the ritual deposit of La Motte (Chapter 2, p. 12) to more stratified with 'Big Men' competing for resources and power. Consequent to this was the emergence of the Warrior Chief and accompanying increase in the role of violence. This increase in inequality and conflict and the subsequent necessity of alliances came to define the social context of this period (Kristiansen and Suchowska-Ducke 2015:373; Verger and Pernet 2013). From the end of the sixth and through the fifth centuries B.C., this new social structure is best represented by two specific archaeological contexts: the heroic warrior burials, adopted from Greco-Etruscan culture, and the *oppidum* fortified settlements.

The Launacien phenomenon was defined by a material—metal—response by the indigenous populations to the trading demands of new external actors (Guilaine 1972; Guilaine et al. 2017). These actors were Euboean Greeks who, since at least the beginning of the eighth century B.C., had established colonies in southern Italy and Sicily (Verger and Pernet 2013). Foundations like Pithekoussa and Cumas exemplify the early colonisation of Greeks in the west and were reinforced later with settlements

such as Gela, Selinonte, and Megara Hyblaea during the second half of the seventh century B.C. This migration opened up communication channels that later would facilitate the great Phocaeen Greek colonisation, which culminated with the foundation of Marseille and then Ampurias along the arch of the Gulf of Lion. However, other actors also seem to have played an important role in the first opening moments of southern France to the Mediterranean.

The Greeks certainly were not the only, nor first, seafaring peoples from the east to visit and settle upon these shores. Phoenician expansion into the western Mediterranean, focused especially on the Iberian Peninsula, had begun sometime in the tenth century B.C. and peaked at the beginning of the sixth. From settlements located on the southern coast of Andalusia, such as Gadir (Cádiz) and Malaka (Málaga), the Phoenicians extended their presence up the eastern littoral and across to the Balearic Islands. Sites such as La Fonteta (Alicante) and Sa Caleta (Ibiza) are representative of this expansion. If not actual settlements, Phoenician activity and influence also significantly impacted the northwest of the Peninsula, and since the 1960s, increasing numbers and varieties of Phoenician artefacts have come to light in Catalonia. The territory around the Ebro River is especially relevant, with sites such as Aldovesta yielding imports from Phoenician colonies in the south of Spain indicative of the intense interaction between Semitic and indigenous populations. Phoenician influence seems to diminish closer to the Pyrenees, and in west Languedoc, only echoes of these interactions are seen.

Etruscan involvement in southern France also cannot be ignored, although the extent and nature of it remains in question (see Chapter 2, p.p. 48–50). Centred in northwestern Italy along the Tyrrhenian Sea, the Etruscan homeland seems a natural and important link in the maritime networks of the western Mediterranean. Etruscan port cities, such as Pyrgi, Gravisca, and Regisvilla, and Etruscan shipwrecks that dot the southern coast of France testify to an active engagement in maritime trade from the second half of the sixth through the fifth centuries B.C.

All of these actors shared a common interest in metal resources that likely was the prime mover in the creation of these early maritime networks. The trade in copper,

lead, and silver had a transformative effect on the socio-cultural organisation of the local societies that responded to this economic opportunity. With the instigation of long-distance trade connections, new ritual behaviours are adopted, such as feasting and alliances sealed through marital exchanges. These commercial relationships also brought about a revolution in craftwork technologies, such as the potter's wheel and cupellation, which optimised the extraction of silver from mineral ores and alloyed base metals. Access to these long-distant exchange networks and new technologies itself became a tool of power over local populations (Bats 2007; Ugolini 2018). The circulation of metal and its control is therefore key to understanding the new context of relations between local elites and foreign actors.

Other than the fact that the artefacts that make up the Rochelongue assemblage are all made from a copper alloy (bronze), the main distinguishing characteristic of the grouping is the diversity of the object types. Discovered in 1964 by A. Bouscaras near Cap d'Agde, the site is situated some two kilometres from the mouth of the Hérault River. The river provided access to the copper-mining district of Cabrières and other mineral-rich areas of the interior. This part of the coast also has important geographical markers, such as Mount St. Loup or Cap d'Agde itself, that served as important navigational milestones for ships. Finally, it should be noted that this coast occupies a central location in the Gulf of Lion littoral zone and served as a strategic crossroad in connection the Catalan coast from Cap de Creus to Provence and the mouth of the Rhone River. Nevertheless, strong northeasterlies are frequent and make navigation risky, especially in areas where the offshore reef emerges, as testified by the numerous shipwrecks from throughout history that dot this stretch of coast.

The Rochelongue site is located approximately 500 m from the shore on a rocky reef that gives the site its name, in some six to eight metres of water. The site was the subject of a series of excavations between 1964 and 1970 and the recovered artefacts were deposited at the Ephebe Museum in Agde. The present research effort represents the first comprehensive study of the assemblage since the objects were lifted from the seabed. The artefacts attached to the site are diverse and include bronze weapons, tools, ornamental elements and an important number of copper ingots. Despite the

fact that he was not an archaeologist and underwater archaeology at the time was in its infancy, Bouscaras created an extensive data record of his excavations and the artefacts he recovered. The documentation is detailed enough to allow the present study to partially reconstruct the archaeological context of the site and, for the first time, a complete site map combining the results of all of the excavation campaigns. This revealed an area encompassing approximately 14 m × 24 m, wherein lighter objects (pins and other adornments) were strewn along a roughly NW-to-SE orientation, which matches the direction of the prevailing storm winds and currents that frequent the area). Four concentrations of heavier ingots were identified, each concentrated within a roughly 4-m² area. Scholars customarily have situated the site within an Etruscan, Phoenician or Greek milieu, despite no real components of the assemblage supporting this claim. These interpretations have been underpinned by terrestrial contexts linked to the Etruscans and Greeks in the south of France, or by the Phoenician maritime dominance in commercialising metals in the western Mediterranean. Likewise, some researchers have supported this opinion with the presence of Greek and Phoenician material in the nearby necropolis such as Peyrou (Agde, Hérault) or Bousquet (Agde, Hérault) (See Chapter 2 p. 30). More recently, the Rochelongue material is being reconsidered and the site now tends to be placed within the Launacien phenomenon, with the exchange of metals as its defining expression.

The cultural characterisation of the materials is not the only discussion that has surrounded the site, as the absence of ship remains has led to a questioning of its nature. The prevailing thought in the literature on the site is that it represents a shipwreck; more precisely, the cargo of a sunken vessel that was carrying raw and scrap metals. A second hypothesis attributes the assemblage to a smelting site located in an area affected by sea level change, while a third considers the assemblage to be the result of ritual deposition and links it to the broader terrestrial phenomenon of Launacien metal hoards, as well as funerary and mythological Indo-European ritual traditions that are documented along the Atlantic facade and British Isles.

The complete lack of any direct or even indirect evidence of boat structure is problematic for the shipwreck hypothesis, while the site's characterisation as

submerged terrestrial remains was discarded almost immediately, since the indication is that sea levels have never risen more than two metres since the Holocene transgression (Ambert 2001; Devillers et al. 2019). As for the votive deposit theory, it is perhaps the most interesting, but also the most difficult to verify. The deformation of some of the Rochelongue objects, symptomatic of a habitual practice in continental European societies since the Bronze Age, certainly bolsters this possibility; however, the presence of even more whole objects and, especially, the many ingot and ingot fragments also part to a trade origin.

This thesis has explored however, rather than solely focussing on dates, provenance and cultural adscription this thesis sought a more in-depth analysis. Previous interpretive efforts have been limited by the absence of a robust methodology. Instead, this thesis has focused on moving beyond such constraints and instead looking for new approaches to evaluating the assemblage that might yield more significant and generalising information about the societies involved in the extraction, manufacture, transportation, exchange, and use/consumption of the materials in the site assemblage. Towards this end, this research has pursued a path towards revealing the site's broader implications from the perspective of an early contact zone within the context of cultural and commercial interactions and maritime connectivity between indigenous and foreign peoples. The region wherein the site is located is viewed within its broader geographical and historical context in order to understand its important strategic position relevant to the metals trade in the western Mediterranean.

The lack of rigorous and comprehensive investigation of the Rochelongue site, its excavation and its material record, together with the lack of clarity as to its cultural and typological definition, has led to the consideration that the archaeological context as incomplete and to erroneous interpretations. The present study has attempted to re-assemble the Rochelongue archaeological record through a detailed reading of the site excavator's journals and a re-assessment of the artefacts of the assemblage using multiple analytical methodologies, with the goal of reconstructing the geographical and cultural connections evidenced in the material of the assemblage. This process has resulted in the identification of participants and exchange mechanisms within the

economic sphere of the Gulf of Lion and Languedoc coast, and in the broader western Mediterranean.

From a theoretical point of view, the reconstruction of connectivity is based on network theory, which can be defined as the abstraction of a past phenomenon into network concepts that permit a visual representation of the phenomenon under study (Brandes et al. 2013:10; Collar et al. 2015:4). More specifically, this thesis has combined aspects of Actor Network Theory (ANT) and Social Network Analysis (SNA). ANT uses humans and objects as a whole to understand how a social reality is integrated. SNA, on the other hand, allows the creation of an appropriate framework, both theoretically and methodologically.

Human ways of thinking and acting, as well as ways of knowing and doing, are integrated into our material culture even in the most insignificant of objects (Knappett 2005). Currently, discussion surrounding interactions between humans and objects has moved from the study of material culture to a much broader concept of 'materiality' (Miller 2005, 2007). This latter covers the processes of human life that are irreducibly embedded in the scope of both the material and the social. Knappett (2011:8–10) argued that in the study of space and connectivity at diverse scales—the approach applied in this research—'we can understand the role of distributed materiality in human interconnectedness' by using 'an object to act as a kind of marker of a non-present space (and time)'. This statement makes materiality especially significant in the study of artefacts as a pivotal element of social relations (Tilley 2004; Meskell 2005; Miller 2005). Along these lines, this thesis research has applied a relational perspective that permits the analysis of human and non-human assemblages at a multi-scale level to characterise complex interdependencies based on cognition, agency, and meaning.

The multiple scale and relevance of considering human and non-human elements as part of the connectivity is reflected in the example of a ship and its innumerable components:

Hull, spars, sails, stays, stores, rudder, crew, water, winds, all of these entities (and many others) have to be held in place, so to speak functionally, if we are to be able to point to an object and call it a ship (Law 2002:95).

In this sense, a network can be defined as ‘a set of items ... with connections between them’ (Newman 2003:168). In this research, such items are both human and non-human and, using network terminology, are defined as ‘nodes’ or ‘vertices’, and the connections between them as ‘links’ or ‘edges’. A relationship network then would consist of additional information that the links can show through a graph (de Nooy et al. 2018). Thus, the application of network concepts can be represented in a model to abstract the particular phenomenon under investigation (Collar et al. 2015:4)—in this case, maritime connectivity. One of the most potent concepts of network that is applicable to archaeology is the notion that individuals are embedded in thick webs of social relations and interactions (Borgatti 2009:1). The application of network analysis, therefore, allows us to create a conceptual bridge between individual agents and complex systems, which has obvious interpretive potential in archaeology (Brughmans 2012:364). Using concepts, such as similarities, social relations, interactions or flows (for a specific explanation of each concept, see the glossary in Appendix 4), we can construct an adequate framework to define the relationships between actors in a network analysis. This thesis considers network analysis as the most appropriate approach to explore connectivity for sea and coastal spaces to gain a wider understanding of the Rochelongue site and its socio-economic context. The use of SNA in this research affects not only theoretical considerations, but the methodology applied as well (Chapter 5). Following Brughmans and colleagues, the ‘relationship between the past phenomena and network data representation (methods) are treated separately’ (Brughmans et al. 2016:7).

The network analysis model was key to the research methodology in visualising the social relations extracted from the Rochelongue material culture. Combining this with a GIS terrain analysis model of the sea and bounding coastlines resulted in the creation of the MCM. None of this would have been possible, of course, without an exhaustive cataloguing of the artefacts, which confirmed the actual contents of the site assemblage, archaeological assessment of the artefacts via comparative analysis and their metallographic analysis using LIA, ICP-MS and pXRF. This application of multiple

methods of analysis provided a multidimensional vision to the study of the deposit that proved successful in addressing the objectives of this research.

The first step of creating a detailed catalogue of the objects held in the Ephebe Museum at Cap d'Agde was to organise the objects according to standard stylistic patterns in the literature for LBA-EIA France. The catalogue is based on three main elements: (1) Minimum Number of Individuals; (2) division of objects by functional categories; and (3) macroscopic identification. It cannot be forgotten that the Rochelongue assemblage is essentially metals (only two ceramic fragments were recorded during excavation, and neither was preserved). So, the use of metal analyses, such as LIA, XRF and ICP-MS, was key to extracting critical data for provenance studies. These results were used not merely to establish cultural adscriptions, but also to define the geographical scope for the network and connectivity modelling. Furthermore, elemental characterisation revealed that objects considered Launacien correspond to expected metallographic compositions of local productions. Other objects, specifically belt buckles and double spring fibulae, have atypical compositions. These artefact types typically are associated with external cultures and, for this reason, the LIA study focussed on them. These objects, along with a third material group, the copper ingots, were used to reconstruct maritime connectivity and its socio-cultural implications. Plano-convex ingots are highly relevant to the Rochelongue study. Apart from representing 71% of the total assemblage, they also are a critical element for studying metallography and metallurgical processes. Since they only are refined (semi-processed), representing a point in the *chaîne opératoire* only one step removed from the extraction (mining) of ore, the information that is obtained is a direct indicator of metal provenance.

Considering that the objective of this thesis was, above all, to investigate the trade of metal within a framework of maritime connectivity by identifying and distinguishing local activity and external influences through cultural interactions, the results have been remarkable. In reviewing previous hypotheses and interpretations of the Rochelongue site through an assessment of the original, unpublished excavation documentation, this research has had to confront the problems of recovering legacy

data from an excavation undertaken decades ago. Under the analytical lens of multiple methods, this thesis has yielded new data and proven a framework based on the concept of 'contact zone', which has allowed this research to overcome traditional theoretical barriers. This thesis has raised an original explanatory hypothesis for the site, while critiquing those previously put forward. The area of the site, according to the artefact scatter, was approximately 24 m × 14 m. If this were in fact a good approximation of the size of the original vessel, it would represent one much larger than any of the contemporary Mediterranean vessels from known shipwreck sites. The associated cargo capacity (tonnage) also would be much greater than the approximately 1.3 tons of material to which the assemblage equates. Additionally, there were large gaps in the dispersal that are difficult to explain, except by resorting to negative evidence for some, presumably organic, cargo that did not survive to the present. Alternatively, upon closer examination, the heavier elements (ingots especially), which probably best maintained their original location when deposited onto the seabed, were grouped in four concentrations. When viewed individually with respect to their object composition (see Chapter 7), these groupings exhibit a consistency in their number, weight and distribution of individual objects that strongly suggests four individual assemblages representing four small vessels, rather than a single one.

Based on the material record of the site and its spatial distribution on the seabed when excavated, these vessels likely were similar to excavated examples of expanded dugouts or log boats from continental sites and other on the British Isles. The capsizing or swamping of such vessels off the coast would have deposited their contents on the seabed, but left no evidence of the boats themselves, which would have been swept away by the very conditions that caused the loss in the first place.

This scenario is bolstered by comparing the Rochelongue site to known contemporary Mediterranean shipwrecks, such as at Bajo de la Campana, Mazarrón, Giglio or Xlendi Bay (Bound 1991; Gambin et al. 2018; Negueruela 2004; Negueruela et al. 2000; Polzer 2014), all of which have a totally different fingerprint. The most obvious difference is that, unlike Rochelongue, all of the Mediterranean—Phoenician, Greek or Etruscan—

wrecks yielded remnants of the ship's hull and equipment, along with possessions of their crews. The cargoes recovered from these wrecks also have different make-ups; they are more diverse in product types and they all include a significant consignment of ceramic vessels—especially transport amphora, but also cooking and tables wares and other types. Expanding upon this comparison, the closest parallel to the Rochelongue site is found on the shores of the British Isles. MBA–LBA sites, such as at Salcombe and Moore Sand and Langdom Bay, are similarly characterised by the preponderance of raw metal ingots and metal—mostly bronze—ornaments and tools and the absence of any hull or vessel. The artefact assemblages from these sites and from Rochelongue also have similar object types and share the same difficulty of interpretation. The totality of the evidence, therefore, including the results of the multipronged assessment of the material, points to the loss of multiple small watercrafts engaged in short-distance coastal transport of metals by a local population.

This interpretation provides some insight to the relevant archaeological context of Rochelongue. Societies traditionally living along the coast of the sea or bank of a river, as evidenced at La Motte (Moyat et al. 2010; Verger et al. 2007), developed a close relationship with their maritime environment in terms of resources exploitation, transportation and trading (Graells 2010). Furthermore, such populations that possessed the capacity to mobilise productive forces and move materials using water transport could be active participants (actors) in regional and long-distance trade networks alike, and guarantee dynamic exchange with external actors.

This new interpretative vision of the Rochelongue site provides a fresh perspective for future studies on the nautical capabilities of indigenous populations before and after the arrival of seafaring eastern Mediterranean cultures. Certainly, indigenous capabilities have been recognised before, for example, by Broodbank (2013: 494), who notes that '[t]he first eastern traders slotted into such networks and presumably benefited from local experience, possibly even local pilots'.

The main contribution of the present research has been to elucidate the connectivity and cultural interactions represented in the Rochelongue material. A contact zone approach has proven successful in illuminating such connections, as well as the

important interactions and agency of indigenous actors. This research provided a more focused analysis of inter-regional encounters, taking into consideration all of the identities and parties involved. The Rochelongue site represents the relationship between Launacien deposits and ritual deposits found in Greek colonies in southern Italy and Sicily, such as at Gela or Selinunte (Verger and Pernet 2013). The degree of centrality of objects like types 7 and 10 bracelets (1.3 and 2.5, respectively) confirms these relationships. These types of adornments, with an original provenance in central France, highlight the transplantation of such materials to ritual contexts in foreign domains.

The capacity and dominion of local actors in moving products between the interior and coast also is reflected in the degree of centrality of deposits such as at Launac and Carcassonne (1.28 and 1.39, respectively). Foreign sites, on the other hand, played a less significant role in this connectivity when looking at the level of connection with west Languedoc. Cities such as Gela and Sciacca both have 0.81 degrees of centrality. The Rochelongue site—more specifically, the people and their vessels it represents—exemplifies a broker role of sorts in negotiating contact between local and foreign populations. Evidence of this is the central position that Rochelongue occupies in the framework of long-distance circulations of raw metal between Hallstattian territory, the Catalonia-Languedoc region and the central Mediterranean. This fact is confirmed by the MCM, which demonstrates the most likely navigation routes and zones, or circuits, of contact. One such circuit is centred on the Tyrrhenian Sea and connects areas of Etruscan influence with Corsica and Sardinia. A second circuit connects Languedoc with neighbouring regions of Catalonia and the Balearic Sea. Both of these zones represent the areas of greatest connectivity and influence as exposed by the material from Rochelongue. Objects such as belt buckles and double-spring fibulae show clearly that, although the latter zone of maritime connectivity extends only to the middle of the Catalan coast, intersecting land routes extend that connectivity to the southern portions of the Iberian Peninsula. This, for example, is the most likely route followed by at least some of the Rochelongue ingots.

Despite these macro results from the social and geographical network maps, it cannot be said that Rochelongue is embedded in these sea routes directly. It would be more accurate to characterise the Rochelongue site as a consequence of exchange networks and mobility that already existed at the end of the seventh/beginning of the sixth centuries B.C. None of the Rochelongue material culture can be associated with the Greek colonial sphere. In fact, the only elements that can be viewed as foreign are best assigned to the Etruscan and Phoenician cultural milieus. The catalogue includes a number of objects, especially metal vessels, that are connected to the Etruscan world, but which also have Sardinian influences. There is no Phoenician cultural material, *per se*, in the Rochelongue assemblage, but this research has identified indirect links to the Phoenician sphere of influence on the Iberian Peninsula, which likely can be traced via the second maritime circuit listed above. Lead isotope analysis revealed that a majority of the Rochelongue copper ingots that were analysed were not the product of local mines, as were most of the Launacien deposits, but instead have a likely provenance in the southwest of the Iberian Peninsula. Elements found at Rochelongue have been verified on land, where a circulation of materials by indigenous actors has been identified along routes that followed the coast (Graells 2013a). This evidence reinforces the idea of a local network that is dynamic enough to meet the needs of new resource demands from foreign cultures.

The results of this thesis research have shed additional light on the circulation of metal, whether in the form of ingots or made objects, and the role of the participating agents. As demonstrated in Chapter 7, the Rochelongue site cannot be defined simply as a Launacien deposit. While it is true that the Rochelongue assemblage includes numerous objects that belong to the Launacien phenomenon, there remain two important differences; the low proportion of broken, deformed or fragmentary pieces in the assemblage and the presence of artefacts closely linked to the Iberian Peninsula, such as double-spring fibulae and belt buckles, give the underwater site a different character than those deposits on land. As noted above, there are virtually no Greek or Phoenician products in the Rochelongue assemblage. This result is not altogether dissimilar to what has been found from contemporary terrestrial sites. For example,

excavation of the approximately 200 tombs in the necropolis at Peyrou (Agde) yielded a mere four Greek ceramic vessels and 14 local imitations of Phoenician wares. In other words, although the 'Phoenician' cultural material is threefold greater than the Greek, both are incredibly rare (Ugolini 2011:230). Furthermore, the Phoenician input is indirect, in the form of influence rather than physical imports. The results, then, show a low intensity of Phoenician and Greek elements for this time period (the number of pieces is not significant), and a much greater density and frequency for intra- and inter-regional exchange than for long distance trade.

Also informative are the connections that this research has revealed for the two most numerous types of artefacts in the Rochelongue assemblage, Launacien- and Iberian-type adornments. Objects of indigenous cultural material have a higher density and a greater number of well-connected actors that function as brokers. Consequently, it can be argued that the cultural interaction is more intense and diverse between the local groups of southern France and the northwestern reaches of the Iberian Peninsula, while the relationship with the areas of southern Italy and Sicily is less dense (less frequent), but more direct. This comparison leads to the conclusion that Phoenician interaction can be understood as a residual influence transmitted through indigenous circuits, predominantly via Catalonia and the Balearic Islands, whereas Greek interaction was more direct and without filters.

This thesis has shown through the micro-network that connects the Rochelongue material and Launacien hoards that the local interactions represented in the assemblage are still dominant. It also has brought more into focus the maritime mobility context of the western Mediterranean. At the turn of the sixth century B.C., there were areas of high connectivity (hubs), but with a significant absence of interactions, which will be used by seafaring foreigners from the east to consolidate their presence in the region and their control of maritime trade. Such a reality is realised especially from the end of the century with the strengthening of Phocaeen and Punic forces in control of all of the critical sea routes.

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APPENDICES

APPENDIX 1

(Catalogue)¹

¹ The entire catalogue for the Rochelongue underwater site contains a total of 1,451 entries. For practical reasons this appendix includes only the artefacts mentioned in the text.

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00002

Artefact Typology	Bracelet	Length (cm)	4,90
Family	Jewellery and clothing accessories	Width (cm)	0,40
Category	Jewellery		
Weight (gr)	8		
Description	Bracelet complete, closed, bronze, without decoration, sub-triangular section.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00007

Artefact Typology	Bracelet	Length (cm)	5,80
Family	Jewellery and clothing accessories	Width (cm)	0,30
Category	Jewellery		
Weight (gr)	4		
Description	Bracelet complete, closed, bronze, without decoration, flat section.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00017

Artefact Typology	Bracelet	Length (cm)	6,70
Family	Jewellery and clothing accessories	Width (cm)	0,40
Category	Jewellery		
Weight (gr)	11		
Description	Bracelet complete, closed, bronze, without decoration, sub-triangular section		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00028

Artefact Typology	Bracelet	Length (cm)	6.00
Family	Jewellery and clothing accessories	Width (cm)	0.60
Category	Jewellery		
Weight (gr)	9		
Description	Fragmented bracelet, section in D, decorated with groups of three curved incisions at the ends leaving five striped lines in the center forming a cartridge.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00033

Artefact Typology	Bracelet	Length (cm)	7.00
Family	Jewellery and clothing accessories	Width (cm)	0,30
Category	Jewellery		
Weight (gr)	6		
Description	Bronze bracelet closed rectangular section decoration with transverse incisions.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00034

Artefact Typology	Bracelet	Length (cm)	7,50
Family	Jewellery and clothing accessories	Width (cm)	0,30
Category	Jewellery		
Weight (gr)	6		
Description	Bracelet bronze closed rectangular section without decoration.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00035

Artefact Typology	Bracelet	Length (cm)	6,70
Family	Jewellery and clothing accessories	Width (cm)	0,20
Category	Jewellery		
Weight (gr)	5		
Description	Bronze bracelet closed rectangular section without decoration.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00063

Artefact Typology	Bracelet	Length (cm)	4.40
Family	Jewellery and clothing accessories	Width (cm)	0.50
Category	Jewellery		
Weight (gr)	7		
Description	Fragmented bracelet, D section, without decoration.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00811

Artefact Typology	Cylinder	Length (cm)	5.00
Family	Work	Width (cm)	1,40
Category	Tool		
Weight (gr)	19		
Description	Fragment of bronze cylinder with perforation.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00086

Artefact Typology	Bracelet	Length (cm)	7.60
Family	Jewellery and clothing accessories	Width (cm)	0,40
Category	Jewellery		
Weight (gr)	10		
Description	Fragment of bracelet affected by corrosion bulbous decoration		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00105

Artefact Typology	Bracelet	Length (cm)	7,40
Family	Jewellery and clothing accessories	Width (cm)	1,20
Category	Jewellery		
Weight (gr)	28		
Description	Fragment of bronze bracelet with continuous bulbous decoration and perforation.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00130

Artefact Typology	Bracelet	Length (cm)	4,70
Family	Jewellery and clothing accessories	Width (cm)	0,50
Category	Jewellery		
Weight (gr)	4		
Description	Fragment of bronze bracelet with continuous fluted decoration with perforation		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00143

Artefact Typology	Bracelet	Length (cm)	3.30
Family	Jewellery and clothing accessories	Width (cm)	0.60
Category	Jewellery		
Weight (gr)	4		
Description	Fragment of bronze bracelet, fine wedges decoration.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00156

Artefact Typology	Bracelet	Length (cm)	9,20
Family	Jewellery and clothing accessories	Width (cm)	1,00
Category	Jewellery		
Weight (gr)	53		
Description	Fragment of bronze bracelet, without decoration.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00161

Artefact Typology	Bracelet	Length (cm)	7.00
Family	Jewellery and clothing accessories	Width (cm)	0.70
Category	Jewellery		
Weight (gr)	13		
Description	Fragment of flat bronze bracelet, without decoration, edge in the middle.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00209

Artefact Typology	Bracelet	Length (cm)	12.50
Family	Jewellery and clothing accessories	Width (cm)	0,40
Category	Jewellery		
Weight (gr)	8		
Description	Fragment of bronze torque or bracelet, without decoration. Circular section. Deformed in the middle, clear mark of intentional cut.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00212

Artefact Typology	Bracelet	Length (cm)	1,40
Family	Jewellery and clothing accessories	Width (cm)	0,80
Category	Jewellery		
Weight (gr)	0.5		
Description	Fragment of bronze bracelet, lines decoration. D section.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00235

Artefact Typology	Bracelet	Length (cm)	3.20
Family	Jewellery and clothing accessories	Width (cm)	2.00
Category	Jewellery		
Weight (gr)	10		
Description	Fragment of bronze bracelet, wedges decoration. Empty section in D. two holes in one of the sides.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00236

Artefact Typology	Bracelet	Length (cm)	5.20
Family	Jewellery and clothing accessories	Width (cm)	2.00
Category	Jewellery		
Weight (gr)	20		
Description	Fragment of bronze bracelet, Bulbous decoration. Empty section in D. Perforation in one of the sides.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00237

Artefact Typology	Bracelet	Length (cm)	2,10
Family	Jewellery and clothing accessories	Width (cm)	2,10
Category	Jewellery		
Weight (gr)	9		
Description	Fragment of bronze bracelet, wedges decoration. Empty D section.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00238

Artefact Typology	Bracelet	Length (cm)	2,20
Family	Jewellery and clothing accessories	Width (cm)	2,10
Category	Jewellery		
Weight (gr)	7		
Description	Fragment of bronze bracelet, wedges decoration. Empty D section.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00243

Artefact Typology	Bracelet	Length (cm)	3,60
Family	Jewellery and clothing accessories	Width (cm)	1,10
Category	Jewellery		
Weight (gr)	3		
Description	Fragment of bronze bracelet, cross decoration. Empty D section.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00244

Artefact Typology	Bracelet	Length (cm)	3.50
Family	Jewellery and clothing accessories	Width (cm)	1,30
Category	Jewellery		
Weight (gr)	3		
Description	Fragment of bronze bracelet, cross decoration. Empty D section.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00245

Artefact Typology	Bracelet	Length (cm)	3,40
Family	Jewellery and clothing accessories	Width (cm)	1,50
Category	Jewellery		
Weight (gr)	4		
Description	Fragment of bronze bracelet, line decoration. Empty D section.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00246

Artefact Typology	Bracelet	Length (cm)	1,80
Family	Jewellery and clothing accessories	Width (cm)	1,80
Category	Jewellery		
Weight (gr)	3		
Description	Fragment of bronze bracelet, line decoration. Empty D section.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00283

Artefact Typology	Ring	Length (cm)	3.30
Family	Jewellery and clothing accessories	Width (cm)	2.60
Category	Jewellery		
Weight (gr)	7		
Description	Bronze ring decorated with four knots.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00284

Artefact Typology Ring
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 5
Description Bronze ring decorated with four knots.

Length (cm) 3,40
Width (cm) 0,30



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00285

Artefact Typology	Ring
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	2
Description	Bronze ring decorated with four knots.

Length (cm)	2.80
Width (cm)	0.30



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00286

Artefact Typology	Ring
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	7
Description	Bronze ring decorated with five knots.

Length (cm)	3,10
Width (cm)	0,40



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00287

Artefact Typology	Ring	Length (cm)	3.00
Family	Jewellery and clothing accessories	Width (cm)	0,30
Category	Jewellery		
Weight (gr)	7		
Description	Bronze ring decorated with twisted body.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00288

Artefact Typology	Ring
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	2
Description	Bronze ring decorated with one knot.

Length (cm)	2.00
Width (cm)	0,20



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00413 (bis)

Artefact Typology	Talon Launacien	Length (cm)	4.20
Family	Hardware	Width (cm)	2.90
Category	Diverse		
Weight (gr)	18		

Description
Small cap, socalled Talon Launacien. Contain an with appendix on the edge and conical tip at the bottom. Empty inside and with multiple lines along the main body. A double perforation its in the higher part.



Metal Sample: NO

LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.00413 (bis)

Artefact Typology	Talon Launacien	Length (cm)	4.20
Family	Hardware	Width (cm)	2.90
Category	Diverse		
Weight (gr)	18		

Description
Small cap, socalled Talon Launacien. Contain an with appendix on the edge and conical tip at the bottom. Empty inside and with multiple lines along the main body. A double perforation its in the higher part.



Metal Sample: NO

LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.00415

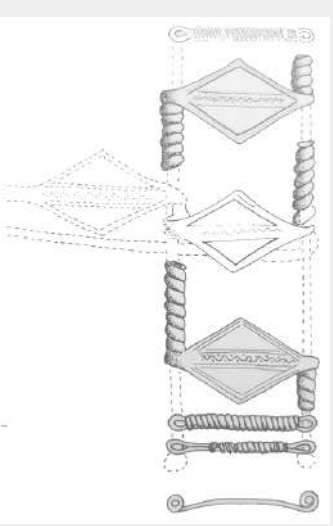
Artefact Typology	Fibulae	Length (cm)	4.80
Family	Jewellery and clothing accessories	Width (cm)	2.50
Category	Jewellery		
Weight (gr)	11		

Description
Fragment of fibula part of a decorative multiple group. Only one spring remain. This model have a parallel in the Iberian Peninsula (Aguilana). Reconstruction after Guilaíne et al. 2017 (page 210 figure 21 no.9).



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00433

Artefact Typology	Bracelet	Length (cm)	6.30
Family	Jewellery and clothing accessories	Width (cm)	0.50
Category	Jewellery		
Weight (gr)	23		
Description	Fragment of bracelet in bronze with deformation that preserves the marks of the cast with sharp edges. Decoration alternate diamond shape and stripes lines.		



Metal Sample: S0053

LIA	NO
XRF	SI
SEM	NO
ICPMS	NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00441

Artefact Typology	Bracelet	Length (cm)	9,00
Family	Jewellery and clothing accessories	Width (cm)	0,40
Category	Jewellery		
Weight (gr)	63		
Description	Fragment of bracelet in bronze. Section in hollow inside. Group decoration of three large bulbs separated by group of incisions.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00453

Artefact Typology	Bracelet	Length (cm)	6,10
Family	Jewellery and clothing accessories	Width (cm)	0,70
Category	Jewellery		
Weight (gr)	13		
Description	Fragment of bronze bracelet decoration in continuous transversal lines.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00454

Artefact Typology	Bracelet	Length (cm)	7,70
Family	Jewellery and clothing accessories	Width (cm)	0,40
Category	Jewellery		
Weight (gr)	5		
Description	Fragment of bronze bracelet continuous bulbous decoration. Drilling in the upper part.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00467

Artefact Typology	Bracelet	Length (cm)	5,10
Family	Jewellery and clothing accessories	Width (cm)	2,00
Category	Jewellery		
Weight (gr)	16		
Description	Fragment of bracelet decoration in bulbs. Hollow section, very affected by erosion.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00469

Artefact Typology	Bracelet	Length (cm)	5.50
Family	Jewellery and clothing accessories	Width (cm)	1,10
Category	Jewellery		
Weight (gr)	12		
Description	Fragment of bracelet decoration in bulbs. Hollow section.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00510

Artefact Typology Ring
Family Hardware
Category Diverse
Weight (gr) 7

Length (cm) 3.00
Width (cm) 0,50

Description
Bronze ring. The two small perforations indicates that can be considered as a part of a Caudron or metal Vessel.



Metal Sample: NO

LIA NO
XRF NO
SEM NO
ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00522

Artefact Typology	Harness	Length (cm)	4,90
Family	Jewellery and clothing accessories	Width (cm)	0,20
Category	Jewellery		
Weight (gr)	12		
Description	Ornament decorated with rope motifs and central and lateral spikes with 2 rings on one of its sides and one on the opposite plus one more on the top.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00524

Artefact Typology	Wheel pendant
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	10
Description	Decorative circular ornament..

Length (cm)	5,90
Width (cm)	0,10



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00529

Artefact Typology	Bell pendant	Length (cm)	3.50
Family	Jewellery and clothing accessories	Width (cm)	2
Category	Jewellery		
Weight (gr)	8		
Description	Bell decorated on its margins by incised lines on the edge.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00544

Artefact Typology	Fibulae	Length (cm)	2.00
Family	Jewellery and clothing accessories	Width (cm)	3.00
Category	Jewellery		
Weight (gr)	9,5		
Description	Fragment of fibulae (serpentine) only remains the loop that the needle with the rest of the body in the form of a croissant.		



Metal Sample: S0031

LIA	YES
XRF	YES
SEM	NO
ICPMS	YES

Research number inventory RCH1.2017.00545

Artefact Typology	Fibulae	Length (cm)	4.50
Family	Jewellery and clothing accessories	Width (cm)	ND
Category	Jewellery		
Weight (gr)	5		
Description	Fragment of fibulae (Sanguisuga type) that preserve part of the spring, body and support of the needle. Decorated with criss-cross incisions on the outer face of the middle arch.		



Metal Sample: S0047

LIA	YES
XRF	YES
SEM	NO
ICPMS	YES

Research number inventory RCH1.2017.00547

Artefact Typology	Fibulae	Length (cm)	5.00
Family	Jewellery and clothing accessories	Width (cm)	2,80
Category	Jewellery		
Weight (gr)	14		

Description
Fragment of fibulae that seems to be part of a decorative multiple group in this case preserve only two spring. This artefact have a direct parallel in the Iberian Peninsula in the archaeological site of Aguilana (Catalonia, Spain).



Metal Sample: S0032

LIA	YES
XRF	YES
SEM	NO
ICPMS	YES



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00548

Artefact Typology	Fibulae	Length (cm)	4.80
Family	Jewellery and clothing accessories	Width (cm)	2.60
Category	Jewellery		
Weight (gr)	11		
Description	Fragment of fibulae part of a decorative multiple group in this case preserve double spring. Parallel in the Iberian Peninsula archaeological site of Agullana(Catalonia, Spain).		



Metal Sample: S0048

LIA	YES
XRF	YES
SEM	NO
ICPMS	YES

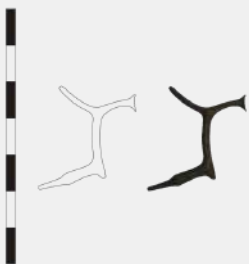
Research number inventory RCH1.2017.00551

Artefact Typology	Fibulae	Length (cm)	2.90
Family	Jewellery and clothing accessories	Width (cm)	ND
Category	Jewellery		
Weight (gr)	2		
Description	Fragment of pivot fibulae that preserve the central body but not the needle that would be embedded in the lower part.		



Metal Sample: S0037

LIA	YES
XRF	YES
SEM	NO
ICPMS	YES



Research number inventory RCH1.2017.00552

Artefact Typology	Fibulae	Length (cm)	2.30
Family	Jewellery and clothing accessories	Width (cm)	ND
Category	Jewellery		
Weight (gr)	0,3		
Description	Fragment of fractured pivot fibulae. Only one of the heads and the needle socket is conserved.		



Metal Sample: S0046

LIA	YES
XRF	YES
SEM	NO
ICPMS	YES



Research number inventory RCH1.2017.00554

Artefact Typology	knife	Length (cm)	10,20
Family	Equipment	Width (cm)	2,60
Category	Offensive armament		
Weight (gr)	30		
Description	Bronze knife blade. Fragmented at the tip and two perforations in the grip area where the blade narrows to fit a handle.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00556

Artefact Typology	knife	Length (cm)	4,10
Family	Equipment	Width (cm)	ND
Category	Offensive armament		
Weight (gr)	9		
Description	Fragment of sheet metal (bronze) possible tableware. Totally deformed.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00560

Artefact Typology	Arrowhead	Length (cm)	4.80
Family	Equipment	Width (cm)	1,30
Category	Offensive armament		
Weight (gr)	3		
Description	Ailerons arrow head, well preserved so called Mailhacien Type.		



Metal Sample: YES

LIA NO

XRF YES

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00561

Artefact Typology	Arrowhead
Family	Equipment
Category	Offensive armament
Weight (gr)	4
Description	Lanceolate arrowhead.

Length (cm)	4,60
Width (cm)	1,10



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00562

Artefact Typology	Sword	Length (cm)	3,70
Family	Tool	Width (cm)	ND
Category	Diverse		
Weight (gr)	10		
Description	Part 1/2 of a sword locket being probably part of a lost scabbard, which would be made in any organic material.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00563

Artefact Typology	Sword	Length (cm)	4.20
Family	Tool	Width (cm)	ND
Category	Diverse		
Weight (gr)	12		
Description	Part 2/2 of a sword locket being probably part of a lost scabbard, which would be made in any organic material.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00566

Artefact Typology Axe
Family Work
Category Tool
Weight (gr) 0,3
Description Socked axe fragment.

Length (cm) 2.60
Width (cm) 0.60



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00567

Artefact Typology	Needle	Length (cm)	8.80
Family	Jewellery and clothing accessories	Width (cm)	0,40
Category	Jewellery		
Weight (gr)	18		
Description	Hair pin of large dimensions oval head and body twisted.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00571

Artefact Typology Bracelet
Family Hardware
Category Diverse
Weight (gr) 3
Description Bronze open bracelet. Circular section.

Length (cm) 4.80
Width (cm) ND



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00589

Artefact Typology	Handle? / torque?	Length (cm)	6.50
Family	Jewellery and clothing accessories	Width (cm)	0.50
Category	Jewellery		
Weight (gr)	9		
Description	serpentine bronze and twisted decoration fractured in one extreme and complete in the other.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00615

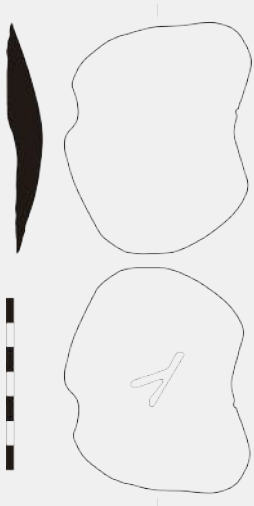
Artefact Typology Copper Ingot
Family Hardware
Category Diverse
Weight (gr) 321
Description Complete copper ingot. Y mark, high erosion.

Length (cm) 9.80
Width (cm) 1.20



Metal Sample: S0096

LIA YES
XRF YES
SEM NO
ICPMS YES



Research number inventory RCH1.2017.00640

Artefact Typology	Lead Ingot
Family	Hardware
Category	Diverse
Weight (gr)	8.115
Description	Complete copper lead.

Length (cm)	22.60
Width (cm)	3,00



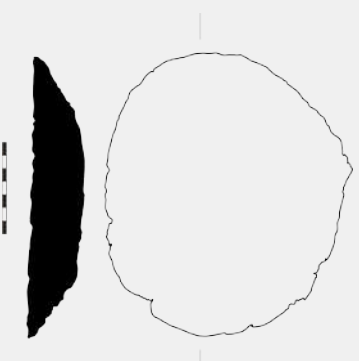
Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00673

Artefact Typology	Axe
Family	Work
Category	Tool
Weight (gr)	91
Description	Complete bronze socked axe. One ring.

Length (cm) 7.60
Width (cm) 2.30



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00681

Artefact Typology	Axe	Length (cm)	7,70
Family	Work	Width (cm)	1,20
Category	Tool		
Weight (gr)	172		
Description	Fragment of bronze socked axe. One ring.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00691

Artefact Typology Axe
Family Work
Category Tool
Weight (gr) 233
Description Flat Axe.

Length (cm) 10,40
Width (cm) 0,90



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00692

Artefact Typology	Axe
Family	Work
Category	Tool
Weight (gr)	86
Description	Complete bronze socked axe. One ring.

Length (cm) 6,70
Width (cm) 1,50



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00693

Artefact Typology Axe
Family Work
Category Tool
Weight (gr) 288
Description Aileron Axe.

Length (cm) 14,90
Width (cm) 1,50



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00694

Artefact Typology Axe
Family Work
Category Tool
Weight (gr) 331
Description Aileron Axe.

Length (cm) 11,40
Width (cm) 1,50



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00698

Artefact Typology	Adze	Length (cm)	9,40
Family	Work	Width (cm)	0,40
Category	Tool		
Weight (gr)	20		
Description	Bronze Adze.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00724

Artefact Typology Axe
Family Work
Category Tool
Weight (gr) 234
Description Bronze socked axe cmplete.

Length (cm) 8,70
Width (cm) 1,80



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00726

Artefact Typology	Axe	Length (cm)	11,00
Family	Work	Width (cm)	1,40
Category	Tool		
Weight (gr)	217		
Description	Bronze socked axe, one side fragmented. V marks.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00748

Artefact Typology Button
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 12
Description Bronze flat button with hook.

Length (cm) 4,10
Width (cm) 4,00



Metal Sample: NO
LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.00749

Artefact Typology Button
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 14
Description Bronze button with hook 4 at the back side.

Length (cm) 4,20
Width (cm) 4,10



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00753

Artefact Typology Button
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 22
Description Bronze hemispherical button.

Length (cm) 2,90
Width (cm) 2,80



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00754

Artefact Typology Bronze bead
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 10
Description Bronze bead.

Length (cm) 2.00
Width (cm) 1.50



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00755

Artefact Typology	Cauldron Handle	Length (cm)	7.50
Family	Domestic utensils	Width (cm)	6.00
Category	Cook		
Weight (gr)	64		
Description	Cauldron Handle.		

Comparative image reference: A. Handle from Rochelongue, B. Monte Sa ldda hoard, Cagliari (Botto 2015:343 Fig.47:2, C. Sardara: cauldron with shallow bowl and lotus flower handles, National Archaeological Museum, Cagliari (Botto 2015:339 Fig.44).



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00757

Artefact Typology	Cage pendant	Length (cm)	2.00
Family	Jewellery and clothing accessories	Width (cm)	4.00
Category	Jewellery		
Weight (gr)	8		
Description	Bronze pendant, cage broken in one of it sides.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00759

Artefact Typology Bell pendant
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 12
Description Bell bronze pendant.

Length (cm) 4,40
Width (cm) 2,10



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00760

Artefact Typology Button
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 15
Description Square bronze button.

Length (cm) 2.90
Width (cm) 2.20



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00765

Artefact Typology Button
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 7
Description Square bronze button.

Length (cm) 2.80
Width (cm) 2.50



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00769

Artefact Typology	Hammer
Family	Work
Category	Tool
Weight (gr)	22
Description	Marti Bronze socked Hammer. Broken top part.

Length (cm)	3,70
Width (cm)	1,30



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00771

Artefact Typology	Hammer
Family	Work
Category	Tool
Weight (gr)	44
Description	Bronze socked Hammer.

Length (cm)	2,90
Width (cm)	1,60



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00777 (bis)

Artefact Typology	Bow terminal	Length (cm)	4.90
Family	Hardware	Width (cm)	ND
Category	Diverse		
Weight (gr)	15		
Description	Arch end (Dedet and Marchand 2015). Exagonal cartridge with double upper perforation and ring finished in peduncle.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00777

Artefact Typology	Belt buckle	Length (cm)	4,40
Family	Jewellery and clothing accessories	Width (cm)	4,90
Category	Jewellery		
Weight (gr)	12		
Description	Belt buckle (acebuchal type) three perforations. It does not keep the hook. The rhomboidal body has a decoration with internal lines repeating the shape of the buckle.		



Metal Sample: S0008

LIA	YES
XRF	YES
SEM	NO
ICPMS	YES

Research number inventory RCH1.2017.00782

Artefact Typology	Harness	Length (cm)	7.50
Family	Jewellery and clothing accessories	Width (cm)	5.70
Category	Jewellery		
Weight (gr)	31		
Description	Decorative ornament plate decorated with transversal lines and chains		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00783

Artefact Typology	Buckle Belt	Length (cm)	6,50
Family	Jewellery and clothing accessories	Width (cm)	4,60
Category	Jewellery		
Weight (gr)	27		
Description	Belt buckle (acebuchal type) three perforations. Complete.		



Metal Sample: S0005

LIA	YES
XRF	YES
SEM	NO
ICPMS	YES

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00784

Artefact Typology	Buckle belt	Length (cm)	9,10
Family	Jewellery and clothing accessories	Width (cm)	3,90
Category	Jewellery		
Weight (gr)	22		
Description	Buckle belt (Fleury) triangular shape perforations at one end equally triangular hollows in intermediate decorative crosspiece retains the hook and in the extension towards the highlights a decorative visel on the other end has lost one of the rear hooks		



Metal Sample: S0004

LIA
XRF
SEM
ICPMS



Research number inventory RCH1.2017.00788

Artefact Typology	Buckle belt
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	26
Description	Buckle belt complete without decoration.

Length (cm)	6.80
Width (cm)	5.60



Metal Sample: S0027

LIA
XRF
SEM
ICPMS



Research number inventory RCH1.2017.00789

Artefact Typology Hammer
Family Work
Category Tool
Weight (gr) 64
Description Bronze Hammer. Complete.

Length (cm) 4.30
Width (cm) 1.80



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00811

Artefact Typology	Cylinder	Length (cm)	5.00
Family	Work	Width (cm)	1,40
Category	Tool		
Weight (gr)	19		
Description	Fragment of bronze cylinder with perforation.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00816

Artefact Typology	Axe
Family	Work
Category	Tool
Weight (gr)	7
Description	Miniature bronze socked axe. One ring.

Length (cm) 3.90
Width (cm) 1.00



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00820

Artefact Typology	Knife	Length (cm)	6,50
Family	Equipment	Width (cm)	2,10
Category	Offensive armament		
Weight (gr)	16		
Description	Knife blade fragmented at the tip and two perforations in the grip area where the blade tapers to fit a handle.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00822

Artefact Typology	Belt buckle
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	7
Description	Buckle belt (Fleury type). Complete.

Length (cm) 5.30
Width (cm) 2.50



Metal Sample: S0012

LIA
XRF
SEM
ICPMS



Research number inventory RCH1.2017.00829

Artefact Typology	Belt buckle	Length (cm)	3.50
Family	Jewellery and clothing accessories	Width (cm)	1,10
Category	Jewellery		
Weight (gr)	3		
Description	Fragment of belt buckle.		



Metal Sample: S0018

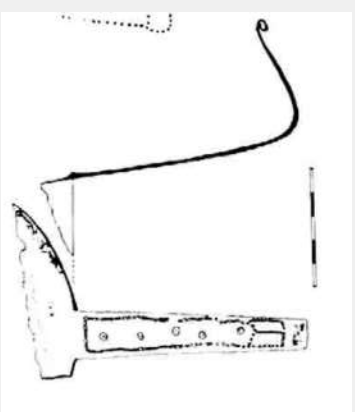
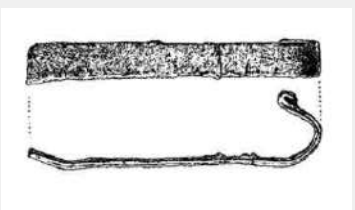
LIA	NO
XRF	YES
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00830

Artefact Typology	Bronze plate	Length (cm)	3.60
Family	Hardware	Width (cm)	1,30
Category	Diverse		
Weight (gr)	11		
Description	Bronze plate S shape. Simula? Reference from Graells 2007:205 Figure.6		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00831

Artefact Typology	Belt buckle	Length (cm)	3.00
Family	Jewellery and clothing accessories	Width (cm)	1,30
Category	Jewellery		
Weight (gr)	12		
Description	Buckle belt (Fleury) preserve hook and main part of the body.		



Metal Sample: S0019

LIA
XRF
SEM
ICPMS



Research number inventory RCH1.2017.00833

Artefact Typology	Belt buckle	Length (cm)	3,10
Family	Jewellery and clothing accessories	Width (cm)	4,10
Category	Jewellery		
Weight (gr)	18		
Description	Buckle belt, decorated with circles in the middle of the body (totally deformed)		



Metal Sample: S0020

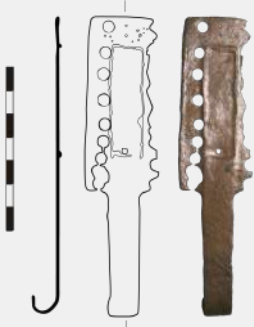
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00844

Artefact Typology	Belt buckle	Length (cm)	12,90
Family	Jewellery and clothing accessories	Width (cm)	3,00
Category	Jewellery		
Weight (gr)	15		
Description	Buckle belt, with multiple perforation and hook preserved.		



Metal Sample: S0027

LIA	
XRF	
SEM	
ICPMS	

Research number inventory RCH1.2017.00846

Artefact Typology	Fibulae	Length (cm)	4.40
Family	Jewellery and clothing accessories	Width (cm)	ND
Category	Jewellery		
Weight (gr)	11		
Description	Spring from fibula		



Metal Sample: S0034

LIA	NO
XRF	YES
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00848

Artefact Typology	Fibulae
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	9
Description	Double spring fibulae.

Length (cm)	8.00
Width (cm)	0.70



Metal Sample: S0039

LIA NO

XRF YES

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00849

Artefact Typology	Fibulae
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	2
Description	Double spring fibulae.

Length (cm)	4.80
Width (cm)	



Metal Sample: S0040

LIA	NO
XRF	YES
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00850

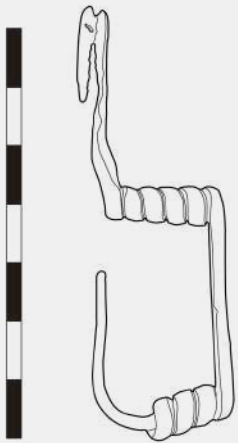
Artefact Typology Fibulae
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 8
Description Double spring fibulae.

Length (cm) 8.00
Width (cm) 2.00



Metal Sample: S0041

LIA NO
XRF YES
SEM NO
ICPMS NO



Research number inventory RCH1.2017.00855

Artefact Typology	Fibulae	Length (cm)	4.20
Family	Jewellery and clothing accessories	Width (cm)	ND
Category	Jewellery		
Weight (gr)	8		
Description	Double spring fibulae with rectangular decorated arch.		



Metal Sample: S0043

LIA	NO
XRF	YES
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.00860

Artefact Typology Button
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 3
Description bronze button

Length (cm) 2.00
Width (cm) 3.00



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00861

Artefact Typology	Button
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	5
Description	Fragment bronze button

Length (cm)	3.20
Width (cm)	2.00



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00862

Artefact Typology	Button	Length (cm)	5.00
Family	Jewellery and clothing accessories	Width (cm)	2.00
Category	Jewellery		
Weight (gr)	6		
Description	Fragment of bronze button		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00863

Artefact Typology Button
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 8
Description Square bronze button

Length (cm) 3,20
Width (cm) 2,50



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00864

Artefact Typology Button
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 18
Description Square bronze button

Length (cm) 3,40
Width (cm) 3,10



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00865

Artefact Typology Harness
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 0.2
Description Bronze conic ornaments (x2)

Length (cm) 0.90
Width (cm) 0.60



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00867

Artefact Typology	Harness	Length (cm)	2,40
Family	Jewellery and clothing accessories	Width (cm)	2,00
Category	Jewellery		
Weight (gr)	3		
Description	Ring ornament		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00905

Artefact Typology Belt buckle
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 13
Description Bronze buckle belt with multiple perforations

Length (cm) 6.00
Width (cm) 2.60



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00912

Artefact Typology	Harness
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	1
Description	Bronze ornament

Length (cm)	3,10
Width (cm)	3,00



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00917

Artefact Typology	Harness
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	4
Description	Bronze ornament.

Length (cm)	6.00
Width (cm)	3.00

Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.00918

Artefact Typology	Wheel pendant	Length (cm)	5.00
Family	Jewellery and clothing accessories	Width (cm)	4.00
Category	Jewellery		
Weight (gr)	3		
Description	Bronze circular pendants (fragmented).		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.00923

Artefact Typology	Cartridge	Length (cm)	5,40
Family	Hardware	Width (cm)	6,10
Category	Diverse		
Weight (gr)	20		
Description	Bronze cartridge with a ring		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00930

Artefact Typology	Cartridge
Family	Hardware
Category	Diverse
Weight (gr)	7
Description	Bronze cartridge with ring

Length (cm)	2.80
Width (cm)	1,10



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00931

Artefact Typology	Cartridge
Family	Hardware
Category	Diverse
Weight (gr)	6
Description	Bronze cartridge with ring

Length (cm)	3.30
Width (cm)	1.00



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00932

Artefact Typology	Cartridge
Family	Hardware
Category	Diverse
Weight (gr)	7
Description	Bronze cartridge with ring

Length (cm)	3,50
Width (cm)	1,10



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00937

Artefact Typology Bead
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 11
Description tubular beads

Length (cm) 3.40/1.80
Width (cm) 1.00



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00938

Artefact Typology	Bead
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	0,1
Description	Tubular bead

Length (cm)	1,40
Width (cm)	0,2



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00939

Artefact Typology	Bead	Length (cm)	0,90
Family	Jewellery and clothing accessories	Width (cm)	0,90
Category	Jewellery		
Weight (gr)	1		
Description	Bead		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00957

Artefact Typology	Harness
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	3
Description	Bronze conic ornament.

Length (cm)	1,70
Width (cm)	1



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00969

Artefact Typology Triangular pendant
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 3
Description Group triangular pendants.

Length (cm) 3.40
Width (cm) 2.00



Metal Sample: NO
LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.00972

Artefact Typology	Needle
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	3
Description	Fragmented bronze needle

Length (cm)	5.00
Width (cm)	0,40



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00977

Artefact Typology	Needle
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	4
Description	Bronze needle

Length (cm)	11,90
Width (cm)	0,20



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.00980

Artefact Typology	Torque
Family	Jewellery and clothing accessories
Category	Jewellery
Weight (gr)	14
Description	Bronze torque with twisted decoration.

Length (cm)	10,40
Width (cm)	0,40



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.01018

Artefact Typology	Scalpatorium	Length (cm)	7,30
Family	Domestic utensils	Width (cm)	0,30
Category	Personal		
Weight (gr)	2		
Description	Bronze needle with double tip, this kind of object is so-called in the literature as 'Scalpatorium'.		



Metal Sample:	NO	
LIA	NO	
XRF	NO	
SEM	NO	
ICPMS	NO	



Research number inventory RCH1.2017.01027

Artefact Typology Ingot bar
Family Hardware
Category Service
Weight (gr) 12
Description Bronze fragment (Ingot bar?)

Length (cm) 3.00
Width (cm) 2.00



Metal Sample: NO
LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.01028

Artefact Typology	Ingot bar
Family	Hardware
Category	Service
Weight (gr)	12
Description	Bronze fragment (ingot bar?)

Length (cm) 2.50
Width (cm) 2.00



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01029

Artefact Typology Ingot bar
Family Hardware
Category Service
Weight (gr) 1
Description Bronze fragment (ingot bar?)

Length (cm) 2.20
Width (cm) 1.70



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01031

Artefact Typology	Ingot bar
Family	Hardware
Category	Service
Weight (gr)	8
Description	Fragment Bronze (ingot bar?)

Length (cm)	2.20
Width (cm)	1.70



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01032

Artefact Typology Ingot bar
Family Hardware
Category Service
Weight (gr) 10
Description Fragment Bronze (ingot bar?)

Length (cm) 2.60
Width (cm) 1.70



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01041

Artefact Typology Metal bowl
Family Domestic utensils
Category Service
Weight (gr) 7
Description Rim of bronze bowl

Length (cm) 4.30
Width (cm) 1.90



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.01049

Artefact Typology Diverse
Family Hardware
Category Diverse
Weight (gr) 38
Description residual object from metal casting

Length (cm) 13.30
Width (cm) 1



Metal Sample: S0051

LIA
XRF
SEM
ICPMS



Research number inventory RCH1.2017.01053

Artefact Typology Sword locket?
Family Equipment
Category Diverse
Weight (gr) 26
Description Sword Locket?

Length (cm) 5,10
Width (cm) 1,00



Metal Sample: NO
LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.01054

Artefact Typology Mirror handle?
Family Domestic utensils
Category Personal
Weight (gr) 15
Description Mirror handle?

Length (cm) 7.60
Width (cm) 1.30



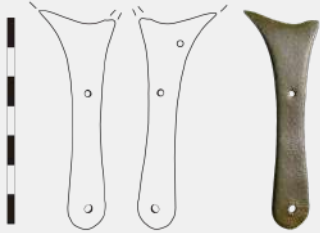
Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.01057

Artefact Typology	Knife	Length (cm)	5,70
Family	Equipment	Width (cm)	1,70
Category	Offensive armament		
Weight (gr)	9		
Description	Trapezoidal bronze fragment with a blunt side and two straight angles, presents a small appendix of rectangular shape.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.01058

Artefact Typology	Knife	Length (cm)	9.00
Family	Equipment	Width (cm)	2.90
Category	Offensive armament		
Weight (gr)	23		
Description	Bronze sheet of rectangular shape, extremely flat presents perforation for the grip, the area presents a convex line sign of much erosion.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.01059

Artefact Typology	Sword	Length (cm)	13,10
Family	Equipment	Width (cm)	2,90
Category	Offensive armament		
Weight (gr)	45		
Description	Rectangular-shaped bronze blade with blunt angles, extremely flat round at the tip.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.01064

Artefact Typology	Spearhead	Length (cm)	16,14
Family	Equipment	Width (cm)	1,90
Category	Offensive armament		
Weight (gr)	35		
Description	Spearhead complete but in bad state of conservation.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

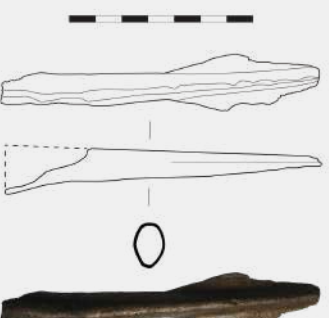


Research number inventory RCH1.2017.01066

Artefact Typology	Spearhead	Length (cm)	12.10
Family	Equipment	Width (cm)	1,40
Category	Offensive armament		
Weight (gr)	48		
Description	Spearhead complete but in bad state of conservation.		



Metal Sample:	NO	
LIA	NO	
XRF	NO	
SEM	NO	
ICPMS	NO	



Research number inventory RCH1.2017.01070

Artefact Typology	Cartridge	Length (cm)	5,90
Family	Hardware	Width (cm)	1,60
Category	Diverse		
Weight (gr)	13		
Description	Part of a sword case? (Dedet and Marchand 2015).		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

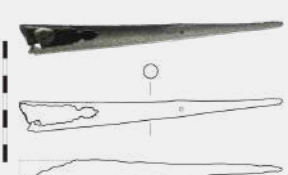
Research number inventory RCH1.2017.01071

Artefact Typology	Spearbase	Length (cm)	15,60
Family	Equipment	Width (cm)	1,30
Category	Offensive armament		
Weight (gr)	39		
Description	Spear base. It conserves the whole body although with a fragmented side		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.01072

Artefact Typology	Spearbase	Length (cm)	14,10
Family	Equipment	Width (cm)	1,30
Category	Offensive armament		
Weight (gr)	33		
Description	Spear base. It conserves the whole body although with a fragmented side		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

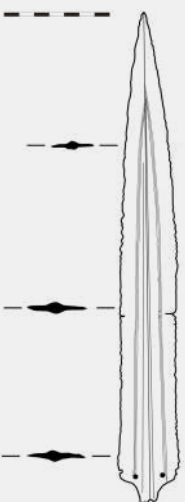
Research number inventory RCH1.2017.01073

Artefact Typology	Sword	Length (cm)	34,70
Family	Equipment	Width (cm)	3,90
Category	Offensive armament		
Weight (gr)	2.37		
Description	Bronze sword of "losangique" form fragmented into three parts. The body ends in an appendix with two perforations to support the handle that is not preserved.		



Metal Sample: NO

LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.01076

Artefact Typology Bracelet
Family Jewellery and clothing accessories
Category Jewellery
Weight (gr) 22
Description Complete bronze bracelet. Section in D

Length (cm) 7,10
Width (cm) 0,50



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01102

Artefact Typology	Bracelet	Length (cm)	9,70
Family	Jewellery and clothing accessories	Width (cm)	2,30
Category	Jewellery		
Weight (gr)	66		
Description	fragment of bracelet decorated with large bulbous separated by spaces. Hollow section bronze parallels in Sicily and Greece.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

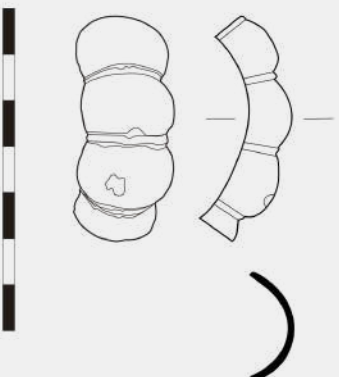


Research number inventory RCH1.2017.01103

Artefact Typology	Bracelet	Length (cm)	4.85
Family	Jewellery and clothing accessories	Width (cm)	2.10
Category	Jewellery		
Weight (gr)	24		
Description	Fragment of bracelet decoration with large bulbs. Hollow section with 4 interior perforations. Parallel Greece and Sicily		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

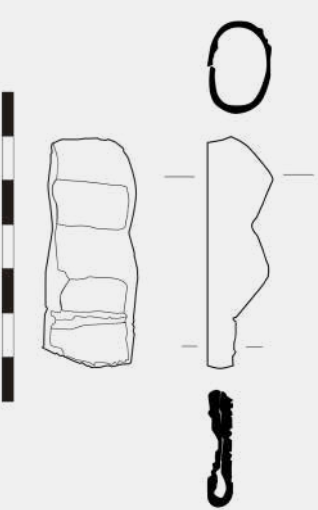


Research number inventory RCH1.2017.01110

Artefact Typology	Bracelet	Length (cm)	5.20
Family	Jewellery and clothing accessories	Width (cm)	2.00
Category	Jewellery		
Weight (gr)	25		
Description	fragment of bracelet decorated with large wedges, hollow section and deformed. Parallels in Sicily and Greece.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.01117

Artefact Typology	Bracelet	Length (cm)	6.80
Family	Jewellery and clothing accessories	Width (cm)	1.00
Category	Jewellery		
Weight (gr)	30		
Description	fragment of bracelet in bronze wedge decoration		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Research number inventory RCH1.2017.01163

Artefact Typology	Ring	Length (cm)	5,70
Family	Jewellery and clothing accessories	Width (cm)	4,60
Category	Jewellery		
Weight (gr)	8		
Description	Complete bronze ring rope decoration. Flat section.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO

Research number inventory RCH1.2017.01170

Artefact Typology Lead ingot
Family Hardware
Category Diverse
Weight (gr) 7.126
Description Complete lead ingot

Length (cm) 22
Width (cm) 2,30



Metal Sample: S0099

LIA YES
XRF YES
SEM NO
ICPMS YES



Research number inventory RCH1.2017.01172

Artefact Typology Lead ingot
Family Hardware
Category Diverse
Weight (gr) 7.708
Description Complete lead ingot

Length (cm) 26
Width (cm) 2,60



Metal Sample: NO

LIA NO
XRF NO
SEM NO
ICPMS NO

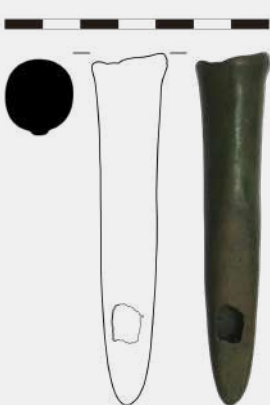


Research number inventory RCH1.2017.01235

Artefact Typology	Spearbase	Length (cm)	9.00
Family	Equipment	Width (cm)	1.70
Category	Offensive armament		
Weight (gr)	59		
Description	Bronze Base Spear. Fracture in one of the side of the object.		



Metal Sample:	YES	
LIA	NO	
XRF	YES	
SEM	NO	
ICPMS	NO	



A line drawing and a silhouette of the spear base. The line drawing shows the object's profile with a small rectangular hole. The silhouette is a solid black shape. A ruler is placed above the line drawing for scale.

Research number inventory RCH1.2017.01236

Artefact Typology Spearbase
Family Equipment
Category Offensive armament
Weight (gr) 29
Description Bronze Base Spear. Two perforation.

Length (cm) 6,70
Width (cm) 1,90



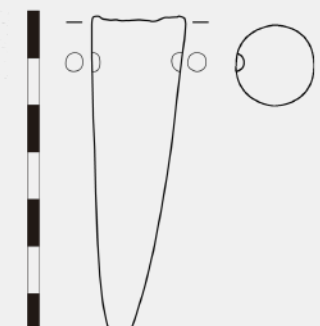
Metal Sample: YES

LIA NO

XRF YES

SEM NO

ICPMS NO



Research number inventory RCH1.2017.01237

Artefact Typology	Axe	Length (cm)	9,90
Family	Work	Width (cm)	2,10
Category	Tool		
Weight (gr)	212		
Description	Bronze socked axe		



Metal Sample: YES

LIA NO

XRF YES

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01238

Artefact Typology	Axe	Length (cm)	9.00
Family	Work	Width (cm)	2.30
Category	Tool		
Weight (gr)	305		
Description	Bronze socked axe		



Metal Sample: YES

LIA NO

XRF YES

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01239

Artefact Typology	Axe
Family	Work
Category	Tool
Weight (gr)	247
Description	Bronze socked axe. Preserved mark trident.

Length (cm)	10,30
Width (cm)	2,80



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01240

Artefact Typology	Axe	Length (cm)	9,30
Family	Work	Width (cm)	3,00
Category	Tool		
Weight (gr)	213		
Description	Bronze socked axe. Lines marked in the main body + ring		



Metal Sample: YES

LIA NO

XRF YES

SEM NO

ICPMS NO

Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.01249

Artefact Typology	Axe	Length (cm)	10,60
Family	Work	Width (cm)	2,00
Category	Tool		
Weight (gr)	133		
Description	Bronze socketed axe, middle edge decorating the main body. One of the sides fractured.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



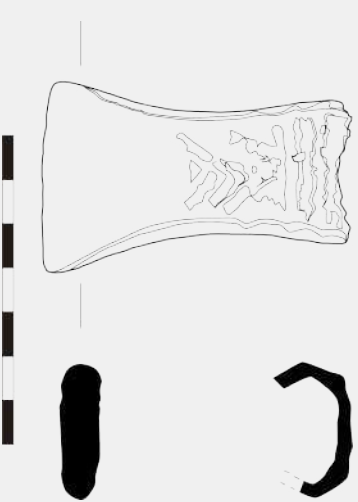
Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.01284

Artefact Typology	Axe	Length (cm)	7.00
Family	Work	Width (cm)	1,20
Category	Tool		
Weight (gr)	85		
Description	Broken bronze socked axe with cross lines decoration in the middle of the body.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.01314

Artefact Typology	Cartridge	Length (cm)	5.90
Family	Diverse	Width (cm)	1.80
Category	Tool		
Weight (gr)	21		
Description	Fragmented bronze cone with double perforation.		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01321

Artefact Typology	Cartridge
Family	Diverse
Category	Tool
Weight (gr)	21
Description	Fragmented bronze cone.

Length (cm)	3,70
Width (cm)	1,60



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01327

Artefact Typology Axe
Family Work
Category Tool
Weight (gr) 253
Description Complete bronze fin axe

Length (cm) 11,50
Width (cm) 1,00



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



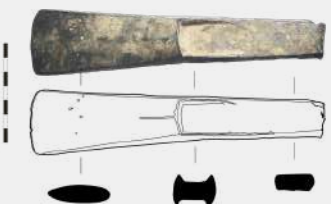
Research number inventory RCH1.2017.01328

Artefact Typology Axe
Family Work
Category Tool
Weight (gr) 801
Description Complete bronze fin axe

Length (cm) 21,00
Width (cm) 1,20



Metal Sample: NO
LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.01329

Artefact Typology Miniature Axe
Family Diverse
Category Diverse
Weight (gr) 7
Description Miniature bronze socked axe

Length (cm) 4.00
Width (cm) ND



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO



Catalogue Rochelongue Shipwreck
Enrique Aragón Núñez
Flinders University - Australia

Research number inventory RCH1.2017.01330

Artefact Typology	Miniature Axe
Family	Diverse
Category	Diverse
Weight (gr)	6
Description	Miniature bronze socked axe

Length (cm)	3.80
Width (cm)	ND



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01360

Artefact Typology	Axe
Family	Diverse
Category	Diverse
Weight (gr)	12
Description	Miniature bronze axe

Length (cm)	4.40
Width (cm)	0.70



Metal Sample: NO

LIA NO

XRF NO

SEM NO

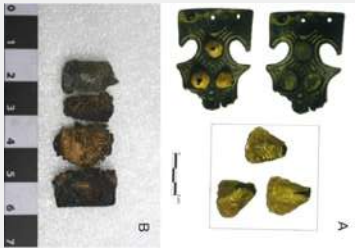
ICPMS NO

Research number inventory RCH1.2017.01367

Artefact Typology	Buckle belt (Deco)	Length (cm)	4,20
Family	Jewellery and clothing accessories	Width (cm)	1,90
Category	Jewellery		
Weight (gr)	3		
Description	Fragment of decorative bronze cones for buckle belt (comparative image source: Graells and Lorio 2017:249 Lam. 13).		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.01382

Artefact Typology	Bronze	Length (cm)	2.60
Family	Jewellery and clothing accessories	Width (cm)	0.50
Category	Jewellery		
Weight (gr)	4		
Description	Fragment handle bronze with lotus decoration.		



Metal Sample:	NO
LIA	NO
XRF	NO
SEM	NO
ICPMS	NO



Research number inventory RCH1.2017.01397

Artefact Typology Bronze
Family Hardware
Category Diverse
Weight (gr) 40
Description Bronze plate (knife?)

Length (cm) 7.20
Width (cm) 1.90



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01404

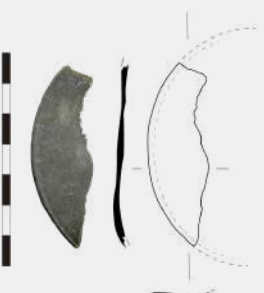
Artefact Typology Bronze
Family Hardware
Category Diverse
Weight (gr) 8
Description Bronze plate (disc?)

Length (cm) 5.80
Width (cm) 3.00



Metal Sample: NO

LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.01427

Artefact Typology	Bronze	Length (cm)	8,40
Family	Hardware	Width (cm)	6,00
Category	Diverse		
Weight (gr)	9		
Description	Bronze sheet (shield-disc?)		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

Research number inventory RCH1.2017.01431

Artefact Typology Bronze
Family Hardware
Category Diverse
Weight (gr) 34
Description 21 bronze sheet

Length (cm) Diverse
Width (cm) Diverse

Metal Sample: NO

LIA NO
XRF NO
SEM NO
ICPMS NO



Research number inventory RCH1.2017.00770

Artefact Typology Hammer

Family

Work

Category Tool

Weight (gr) 58

Description

Bronze socked Hammer . V mark.

Length (cm) 3,10

Width (cm) 1,70



Metal Sample: YES

LIA NO

XRF YES

SEM NO

ICPMS NO

Research number inventory RCH1.2017.00775

Artefact Typology	Hammer	Length (cm)	5,00
Family	Work	Width (cm)	1,80
Category	Tool		
Weight (gr)	110		
Description	Bronze socked Hammer. Y mark		



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

APPENDIX 1

(Catalogue)¹

¹ The entire catalogue for Rochelongue Shipwreck contains a total of 1,451 entries. For practical reasons this appendix includes only the artefacts mentioned in the text.

Research number inventory RCH1.2017.00774

Artefact Typology	Hammer
Family	Work
Category	Tool
Weight (gr)	98
Description	Bronze socked Hammer. X mark.

Length (cm)	5,70
Width (cm)	1,80



Metal Sample: NO

LIA NO

XRF NO

SEM NO

ICPMS NO

APPENDIX 2

(Samples Catalogue)

S 0044

Fibule (fragment)

2013.00.365



Alliage cuivreux

N°relocalisation

AS.64.587.190

Ancien numéro

1816

Mode de prélèvement

- ☐ Mèche en titane; 1.5 mm de diamètre
☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

/

Date du prélèvement

06/07/2017

Poids de l'échantillon

16

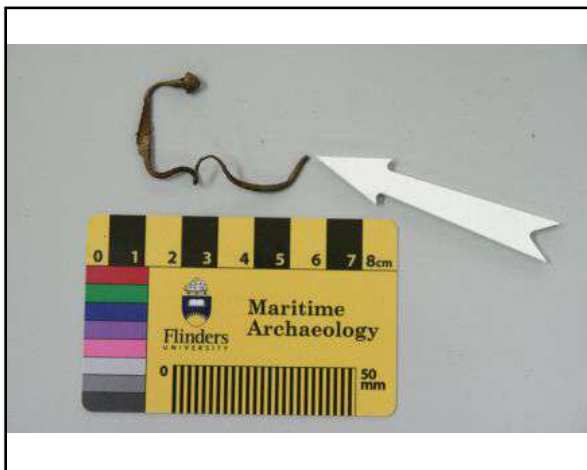
mg

Poids de l'artefact
après prélèvement

2.000

g

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0046

Fibule (fragment)

2013.00.404



Alliage cuivreux

N°relocalisation

(...)77

Ancien numéro

1855

Mode de prélèvement

- ☐ Mèche en titane; 1.5 mm de diamètre
☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

/

Date du prélèvement

17/05/2017

Poids de l'échantillon

8

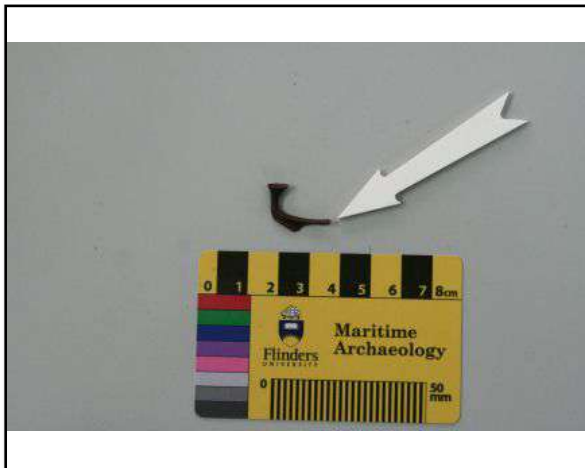
mg

Poids de l'artefact
après prélèvement

1.030

g

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0037

Fibule

2013.00.371



Alliage cuivreux

N°relocalisation

(...)78

Ancien numéro

Mode de prélèvement

- ☐ Mèche en titane; 1.5 mm de diamètre
☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

/

Date du prélèvement

16/05/2017

Poids de l'échantillon

5

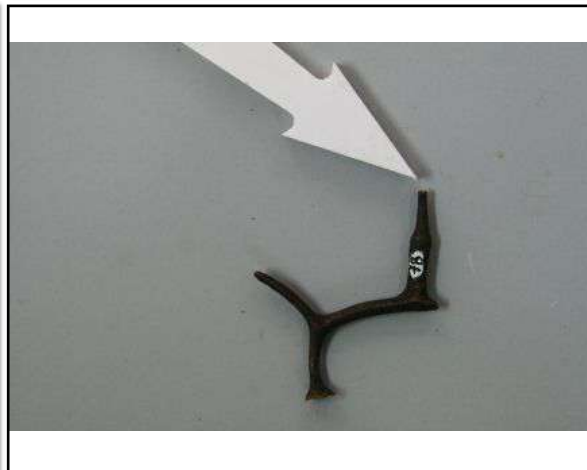
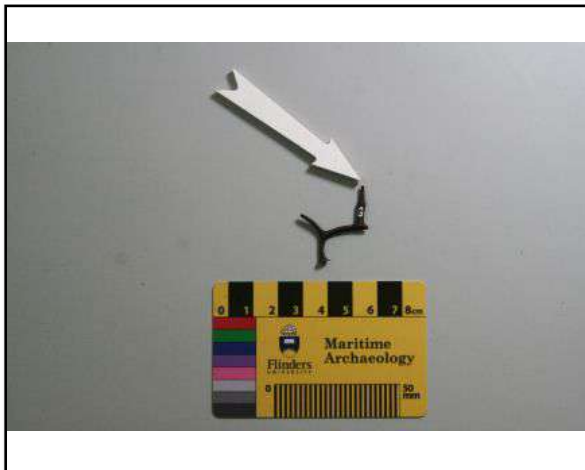
mg

Poids de l'artefact
après prélèvement

1.500

g

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0048

Fibule (fragment)

2013.00.440



Alliage cuivreux

N°relocalisation

(...)97

Ancien numéro

1893

Mode de prélèvement

- ☐ Mèche en titane; 1.5 mm de diamètre
☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

/

Date du prélèvement

06/07/2017

Poids de l'échantillon

8

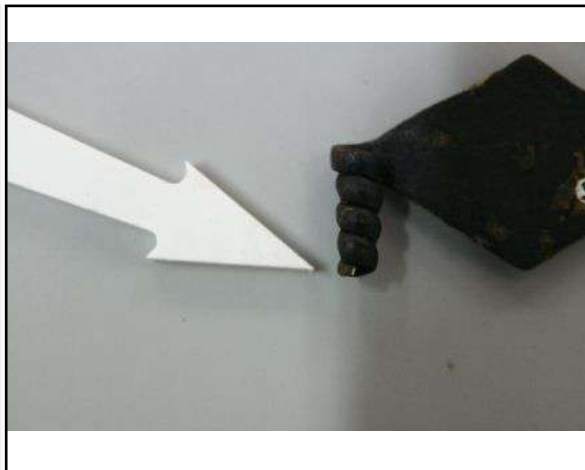
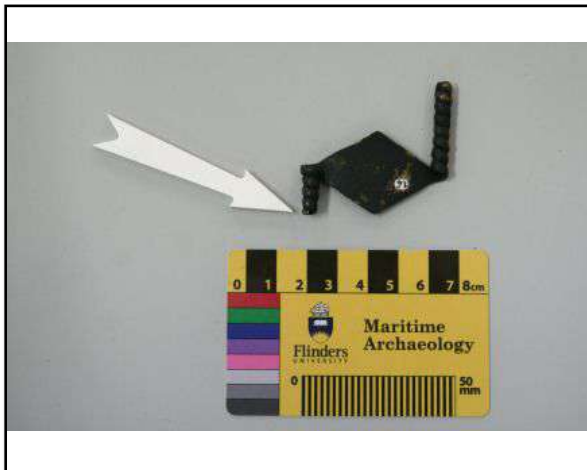
mg

Poids de l'artefact
après prélèvement

10.881

g

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0041

Fibule

2938.1.20



Alliage cuivreux

Date du prélèvement 15/05/2017

N°relocalisation

Poids de l'échantillon 16 mg

Ancien numéro

Poids de l'artefact
après prélèvement 8.345 g

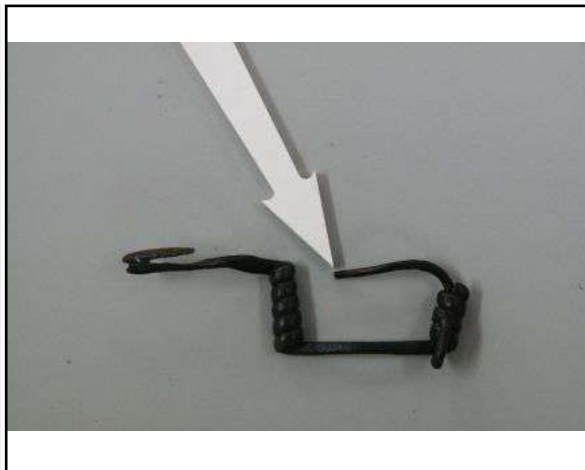
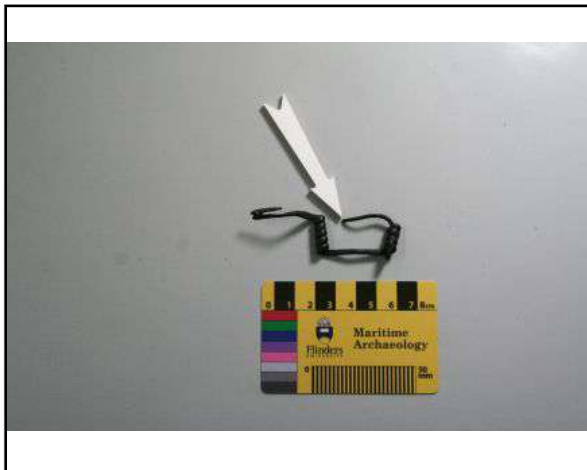
Mode de prélèvement

- ☐ Mèche en titane; 1.5 mm de diamètre
☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

/ La muestra fue tomada de la zona de la aguja de la fibula no del cuerpo

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0006

Boucle de ceinturon (Fragment)

2013.00.157



Alliage cuivreux

N°relocalisation

AS.64.586.62

Ancien numéro

Mode de prélèvement

- ☐ Mèche en titane; 1.5 mm de diamètre
☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

2 essais ont été faits:

sample1= drill = 10mg --> dust

sample2=clic = 11mg --> OK (S0006-2)

Métal blanc!!

Date du prélèvement

06/07/2017

Poids de l'échantillon

11

mg

Poids de l'artefact
après prélèvement

26.338

g

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0002

Boucle de ceinturon (Fragment)

2013.00.153



Alliage cuivreux

N°relocalisation

AS.65.320.60

Ancien numéro

Mode de prélèvement

- ☐ Mèche en titane; 1.5 mm de diamètre
☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

/

Date du prélèvement

06/07/0201

Poids de l'échantillon

8

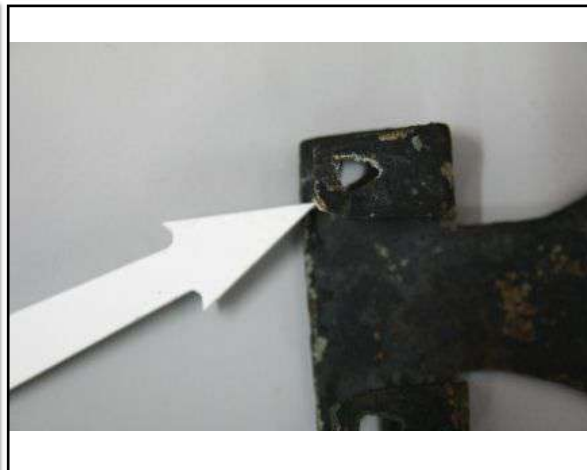
mg

Poids de l'artefact
après prélèvement

25.601

g

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0001

Boucle de ceinturon (Fragment)

2013.00.152



Alliage cuivreux

N°relocalisation

AS.65.320.65

Ancien numéro

Date du prélèvement

06/07/2017

Poids de l'échantillon

12

mg

Poids de l'artefact
après prélèvement

28.197

g

Mode de prélèvement

- ☐ Mèche en titane; 1.5 mm de diamètre
☒ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

Objet déjà restauré

Présence de cire sur la surface métallique

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0005

Boucle de ceinturon (Fragment)

2013.00.156



Alliage cuivreux

N°relocalisation

AS.56.408.63

Ancien numéro

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

L'objet a été transpercé de part en part lors du prélèvement.
Belle spirale!
Objet restauré; présence de cire sur la surface métallique

Date du prélèvement

06/07/2017

Poids de l'échantillon

7

mg

Poids de l'artefact
après prélèvement

30.402

g

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0036

Fibule

2938.1.3



Alliage cuivreux

Date du prélèvement 06/07/2017

N°relocalisation

Poids de l'échantillon 13 mg

Ancien numéro

Poids de l'artefact après prélèvement 41.149 g

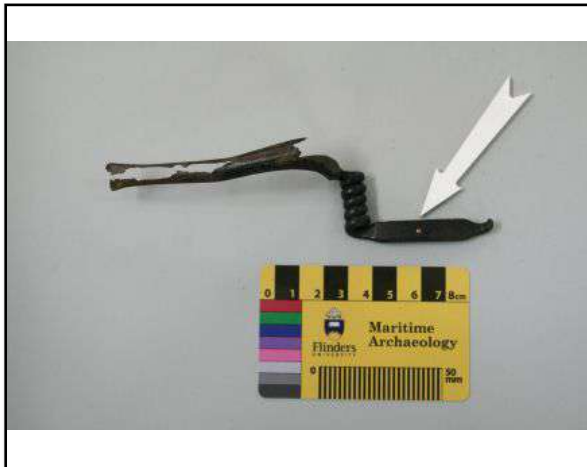
Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Remarques sur le prélèvement à effectuer

/

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0055

Lingot

Alliage cuivreux

Date du prélèvement 22/06/2017

N°relocalisation

AS.64.L (130 180) 29

Ancien numéro

1595

Poids de l'échantillon

37 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

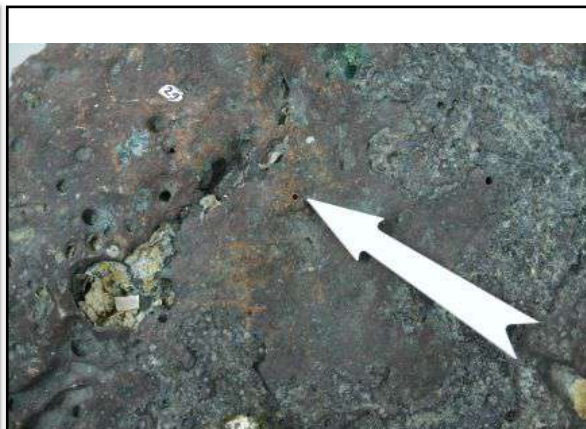
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.170



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0056

Lingot

Alliage cuivreux

Date du prélèvement 22/06/2017

N°relocalisation

(….)10

Ancien numéro

1592

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Poids de l'échantillon

19 mg

Côté du lingot

- ☐ Plat
☒ Bombé

Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Echantillon refait car doute d'avoir fait un échange de numéro. (avec le S0083)

2013.00.171



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0057

Lingot

Alliage cuivreux

Date du prélèvement

22/06/2017

N°relocalisation

(….)37

Ancien numéro

1594

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Poids de l'échantillon

52

mg

Côté du lingot

- ☒ Plat
☐ Bombé

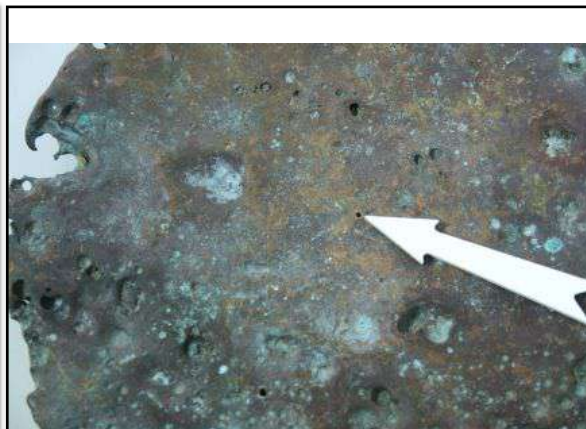
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche

2013.00.172



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0059

Lingot

Alliage cuivreux

Date du prélèvement 23/06/2017

N°relocalisation

AS.64.L.190.11

Ancien numéro

1598

Poids de l'échantillon

37 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

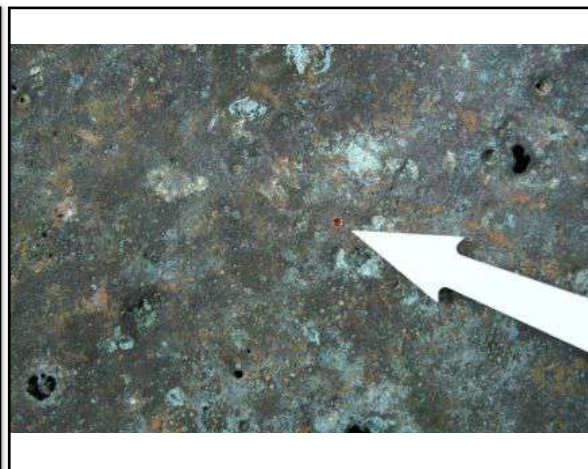
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche

2013.00.174



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0060

Lingot

Alliage cuivreux

Date du prélèvement 23/07/2017

N°relocalisation

AS.64.L10.411

Ancien numéro

1596

Poids de l'échantillon

23 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

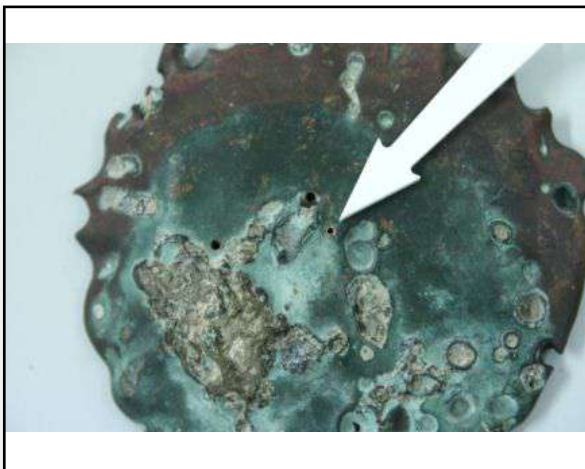
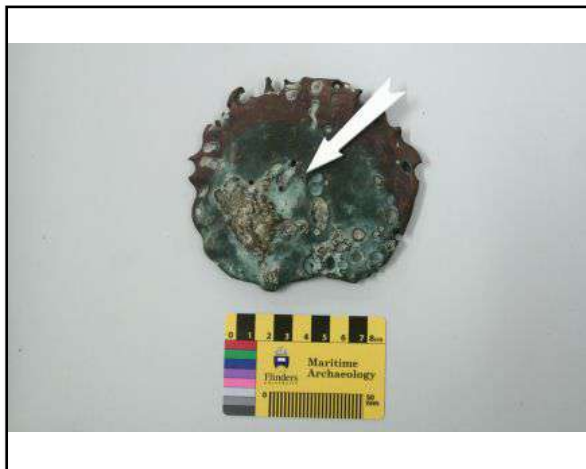
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.175



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0062

Lingot

Alliage cuivreux

Date du prélèvement 18/05/2017

N°relocalisation

(….)32

Ancien numéro

1602

Poids de l'échantillon

17 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.177



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0063

Lingot

Alliage cuivreux

Date du prélèvement 18/05/2017

N°relocalisation

(….)04

Ancien numéro

1603

Poids de l'échantillon

23 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.178



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0066

Lingot

Alliage cuivreux

Date du prélèvement 23/06/2017

N°relocalisation

(….)17

Ancien numéro

1605

Poids de l'échantillon

27 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche

2013.00.181



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0067

Lingot

Alliage cuivreux

Date du prélèvement

23/06/2017

N°relocalisation

AS.64.L.346.03

Ancien numéro

1604

Poids de l'échantillon

6

mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

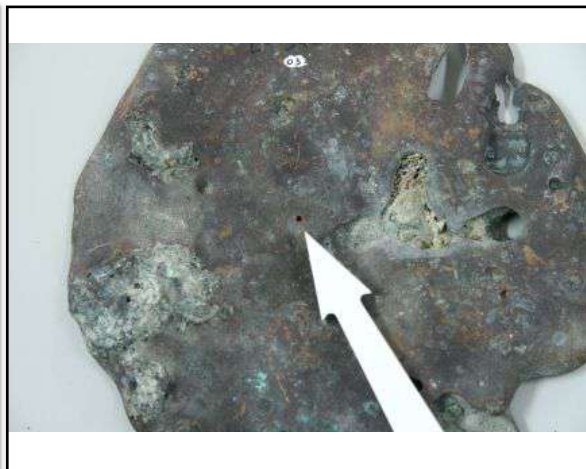
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.182



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0068

Lingot

Alliage cuivreux

Date du prélèvement 23/06/2017

N°relocalisation

(….)01

Ancien numéro

1606

Poids de l'échantillon

17 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

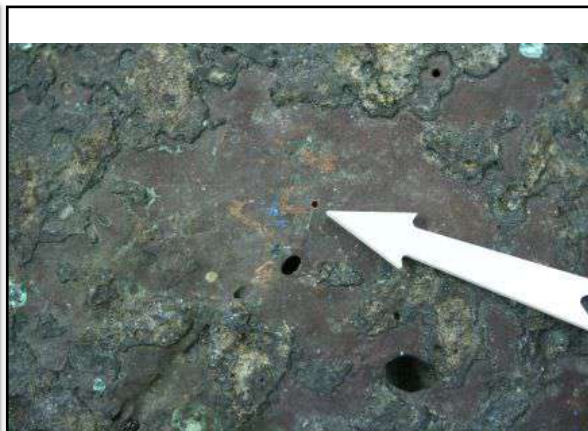
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche.

2013.00.183



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0071

Lingot

Alliage cuivreux

Date du prélèvement 29/05/2017

N°relocalisation

(….)16

Ancien numéro

1609

Poids de l'échantillon

33 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☒ Bombé

Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible; Localisée vers le centre du lingot.

Essai1: sur le plat= mèche cassée. retirée

Essai2: côté bombé = OK

2013.00.186



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0072

Lingot

Alliage cuivreux

Date du prélèvement 27/06/2017

N°relocalisation

AS.64.L.117.44

Ancien numéro

1610

Poids de l'échantillon

17 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

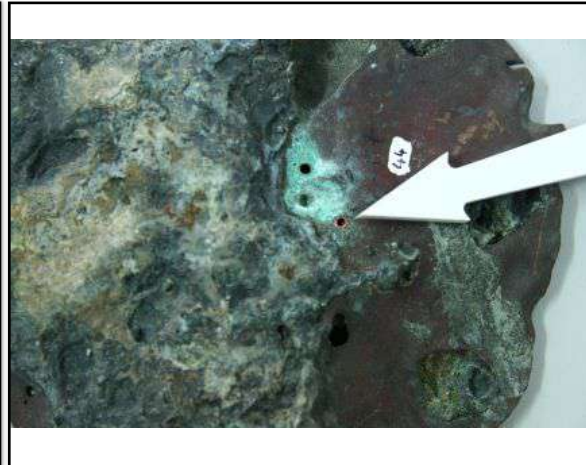
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.187



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0073

Lingot

Alliage cuivreux

Date du prélèvement 22/06/2017

N°relocalisation

AS.64.L.228.34

Ancien numéro

1611

Poids de l'échantillon

30 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

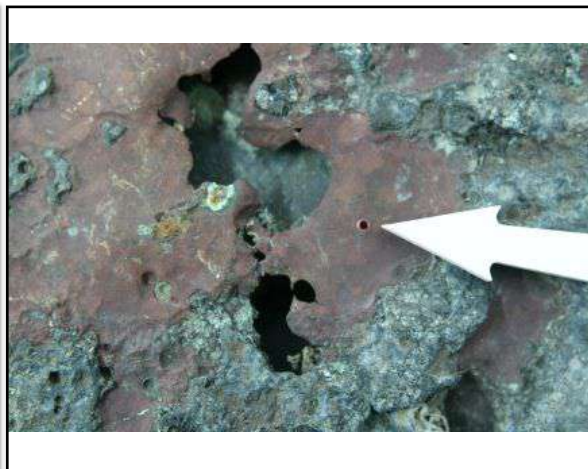
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche et au niveau du lingot.

2013.00.188



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0076

Lingot

Alliage cuivreux

Date du prélèvement

29/05/2017

N°relocalisation

AS.64.L140.33

Ancien numéro

1628

Poids de l'échantillon

42 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

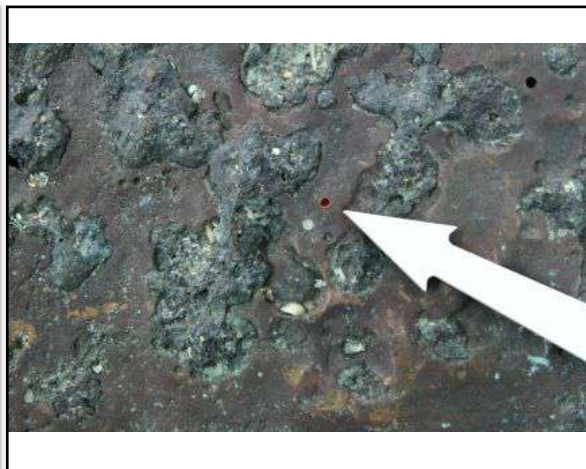
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.205



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0078

Lingot

Alliage cuivreux

Date du prélèvement 22/06/2017

N°relocalisation

AS.64.L.44-40

Ancien numéro

1630

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Poids de l'échantillon

10 mg

Côté du lingot

- ☐ Plat
☒ Bombé

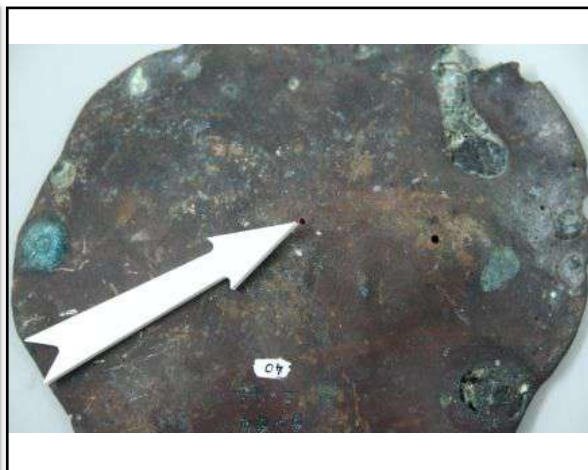
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.207



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0079

Lingot

Alliage cuivreux

Date du prélèvement

22/05/2017

N°relocalisation

AS.64.L.183.36

Ancien numéro

1633

Poids de l'échantillon

8

mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

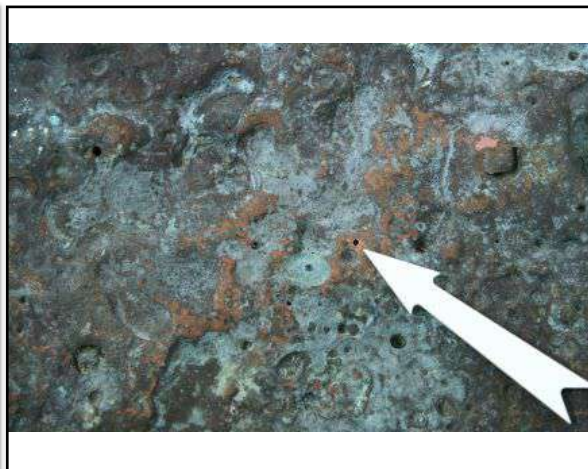
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.208



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0080

Lingot

Alliage cuivreux

Date du prélèvement 22/05/2017

N°relocalisation

(….)45

Ancien numéro

1632

Poids de l'échantillon

10 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

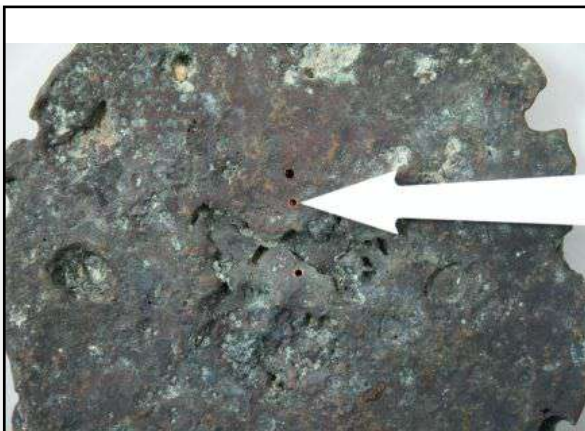
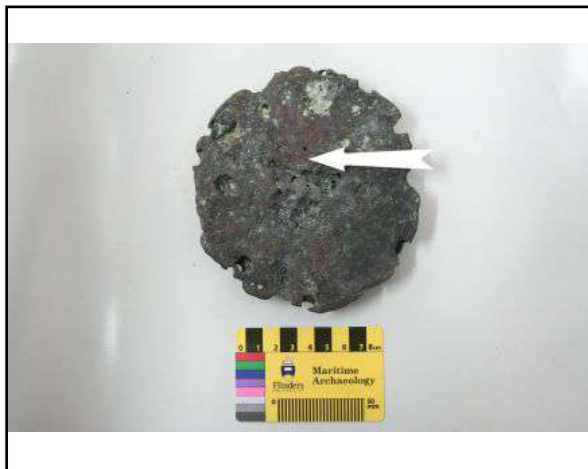
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible; Localisée vers le centre du lingot
2 samples: S0080-1=spirale= 3mg (to send)
S0080-2=dust=10mg (in the lab)
Beaucoup de produits de corrosion.

2013.00.209



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0081

Lingot

Alliage cuivreux

Date du prélèvement 22/05/2017

N°relocalisation

(...)32

Ancien numéro

1631

Poids de l'échantillon

13 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.210



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0083

Lingot

Alliage cuivreux

Date du prélèvement 22/06/2017

N°relocalisation

AS.64.L.231.39

Ancien numéro

1634

Poids de l'échantillon

26 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

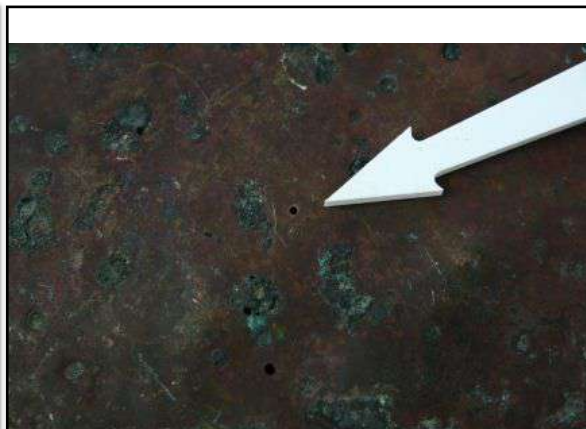
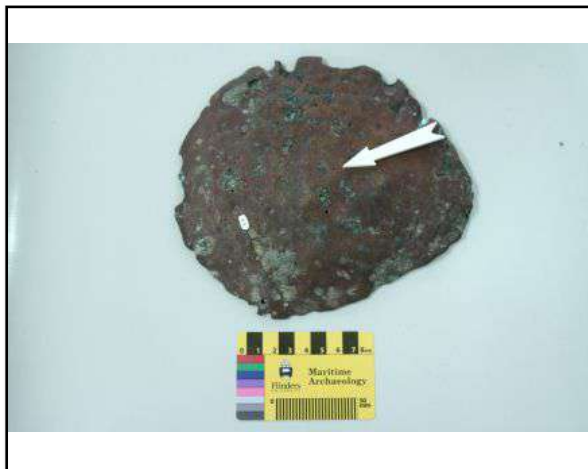
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche.
Echantillon refait car doute d'avoir fait un échange de numéro. (avec le S0056)

2013.00.212



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0084

Lingot

Alliage cuivreux

Date du prélèvement 22/06/2017

N°relocalisation

(….)38

Ancien numéro

1637

Poids de l'échantillon

42 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

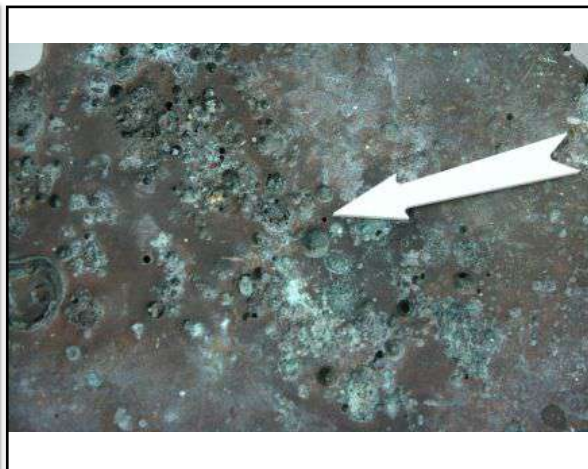
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche

2013.00.213



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0087

Lingot

Alliage cuivreux

Date du prélèvement 29/05/2017

N°relocalisation

AS.64.L.148-24

Ancien numéro

1639

Poids de l'échantillon

32 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☒ Plat
☐ Bombé

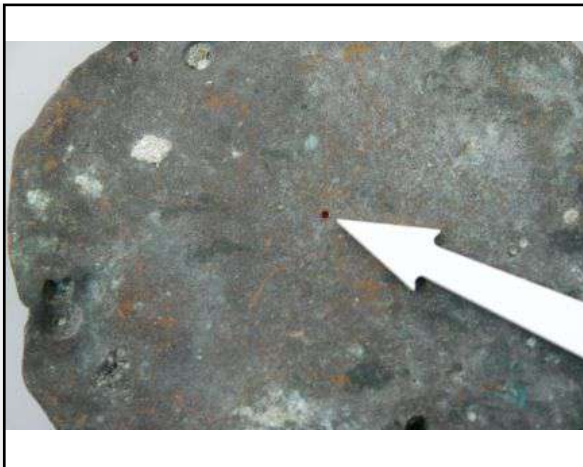
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche

2013.00.216



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0088

Lingot

Alliage cuivreux

Date du prélèvement 29/05/2017

N°relocalisation

AS.64.L.46.41

Ancien numéro

Poids de l'échantillon

10 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

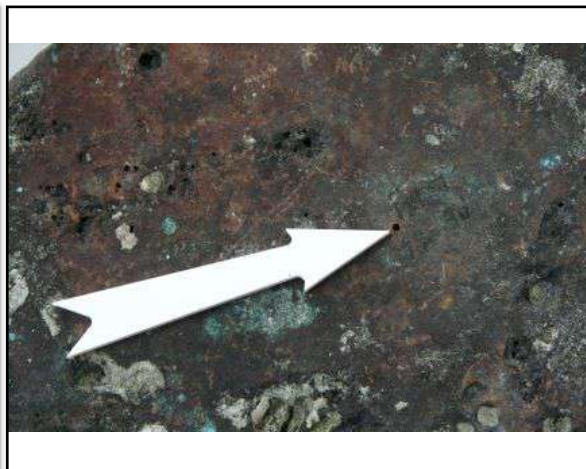
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.217



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0090

Lingot

Alliage cuivreux

Date du prélèvement

29/05/2017

N°relocalisation

AS.64.572-410

Ancien numéro

1642

Poids de l'échantillon

20 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

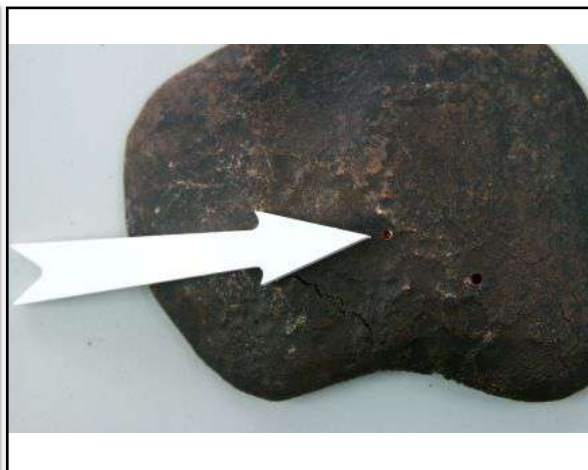
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot

2013.00.219



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0094

Lingot

Alliage cuivreux

Date du prélèvement 29/05/2017

N°relocalisation

(...13)

Ancien numéro

Poids de l'échantillon

71 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Côté du lingot

- ☐ Plat
☒ Bombé

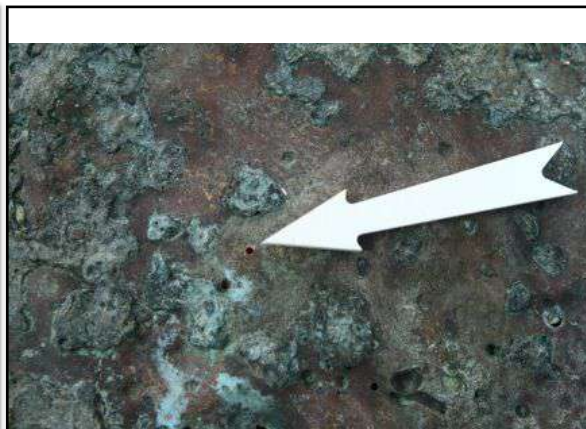
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche

2013.00.226



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0096

Lingot plomb

2938.13.12



Plomb

Date du prélèvement 22/07/2017

N°relocalisation

Ancien numéro

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Poids de l'échantillon

14 mg

Côté du lingot

- ☐ Plat
☒ Bombé

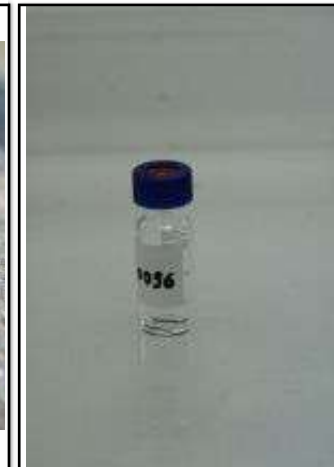
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible; Localisée vers le centre du lingot
Les prélèvements des lingots de plomb ont été effectués en dernier pour éviter toute pollution de l'environnement proche.

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0097

Lingot

Alliage cuivreux

Date du prélèvement 29/05/2017

N°relocalisation

Ancien numéro

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Poids de l'échantillon

60 mg

Côté du lingot

- ☐ Plat
☒ Bombé

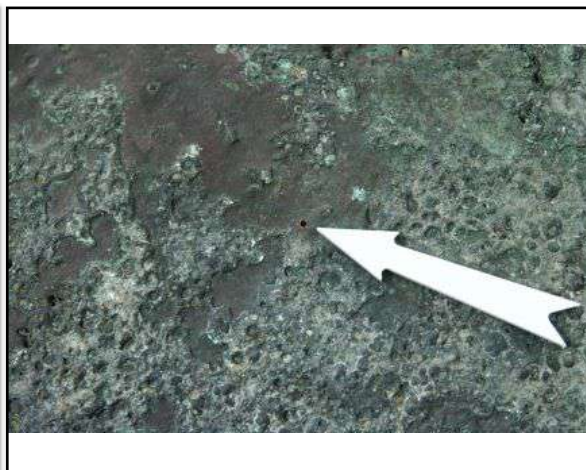
Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible
Localisée vers le centre du lingot
Prélevé directement sur la mèche

2938.13.13



Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0098

Lingot plomb

2938.13.14



Plomb

Date du prélèvement 22/07/2017

N°relocalisation

Ancien numéro

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Poids de l'échantillon

88 mg

Côté du lingot

- ☐ Plat
☒ Bombé

Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible; Localisée vers le centre du lingot
Les prélèvements des lingots de plomb ont été effectués en dernier pour éviter toute pollution de l'environnement proche.
2 essais: trop de produits de corrosion sur le premier test. Second OK.

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0099

Lingot plomb

2938.13.15



Plomb

Date du prélèvement 22/07/2017

N°relocalisation

Ancien numéro

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

Poids de l'échantillon

11 mg

Côté du lingot

- ☐ Plat
☒ Bombé

Remarques sur le prélèvement à effectuer

Zone la moins corrodée possible; Localisée vers le centre du lingot
Les prélèvements des lingots de plomb ont été effectués en dernier pour éviter toute pollution de l'environnement proche.

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



S 0106

Galène

2017.01.440



Plomb

Date du prélèvement

01/06/2017

N°relocalisation

RCH1.2017.01.440

Ancien numéro

Poids de l'échantillon

110 mg

Mode de prélèvement

- ☒ Mèche en titane; 1.5 mm de diamètre
☐ Fragments pris sur un bord déjà cassé

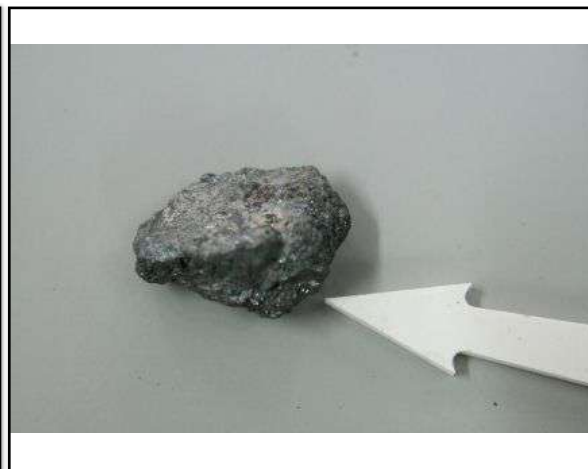
Côté du lingot

- ☐ Plat
☐ Bombé

Remarques sur le prélèvement à effectuer

Prélèvement avec mèche en titane tapée au marteau
Poids du nodule: 18.880g après prélèvement de l'échantillon.

Localisation du prélèvement réalisé et zoom



Photos du prélèvement



APPENDIX 3

(Metal analysis data)

Table 1. Lead Isotope Analysis Results

ID	Sample	$^{206}\text{Pb}/^{204}\text{Pb}$	Error (2SE)	$^{207}\text{Pb}/^{204}\text{Pb}$	Error (2SE)	$^{208}\text{Pb}/^{204}\text{Pb}$	Error (2SE)	$^{208}\text{Pb}/^{206}\text{Pb}$	Error (2SE)	$^{207}\text{Pb}/^{206}\text{Pb}$	Error (2SE)
S 0044	Fibula (fragment)	18.2828	0.0006	15.6446	0.0006	38.4547	0.0016	2.10333	0.00004	0.85570	0.00001
S 0046	Fibula (fragment)	18.2533	0.0005	15.6375	0.0005	38.4218	0.0015	2.10493	0.00004	0.85670	0.00001
S 0037	Fibule	18.2536	0.0007	15.6382	0.0007	38.4244	0.0020	2.10503	0.00004	0.85672	0.00001
S 0048	Fibula (fragment)	18.2199	0.0007	15.6213	0.0006	38.3708	0.0017	2.10598	0.00003	0.85737	0.00001
S 0041	Fibula	18.2579	0.0007	15.6422	0.0007	38.4386	0.0019	2.10532	0.00003	0.85674	0.00001
S 0006	Buckle Belt	18.2517	0.0007	15.6376	0.0007	38.4186	0.0018	2.10493	0.00004	0.85678	0.00001
S 0002	Buckle Belt	18.5166	0.0007	15.6587	0.0007	38.5620	0.0017	2.08256	0.00003	0.84566	0.00001
S 0001	Buckle Belt	18.3364	0.0007	15.6398	0.0007	38.4600	0.0017	2.09746	0.00003	0.85294	0.00001
S 0005	Buckle Belt	18.1879	0.0006	15.5917	0.0006	38.1978	0.0016	2.10017	0.00003	0.85725	0.00001
S 0036	Fibula	18.2520	0.0006	15.6370	0.0006	38.4234	0.0016	2.10516	0.00003	0.85673	0.00001
S 0055	Ingot	17.9923	0.0005	15.5489	0.0005	37.9316	0.0014	2.10821	0.00003	0.86419	0.00001
S 0056	Ingot	17.9840	0.0006	15.5508	0.0006	37.9370	0.0014	2.10948	0.00003	0.86470	0.00001
S 0057	Ingot	18.2822	0.0008	15.6305	0.0007	38.3022	0.0019	2.09505	0.00004	0.85496	0.00001
S 0059	Ingot	17.8025	0.0009	15.5514	0.0009	37.8772	0.0021	2.12764	0.00004	0.87355	0.00001
S 0060	Ingot	18.5278	0.0007	15.6573	0.0006	38.6514	0.0015	2.08613	0.00003	0.84507	0.00001
S 0062	Ingot	18.1006	0.0009	15.5729	0.0008	38.1080	0.0022	2.10535	0.00004	0.86035	0.00001
S 0063	Ingot	19.1530	0.0012	15.6989	0.0010	38.6859	0.0026	2.01984	0.00004	0.81966	0.00001
S 0066	Ingot	17.6815	0.0010	15.5357	0.0009	37.7914	0.0023	2.13734	0.00004	0.87864	0.00001
S 0067	Ingot	19.1667	0.0024	15.6587	0.0021	39.6873	0.0056	2.07064	0.00009	0.81697	0.00003
S 0068	Ingot	18.0498	0.0010	15.5706	0.0009	37.8712	0.0022	2.09815	0.00004	0.86264	0.00001

S 0071	Ingot	17.9777	0.0008	15.5489	0.0007	37.9316	0.0019	2.10992	0.00004	0.86490	0.00001
S 0072	Ingot	17.9815	0.0009	15.5501	0.0008	37.9386	0.0022	2.10986	0.00004	0.86478	0.00001
S 0073	Ingot	17.4633	0.0013	15.5068	0.0012	37.5910	0.0030	2.15257	0.00004	0.88796	0.00002
S 0076	Ingot	18.0026	0.0009	15.5542	0.0008	37.9569	0.0022	2.10841	0.00006	0.86400	0.00002
S 0078	Ingot	17.6949	0.0007	15.5342	0.0006	37.8149	0.0017	2.13705	0.00004	0.87789	0.00001
S 0079	Ingot	17.4488	0.0006	15.5032	0.0006	37.5712	0.0016	2.15322	0.00004	0.88850	0.00001
S 0080	Ingot	17.9884	0.0006	15.5510	0.0006	37.9409	0.0015	2.10918	0.00003	0.86450	0.00001
S 0081	Ingot	18.7225	0.0030	15.6385	0.0027	38.9601	0.0070	2.08092	0.00010	0.83527	0.00003
S 0083	Ingot	18.3030	0.0010	15.6481	0.0010	38.3940	0.0025	2.09770	0.00004	0.85495	0.00001
S 0084	Ingot	17.9796	0.0009	15.5505	0.0008	37.9365	0.0020	2.10997	0.00005	0.86490	0.00001
S 0087	Ingot	18.2170	0.0013	15.5957	0.0012	38.2200	0.0028	2.09804	0.00005	0.85611	0.00001
S 0088	Ingot	17.9772	0.0007	15.5479	0.0006	37.9280	0.0017	2.10978	0.00004	0.86486	0.00001
S 0090	Ingot	19.1279	0.0013	15.6918	0.0010	38.9269	0.0027	2.03509	0.00004	0.82036	0.00002
S 0094	Ingot	17.9884	0.0010	15.5486	0.0009	37.9301	0.0024	2.10859	0.00005	0.86437	0.00001
S 0096	Ingot	18.4019	0.0007	15.6500	0.0007	38.5245	0.0019	2.09350	0.00004	0.85045	0.00001
S 0097	Ingot	17.9799	0.0007	15.5487	0.0007	37.9306	0.0018	2.10962	0.00004	0.86478	0.00001
S 0098	Ingot	18.4010	0.0009	15.6496	0.0008	38.5346	0.0022	2.09415	0.00004	0.85048	0.00001
S 0099	Ingot	18.3985	0.0008	15.6495	0.0007	38.5244	0.0019	2.09389	0.00004	0.85059	0.00001
S 0106	Hematite	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	n	²⁰⁶ Pb/ ²⁰⁴ Pb	2 SD	²⁰⁷ Pb/ ²⁰⁴ Pb	2 SD	²⁰⁸ Pb/ ²⁰⁴ Pb	2 SD	²⁰⁸ Pb/ ²⁰⁶ Pb	2 SD	²⁰⁷ Pb/ ²⁰⁶ Pb	2 SD
NBS981	6	16.9431	0.0007	15.5006	0.0006	36.7284	0.0021	2.16774	0.00005	0.91486	0.00001

Table 2. Comparative isotopic data

Table 2.1 Isotopic published data France

Site	Sample	Pb 207/206	Pb 208/204	Pb 207/204	Pb 206/204
Arz_artefact	30013br	0.85457	38.429	15.636	18.296
Bautares_artefact	Baut 2132	0.85391	38.43	15.629	18.304
Bautares_artefact	Baut 2146	0.85567	38.474	15.655	18.295
Bautares_artefact	Baut 2147	0.84473	38.625	15.651	18.528
Bautares_artefact	Baut 2158	0.84281	38.72	15.672	18.595
Bautares_artefact	Baut 2185	0.84863	38.566	15.653	18.445
Bautares_artefact	Baut 2212	0.84547	38.705	15.673	18.538
Bautares_ingot	Baut L2	0.81755	38.632	15.668	19.165
Bautares_ingot	Baut L4	0.83882	38.673	15.665	18.675
Bautares_ingot	Baut L6	0.83332	38.83	15.67	18.804
Bautares_ingot	Baut L8	0.84132	38.5	15.609	18.553
Bautares_ingot	Baut L9	0.83114	38.624	15.65	18.83
Briatexte_artefact	BRI1	0.85873	38.341	15.621	18.19
Carcassonne_artefact	EC1	0.84404	38.697	15.66	18.554
Carcassonne_artefact	EC2	0.87469	37.798	15.511	17.733
Carcassonne_artefact	EC9	0.85398	38.464	15.638	18.311
Carcassonne_artefact	EC26	0.84755	38.652	15.666	18.484
Carcassonne_artefact	EC14	0.85007	38.598	15.658	18.419
Croix_artefact	CDM2291	0.86598	38.097	15.568	17.977
Croix_artefact	CDM2292	0.84943	38.511	15.619	18.388
Croix_artefact	CDM2294	0.84669	38.669	15.664	18.5
Launac_artefact	FZ36287	0.8526	38.512	15.653	18.36
Launac_artefact	FZ36288	0.8518	38.55	15.66	18.385

Launac_artefact	FZ36290	0.8512	38.57	15.665	18.404
Launac_artefact	FZ36291	0.8399	38.8	15.677	18.667
Launac_artefact	FZ36292	0.8436	38.731	15.684	18.593
Launac_artefact	FZ36295	0.8303	38.694	15.658	18.859
Launac_artefact	FZ36296	0.8436	38.607	15.641	18.541
Launac_artefact	FZ36297	0.8341	38.825	15.675	18.793
Launac_artefact	FZ36299	0.8508	38.566	15.657	18.403
Launac_artefact	FZ36300	0.841	38.682	15.664	18.626
Launac_artefact	FZ36301	0.8572	38.358	15.622	18.225
Launac_artefact	FZ36319	0.8441	38.745	15.68	18.576
Launac_artefact	FZ36320	0.8464	38.672	15.672	18.515
Launac_artefact	FZ36322	0.8463	38.695	15.671	18.518
Launac_ingot	FZ36339	0.8328	38.867	15.689	18.838
Launac_ingot	FZ36340	0.8873	37.598	15.506	17.476
Launac_ingot	FZ36341	0.8446	38.583	15.62	18.494
Launac_ingot	FZ36343	0.8333	38.827	15.672	18.808
Launac_ingot	FZ36345	0.8341	38.836	15.673	18.791
Launac_ingot	FZ36346	0.8347	38.963	15.702	18.813
Launac_ingot	FZ36347	0.8372	38.713	15.667	18.715
Launac_ingot	FZ36348	0.8432	38.559	15.608	18.51
Launac_ingot	FZ36349	0.8355	39.034	15.707	18.798
Launac_ingot	FZ36350	0.8272	38.713	15.666	18.938
Launac_ingot	FZ36351	0.8177	38.659	15.679	19.175
Launac_ingot	FZ36352	0.8232	38.625	15.611	18.965
Launac_ingot	FZ36353	0.8535	38.467	15.652	18.338
Launac_ingot	FZ36354	0.8341	38.882	15.685	18.806
Launac_ingot	FZ36342	0.83545	38.87	15.682	18.771
Null	CDM2382	0.84451	38.677	15.673	18.558
Roque_artefact	LOD1	0.85378	38.405	15.621	18.295
Roque_artefact	LOD3	0.84801	38.638	15.665	18.473

Roque_artefact	LOD7	0.84218	38.557	15.64	18.57
Roque_ingot	SAT329	0.86356	37.98	15.558	18.016
Roque_ingot	SAT363	0.83541	38.944	15.691	18.783
Roque_ingot	SAT367	0.83908	38.727	15.634	18.632
Roque_ingot	SAT391	0.86964	38.295	15.611	17.951
Roque_ingot	SAT398	0.88911	37.526	15.487	17.42
Roque_ingot	SAT416	0.83356	38.834	15.683	18.815
Roque_ingot	SAT419	0.83618	38.84	15.673	18.744

Table 2.2 Isotopic published data Spain

ID	Site	Pb 207/206	Pb 208/204	Pb 207/204	Pb 206/204
5051	El Calvari	0,8562	38.4390	15,642	18.268
PA12932	El Calvari	0,8565	38.4230	15,638	18.257
PA10907	El Calvari	0,8557	38.3990	15,629	18.265
PA13573	El Calvari	0,8558	38.4090	15,632	18.267
PA12793	El Calvari	0,8563	38.3960	15,625	18.247
PA12794	El Calvari	0,8387	38.8640	15,671	18.685
PA12792	El Calvari	0,8554	38.4050	15,631	18.273
PA13012	Vilanera	0,85687	38.4230	15,637	18.250
PA13007	Vilanera	0,85613	38.4500	15,646	18.275
CX 1012	Can Xac	0,85576	38.4410	15,642	18.279
PA12793	Linares	0,8563	38.4000	15,63	18.247
PA12792	Linares	0,8554	38.4000	15,63	18.273
PA13568	El Calvari	0,8561	38,383	15,622	18.247
298-1-61	Can Roqueta	0,8383	38,839	15,708	18.738
Linda Mariquita Galena	El Calvari	0,85481	38,502	15,675	18.338
UE 154 Galena	El Calvari	0,85507	38,423	15,657	18.310
UE 149 Escoria	El Calvari	0,85453	38,484	15,669	18.337

Table 2.3 Isotopic unpublished data Spain

ID	Site	208/206	207/206	206/204	207/204	208/204
MA-161700	Vila do Touro	2.1433	0.88319	17.556	15.505	37.626
56	Fonteta	2.11094	0.86487	17.94727	15.5221	37.8856
2009	El Risco	2.117733	0.8662333	17.9667	15.56335	38.04867
1150	San Marti de Ampurias	2.10975	0.8649	17.9761	15.5475	37.9251
MA-161698	Quinta do Erdeval	2.1166	0.86553	17.979	15.561	38.054
1648	Font de la Canya	2.10963	0.86482	17.9803	15.5497	37.9318
1652	Font de la Canya	2.10691	0.86364	18.0096	15.5538	37.9445

Table 3. Inductively Coupled Plasma Mass Spectrometry results

LAB CODE	ID	P	Sc	Ti	Na	Mg	Al	K	Ca	V	Cr	Fe	Mn	Co	Ni	Cu	Zn	Ga	As	Rb	Sr	Y
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
D.18.10.01	S0055	223	<LMD	37.2	183	37.2	85.7	51.3	159	<LMD	2.00	37.1	0.86	2.71	103	99.2	393	0.12	12.2	0.34	0.22	<LMD
D.18.10.02	S0056	80.2	<LMD	37.7	77.1	16.2	26.1	15.7	122	<LMD	0.48	79.5	1.01	1.55	152	98.0	249	0.10	6.66	0.24	0.71	<LMD
D.18.10.03	S0059	34.2	<LMD	49.7	56.9	12.3	16.8	14.4	49.9	0.46	1.38	145	0.56	12.8	315	98.4	151	0.11	142	0.17	<LMD	<LMD
D.18.10.04	S0057	121	<LMD	23.6	141	26.3	76.2	28.4	51.6	0.73	0.86	28.0	0.28	46.8	1337	99.5	151	0.13	25.6	0.19	0.26	<LMD
D.18.10.05	S0066	56.1	<LMD	56.4	58.5	15.5	30.6	13.7	43.9	0.26	1.56	22.6	0.24	52.1	508	99.9	140	0.12	89.4	0.18	<LMD	<LMD
D.18.10.06	S0068	93.3	<LMD	49.4	90.0	18.2	17.2	22.1	49.3	0.23	2.13	28.4	0.30	18.5	430	97.8	142	0.11	141	0.26	0.15	<LMD
D.18.10.07	S0071	76.7	<LMD	40.9	62.4	23.3	25.5	18.4	53.1	0.17	0.78	23.3	0.29	4.65	95.1	98.1	332	0.15	13.9	0.18	0.29	<LMD
D.18.10.08	S0072	254	<LMD	10.4	223	53.9	45.7	57.2	79.3	0.28	1.46	44.1	0.43	7.95	130	96.8	344	0.13	28.8	0.64	0.36	<LMD
D.18.10.09	S0073	64.4	<LMD	35.0	41.1	25.4	14.5	17.0	33.8	<LMD	0.39	42.3	0.30	48.9	131	93.2	208	0.14	<LMD	<LMD	<LMD	<LMD
D.18.10.10	S0076	78.1	<LMD	23.1	45.1	21.1	15.1	15.6	40.4	<LMD	0.39	17.4	0.20	1.12	94.9	92.5	336	0.16	9.36	<LMD	<LMD	<LMD
D.18.10.11	S0078	253	<LMD	21.2	212	45.5	45.8	41.7	69.9	0.21	1.37	135	1.53	16.3	338	99.6	246	0.18	2702	<LMD	0.32	<LMD
D.18.10.12	S0079	220	<LMD	22.5	178	12.0	31.2	34.1	81.6	0.50	4.03	64.0	0.71	30.8	102	96.8	165	0.12	<LMD	<LMD	0.26	<LMD
D.18.10.13	S0083	86.8	<LMD	7.63	56.3	13.4	9.51	16.7	22.0	<LMD	0.55	19.7	0.24	40.9	1278	95.8	142	0.13	27.5	<LMD	<LMD	<LMD
D.18.10.14	S0084	139	<LMD	16.9	130	21.3	32.7	34.0	101	<LMD	0.52	51.6	0.77	7.42	133	96.7	1214	0.14	8.35	<LMD	4.21	<LMD
D.18.10.15	S0087	78.6	<LMD	8.3	62.4	17.3	12.9	16.4	35.9	<LMD	0.37	179	0.46	306	1780	94.5	145	0.15	1079	<LMD	<LMD	<LMD
D.18.10.16	S0094	38.4	<LMD	41.0	31.7	15.8	8.70	10.5	34.7	0.21	0.64	14.04	0.18	3.18	93.8	99.6	450	0.17	8.15	<LMD	<LMD	<LMD
D.18.10.17	S0096	817	0.590	38.1	57.0	340	67.5	6.76	323	1.01	2.47	28.3	0.68	0.34	0.52	0.02	4.04	0.48	<LMD	<LMD	<LMD	<LMD
D.18.10.18	S0097	69.2	<LMD	24.8	46.9	20.4	10.3	11.7	31.3	0.50	1.23	28.7	0.30	2.36	75.0	98.1	523	0.18	14.2	<LMD	<LMD	<LMD

D.18.10.19	S0098	119 7	1.00	16.0	58.4	360	70.3	8.33	300	0.66	1.14	12.5	0.60	0.26	<LM D	0.02	2.35	0.50	<LM D	<LMD	<LM D	<LM D
D.18.10.20	S0106	98.7	<LM D	7.72	175	157	1528	57.9	121	4.06	6.02	4392 5	37.0	0.47	4.24	0.02	5.29	0.54	5.76	0.18	2.93	<LM D
LMD (ppm)		3.5	0.151	0.14	0.36	0.80	0.49 8	0.66	0.53 6	0.142	0.16	4.9	0.15	0.18	0.22	0.01	1.30		2.93	0.12	0.15	0.15
QCS (Recovery %)		115	105	105	111	98.2	96.8	118	101	100	97.7	101	103	95.0	100	110	96.0	95.8	98.2	101	95.5	103
Error %		9.2	0.841	4.27	3.36	5.57	1.19	3.26	5.01	0.73	0.72	1.08	0.61	0.73	0.65	11.6	1.01	0.67	0.6	0.58	0.54	0.70

LAB CODE	ID	Ag	Ba	Sn	Sb	La	Ce	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Pb	Bi	Th	U
		pp m	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	pp m	ppm	ppm	ppm
D.18.10.01	S0055	464	1.16	15.8	78.0	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	243 6	15.6	<LM D	<LM D
D.18.10.02	S0056	637	1.51	18.2	100	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	239 0	1.20	<LM D	<LM D
D.18.10.03	S0059	105	3.46	6.96	11.1	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	43.1	1.53	<LM D	<LM D
D.18.10.04	S0057	344	2.76	32.6	400	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	16.4	1.21	<LM D	<LM D
D.18.10.05	S0066	71. 2	1.88	28.8	26.7	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	67.5	5.89	<LM D	<LM D
D.18.10.06	S0068	159	2.50	18.5	37.4	<LM D	0.20	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	56.5	2.85	<LM D	<LM D
D.18.10.07	S0071	42. 9	1.36	5.76	148	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	476 6	5.12	<LM D	<LM D
D.18.10.08	S0072	529	0.37	21.8	92.9	<LM D	0.40	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	226 7	6.52	<LM D	<LM D
D.18.10.09	S0073	140	1.53	4.75	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	597	1.80	<LM D	<LM D
D.18.10.10	S0076	513	1.52	4.15	104	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	261 3	16.20	<LM D	<LM D
D.18.10.11	S0078	59. 9	1.63	29.0	49.6	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	159	178	<LM D	<LM D
D.18.10.12	S0079	207	1.44	6.35	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	333	1.11	<LM D	<LM D
D.18.10.13	S0083	329	0.42	31.2	434	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	20.9	1.37	<LM D	<LM D
D.18.10.14	S0084	639	1.21	<LM D	129	0.27	0.41	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	828 7	1.96	<LM D	<LM D
D.18.10.15	S0087	39. 2	0.83	216	306	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	517	58.1	<LM D	<LM D
D.18.10.16	S0094	479	2.44	3.90	100	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LM D	<LMD	<LM D	<LM D	175 1	10.6	<LM D	<LM D

PA26680	Ingot	0.35	ND	99.5	ND	0.05	ND	0.1	ND	ND	0.05	ND
PA26681F	Ingot	ND	0.07	99.9	ND	ND	ND	ND	ND	ND	0.05	ND
PA26682F	Ingot	0.2	0.16	99.7	ND	ND	ND	ND	ND	ND	ND	ND
PA26683F	Ingot	ND	ND	100.0	ND	ND	ND	ND	ND	ND	ND	ND
PA26684F	Ingot	ND	ND	99.3	ND	ND	ND	ND	ND	ND	0.67	ND
PA26685F	Ingot	ND	ND	99.7	ND	ND	ND	ND	ND	ND	0.32	ND
PA26686F	Ingot	0.14	ND	99.0	ND	ND	ND	ND	ND	ND	0.86	ND
PA26687F	Ingot	0.11	ND	99.5	ND	ND	ND	ND	ND	ND	0.37	ND
PA26688F	Ingot	ND	0.07	99.6	ND	0.29	ND	ND	ND	ND	ND	ND
PA26689F	Ingot	0.15	ND	99.7	ND	ND	ND	ND	ND	ND	0.11	ND
PA26690F	Ingot	ND	ND	99.8	ND	ND	ND	ND	ND	ND	0.18	ND
PA26691F	Ingot	0.19	0.22	98.9	ND	ND	ND	0.09	ND	ND	0.64	ND
PA26692F	Ingot	ND	0.13	99.9	ND	ND	ND	ND	ND	ND	ND	ND
PA26693F	Ingot	ND	ND	98.2	ND	ND	ND	ND	ND	ND	1.77	ND
PA26694F	Ingot	ND	ND	99.4	ND	ND	ND	ND	ND	ND	0.17	0.4
PA26695	nail	0.15	ND	99.4	ND	0.13	ND	ND	0.16	ND	0.19	ND
PA26696	Nail	0.11	ND	95.6	ND	ND	ND	3.35	0.25	ND	0.63	ND
PA26697	Hematite	99.81	ND	ND	ND	0.03	ND	ND	ND	ND	ND	ND
PA26698	Ingot	0.07	0.21	99.7	ND	ND	ND	ND	ND	ND	ND	ND
PA26699F	Ingot	ND	ND	97.8	ND	0.15	0.26	ND	ND	ND	ND	1.8
PA26700	Ingot	ND	ND	99.9	ND	ND	ND	ND	ND	ND	0.08	ND
PA26701	Ingot	0.06	ND	99.9	ND	ND	ND	ND	ND	ND	0.05	ND
PA26702	Ingot	ND	0.05	99.9	ND	0.07	ND	ND	ND	ND	ND	ND
PA26703	Ingot	0.18	0.21	99.5	ND	0.06	ND	ND	ND	ND	0.02	ND
PA26704	Ingot	0.06	ND	99.8	ND	ND	ND	ND	ND	ND	0.19	ND
PA26705	Slag	ND	0.08	91.5	ND	0.18	ND	6.81	ND	ND	1.28	0.2
PA26709	Slag	0.62	ND	98.4	ND	0.59	ND	ND	ND	ND	0.39	ND
PA26710	Ingot	ND	ND	99.7	ND	0.1	ND	0.08	ND	ND	0.09	ND
PA26711B	Ingot	0.19	0.08	99.5	ND	0.16	ND	ND	ND	ND	0.09	ND
PA26712	Ingot	0.14	ND	99.7	ND	ND	ND	ND	ND	ND	0.07	ND

PA26713	Ingot	ND	0.26	97.7	ND	1.9	ND	0.15	ND	ND	ND	ND
PA26714F	Ingot	ND	ND	99.7	ND	ND	ND	ND	ND	ND	0.1	0.2
PA26715	Slag	ND	0.09	99.7	ND	0.11	ND	0.08	ND	ND	0.04	ND
PA26717	Ingot	0.06	0.07	99.4	ND	ND	0.41	ND	ND	ND	0.06	ND
PA26718	Ingot	0.08	ND	99.7	ND	ND	ND	ND	ND	ND	0.18	ND
PA26719	Ingot	0.18	ND	99.4	ND	ND	ND	ND	ND	ND	0.37	ND
PA26720B	Slag	ND	ND	99.9	ND	0.08	ND	ND	ND	ND	ND	ND
PA26721	Arrow	0.06	0.1	91.8	ND	ND	ND	7.04	ND	ND	1.05	ND
PA26722	Arrow	0.44	0.05	85.8	ND	ND	ND	13.4	ND	ND	0.3	ND
PA26722DUP.	Arrow	0.11	0.11	92.6	ND	ND	ND	6.39	ND	ND	0.8	ND
PA26723	Spear	0.22	0.07	86.8	0.14	0.92	ND	11.3	ND	ND	0.5	ND
PA26724B	Spear	0.28	0.07	83.6	ND	ND	ND	14.3	ND	ND	1.64	ND
PA26725	Spear	0.1	0.08	89.4	ND	0.13	0.16	9.14	ND	ND	0.84	0.1
PA26726	Base-Spear	0.24	0.11	88.8	ND	0.35	ND	8.84	ND	ND	1.63	ND
PA26727	Base-Spear	ND	0.08	89.7	ND	0.15	ND	9.68	ND	ND	0.36	ND
PA26728	Socked Axe	0.21	0.14	88.9	ND	0.2	ND	9.71	ND	ND	0.88	ND
PA26729	Socked Axe	3.57	ND	85.8	ND	0.15	ND	8.7	ND	ND	1.19	0.6
PA26730	Socked Axe	0.27	0.07	93.2	ND	0.2	ND	6.03	ND	ND	0.2	ND
PA26731	Socked Axe	0.17	0.06	82.4	ND	0.09	ND	16.2	ND	ND	1	0.1
PA26732	Socked Axe	0.63	ND	83.2	ND	0.07	ND	15.9	ND	ND	0.21	ND
PA26733	Hammer	0.35	0.1	93.7	ND	0.14	ND	5.19	ND	ND	0.53	ND
PA26734	Bracelet	0.08	0.12	85.9	ND	0.23	ND	12.3	ND	ND	1.29	ND
PA26735	Bracelet	ND	0.09	89.7	ND	0.2	ND	9.61	ND	ND	0.44	ND
PA26736	Bracelet	0.18	ND	83.3	ND	0.27	ND	15.1	ND	ND	1.15	ND
PA26737	Bracelet	0.24	0.09	87.2	ND	ND	ND	10.7	ND	ND	1.71	ND
PA26738	Bracelet	0.12	ND	85.1	ND	0.37	ND	13.7	ND	ND	0.51	0.2
PA26739	Bracelet	ND	ND	86.6	ND	0.97	ND	12.4	ND	ND	0.05	ND
PA26740	Bracelet	0.22	0.1	88.5	ND	0.15	ND	10.4	ND	ND	0.63	ND

APPENDIX 4

(SNA/GIS Data)²

² Due to the extension of the data used for the maritime connectivity model (SNA / GIS data), the entire data set has been deposited in a cloud that can be accessed through the following link:

<https://www.dropbox.com/sh/pwhsh1tdyfo7xnq/AAAhJMNHtBloX35hMPaTNLkma?dl=0>

APPENDIX 5

(Network Science Glossary)

Source. Collar, A., F. Coward, T. Brughmans and B.J. Mills 2015 Networks in archaeology: phenomena, abstraction, representation. *Journal of Archaeological Method and Theory* 22(1):1–32.

Actor: See node.

Acyclic network: Defined as a directed network with no cycles. For example, the directed network in figure 1b is not acyclic because it includes the cycle 2-3-4-2. Examples of acyclic networks include citation networks and dendrograms.

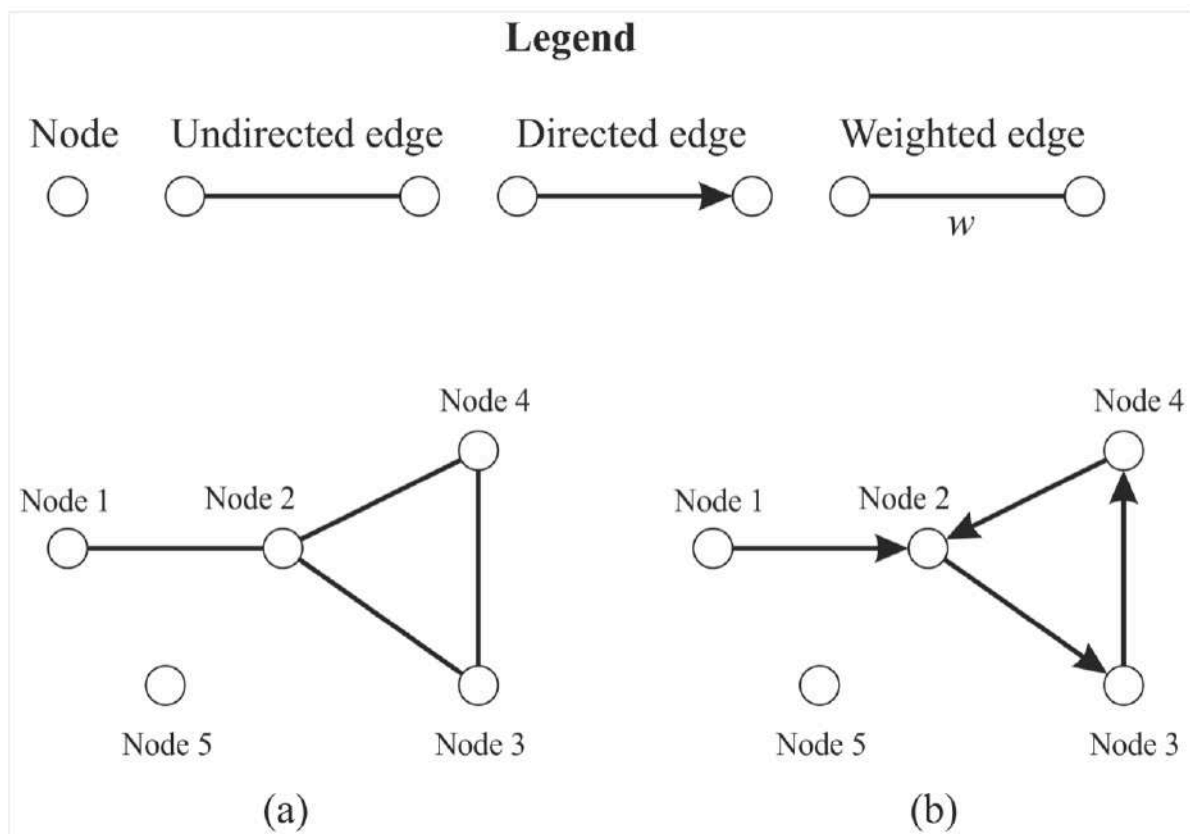


Figure. 1. Example network used in some of the definitions below to clarify network concepts.

Adjacency matrix: Defined as a way of representing a network where there is a row and a column for each node, and the values in the cells indicate whether an edge exists between a pair of nodes.

Affiliation network: See two-mode network.

Arc: See directed edge.

Average degree: See degree.

Average shortest path: See geodesic.

Betweenness centrality: A node's betweenness centrality is defined as the fraction of the number of geodesics passing through this node over the number of geodesics between all pairs of nodes in the network. Nodes with a high betweenness centrality are often considered to be important intermediaries for controlling the flow of resources between other nodes, because they are located on paths between many other node pairs. The concept of brokerage is often mentioned in relation to betweenness centrality. Nodes which are incident to the only edge connecting two subsets of nodes in the network are in a position to broker the relationship between these nodes. These nodes will typically have a high betweenness centrality but not necessarily a high degree or closeness centrality. Betweenness centrality was first quantitatively expressed by Anthonisse (1971) and Freeman (1977).

Bipartite network: See two-mode networks.

Blockmodel: Defined as a partitioning into blocks of structurally equivalent nodes, where the blocks are connected by hypothesised edges.

In blockmodelling the rows and columns of adjacency matrices are arranged so that structurally equivalent nodes are in adjacent positions in the matrix, and the edges between different blocks can be studied. First introduced by White, Boorman, and Breiger (1976).

Brokerage: see betweenness centrality.

Centrality: Defined as a family of measures of the node's position within the network, which represent a ranking of nodes (see betweenness, closeness, degree, and eigenvector centralities). Centrality measures are used to identify the most important or prominent nodes in the network, depending on the different definitions of importance or prominence implemented in the network measure used.

Clique: A clique is a subset of nodes in a network, where every pair of nodes is connected by an edge. In the social sciences only cliques of three nodes or more are usually considered. For example, in figure 1a nodes 2, 3, 4 form a clique of size 3. The definition of a clique is independent of whether it applies to the whole network or not. For example, a network can consist of multiple cliques, or an entire network can be one clique. The latter can also be called a complete network.

Closeness centrality: The closeness centrality of a node is defined as the inverse of the sum of the geodesics of that node to all other nodes divided by the number of nodes in the network. The closeness centrality of a node gives an indication of how close this node is to all other nodes in the network, represented as the number of steps in the network that are necessary on average to reach another node. Nodes with a high closeness centrality score could be considered

important or prominent, since they can share and obtain resources in less steps than other nodes. Early quantitative implementations of closeness centrality are reviewed by Freeman (1979).

Clustering coefficient: Defined as the number of closed triplets over the total number of triplets in a network, where a triplet is a set of three nodes with two (open triplet) or three (closed triplet) undirected edges between them.

The clustering coefficient represents the average probability that two nodes connected to a third node are themselves connected, and it is commonly used for this purpose since the publication of the ‘small-world’ network model (Watts and Strogatz 1998). The clustering coefficient of a network is closely related to the concept of transitivity in the social sciences, which captures the notion that “a friend of a friend is a friend”. Transitivity refers to the tendency of an open triplet to become a closed triplet.

Cohesion: See density.

Complete network: See clique.

Connected component: Defined as a subset of an undirected network in which any pair of nodes can be connected to each other via at least one path, and where there can be no paths to any nodes outside this subset.

For example, in the undirected network in figure 5a there are two connected components: node 5, and nodes 1, 2, 3, 4.

Connection: See edge.

Cycle: Defined as a path in a directed network in which the starting node and ending node are the same. It is also called a closed path.

For example, in figure 1b the path 2-3-4-2 is a cycle. See also acyclic network.

Degree: The degree of a node is defined as the number of edges incident to this node.

The average degree of a network is the sum of the degrees of all nodes in this network divided by the number of nodes. In a directed network, the indegree of a node refers to the number of incoming incident edges of a node. In a directed network, the outdegree of a node refers to the number of outgoing incident edges of a node. For example, node 2 in figure 1a has a degree of 3, whilst in figure 1b the same node can be said to have an indegree of 2 and an outdegree of 1.

Degree centrality: Defined as the centrality of a node based on the number of edges incident to this node. According to the degree centrality measure, a node is important or prominent if it has edges to a high number of other nodes.

Degree distribution: Defined as the probability distribution of all degrees over the whole network.

The measure is commonly used to compare the structure of networks since the publication of the 'scale-free' network structure (Albert & Barabási 2002, p. 49; Barabási & Albert 1999; Newman 2010, p. 243-247). In 'scale-free' networks the degree distribution follows a power-law.

Density: Defined as the fraction of the number of edges that are present to the maximum possible number of edges in the network.

Cohesion is a commonly used concept which is often operationalised using the density measure. For other cohesion measures see Wasserman and Faust (1994, 249-290).

Diameter: Defined as the length of the longest geodesic in the network.

Directed edge: Defined as an ordered pair of nodes, which is often graphically represented as an arrow drawn from a starting node to an end node.

A directed edge is asymmetric. It connects a starting node with an ending node, and cannot be traversed in the other direction. For example, all edges in figure 1b are directed edges.

Directed network: Defined as a set of nodes and a set of directed edges.

A path through a directed network will need to follow the direction of the directed edges. For example, the network in figure 1b is a directed network.

Distance: See path length.

Dyad: Defined as any pair of nodes in a network that may or may not have an edge between them. For undirected edges there are two possible dyadic relationships: connected, or not connected. For directed edges, there are four: unconnected; connected in one direction; connected in the other direction; connected in both directions.

Edge: Defined as a line between a pair of nodes, representing some kind of relationship between them.

Many synonyms exist to refer to an edge, including tie, arc, relationship, link, connection and line. An edge can be directed or undirected, and weighted or unweighted. The concept 'arc' is often used to refer to a directed edge.

Ego-network: Defined as a network consisting of a node (called ego), the nodes it is directly connected to, and the edges between these nodes.

Eigenvector centrality: The eigenvector centrality of a node is defined in terms of the eigenvector centrality of nodes incident on it.

More descriptively, instead of assigning a single centrality score to a node, a node's eigenvector centrality is defined in terms proportional to the nodes incident on it. A node with a high eigenvector centrality is a node that is connected to other nodes with a high eigenvector centrality. See Newman (2010, 169-172) for the procedure to calculate eigenvector centrality.

Embeddedness: A polyvalent concept that comprises two variants. The first is the structural integration of a node or any group of nodes within the network. Different measures for structural integration exist. The E/I index is one example of this, which is calculated as a ratio of the number of edges within a group of nodes (internal) and between groups of nodes (external). The second variant, as popularized in economic theory through the work of Polanyi (1944) and Granovetter (1985), relates to the intertwined nature of social, economic, political, religious, and cultural interactions. See Borck et al. (this issue) and Hess (2004) for overviews of this concept.

Equivalence: See structural equivalence.

Geodesic: Defined as the path between a pair of nodes with the shortest path length.

Sometimes referred to as the shortest path length between a pair of nodes. For example, the geodesic between nodes 1 and 3 in figure 1b is the path 1-3 with a length of 1. The average shortest path length is the average of all geodesics in a network.

Graph: See network.

Heterophily: Defined as a tendency of nodes to become connected to other nodes that are dissimilar under a certain definition of dissimilarity.

For example, in figure 2a a node with an attribute value represented in grey will have a tendency of being connected to a node with a different attribute value represented in white.

Homophily: Defined as a tendency of nodes to become connected to other nodes that are similar under a certain definition of similarity.

For example, in figure 2b a node with an attribute value represented in grey will have a tendency of being connected to a node with the same attribute value.

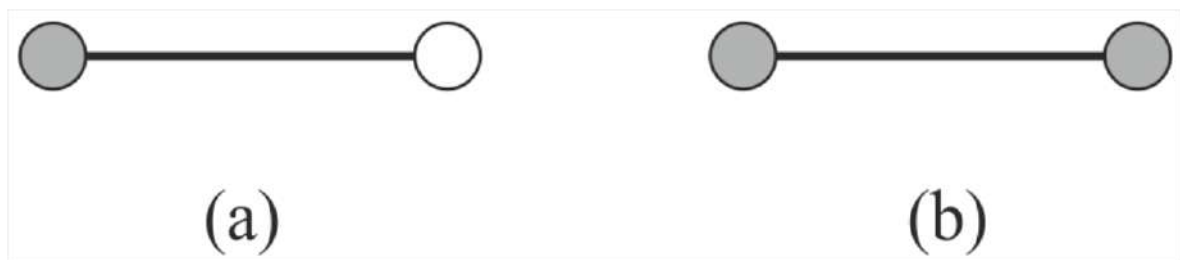


Figure. 2: Nodes with two different attribute values, represented as the white or grey fill of nodes. (a) Heterophily represents a tendency of nodes being connected to other nodes with a different attribute value. (b) Homophily represents a tendency of nodes being connected to other nodes with the same attribute value.

Indegree: See degree.

Isolates: Defined as nodes in a network which have no incident edges.

For example, node 5 in figure 1a is an isolate.

Line: See edge.

Link: See edge.

Network: Defined as a set of nodes and a set of edges.

In mathematics a network is referred to as a graph, whilst in the social sciences networks often consist of social nodes and edges, and are referred to as social networks.

Node: Defined as an atomic discrete entity representing a network concept.

A vertex (plural vertices) is a commonly used synonym to refer to a node. The term actor is sometimes used as a synonym for nodes in the social sciences.

One-mode network: See two-mode network.

Outdegree: See degree.

Path: Defined as a walk between a pair of nodes in which no nodes and edges are repeated.

For example, nodes 1 and 3 in figure 1b are connected by the path 1-2-3.

Path length: Defined as the number of edges in a path.

For example, nodes 1 and 3 in figure 1b are connected by the path 1-2-3, which has a path length of 2.

Power-law: Defined as a mathematical relationship between two entities where the frequency of one entity varies as a power of the second entity. More formally, the probability of a node with degree k is proportional to $k^{-\alpha}$.

Commonly used to describe the degree distribution of networks with a 'scale-free' structure (Barabási & Albert 1999). When a network's degree distribution follows a power-law, it implies that few nodes have a much higher degree than all other nodes in the network and most nodes have a very low degree. Nodes with a very high degree, sometimes referred to as "hubs" in the network, significantly reduce the average shortest path length of the network.

Relationship: See edge.

Shortest path: See geodesic.

‘Small-world’ network: A ‘small-world’ network is defined as a network in which the average shortest path length is almost as small as that of a uniformly random network with the same number of nodes and density, whereas the clustering coefficient is much higher than in a uniformly random network (a uniformly random network is defined as a network in which each edge exists with a fixed probability p). The ‘small-world’ network structure as described here was first published by Watts and Strogatz (1998). This structure illustrates that relatively few edges between clusters of nodes are needed to significantly reduce the average shortest path length. It implies that resources can flow between any pairs of nodes in the network relatively efficiently, whilst maintaining a high degree of clustering.

Social network: See network.

Strongly connected component: Defined as a connected component in a directed network.

In a directed network a connected component is always either strongly or weakly connected. For example, in figure 1b node 5 is a connected component, whilst the set of nodes 1, 2, 3, and 4 are not because node 1 cannot be reached by a path from the other nodes.

Strong tie: A number of theoretical network models used in the social sciences rely on a distinction between strong and weak ties (particularly those drawing on Granovetter 1973). The distinctions between the two, however, are rarely formally defined. In general, strong ties are used to describe frequently activated relationships (such as family/kin ties) whereas weak ties are used to describe infrequently accessed connections (acquaintances). Strong ties tend to be among actors with similar sets of overlapping relationships whereas weak ties more often connect sets of actors who would otherwise be unconnected. In weighted networks, thresholds on the distribution of weights across a network as a whole are often used to define strong vs. weak ties though there are no consistent rules used for this distinction.

Structural equivalence: Defined as, two nodes are structurally equivalent if they have identical edges to and from all other nodes in the network (see Lorrain and White 1971).

Structural equivalence is used to identify nodes which have the same position in a network. It can be used to inform blockmodelling. In the social sciences, the structural similarities identified through structural equivalence are used to study social positions and social roles.

Tie: see edge.

Transitivity: see clustering coefficient.

Two-mode network: Defined as a network in which two sets of nodes are defined as modes. In a two-mode network, nodes of one mode can only be connected to nodes of another node.

Two-mode networks are sometimes referred to as bipartite networks. The definition of modes depends on the research context. In the social sciences two-mode networks are often used as a representation of affiliation networks, where one mode represents individuals and the other mode represents institutions or other concepts these individuals are affiliated with (given the definition of affiliation within the research context). For example, individuals may be affiliated to political parties, or be members on different boards of directors. The most common example of the use of two-mode networks in archaeology is to represent sites as one mode and the artefact types found on sites as a second mode. Two-mode networks can be transformed into two different one-mode networks by focusing on either one of the two modes. In a one-mode network, only the nodes of one of the two modes is included, and pairs of nodes are connected by an edge if both have a connection to at least one node of the other mode in the two-mode network. For example, the two-mode network in figure 3a (where two different modes are represented as nodes with a different colour) can be transformed into a one-mode network of only grey nodes (Fig. 3b) or a one-mode network of only white nodes (Fig. 3c).

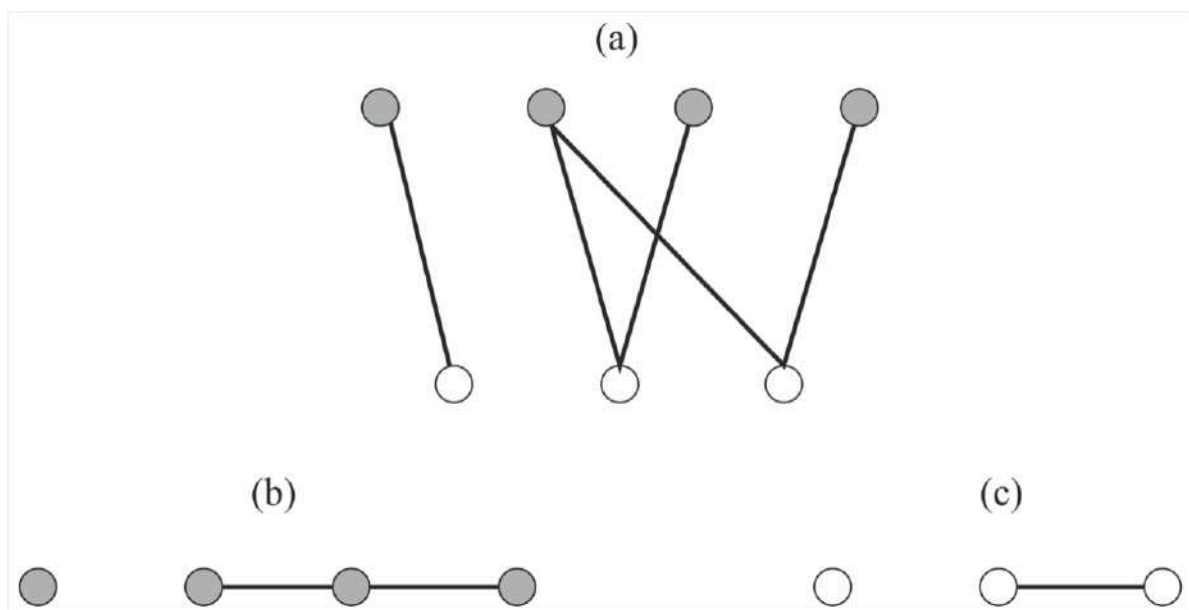


Figure. 3: (a) Representation of a two-mode network, where nodes belonging to different modes are represented with a white or grey fill. (b) One-mode representation of the grey mode in the two-mode network of (a). (c) one-mode representation of the white mode in the two-mode network of (a).

Undirected edge: Defined as an unordered pair of nodes, which is often graphically represented as a line drawn between the pair of nodes. An undirected edge is symmetric. Typically just called an edge. For example, all edges in figure 1a are undirected edges.

Undirected network: a set of nodes and a set of undirected edges. An undirected network is symmetric. For example, the network in figure 1a is an undirected network.

Unweighted edge: Defined as an edge which is not weighted. Typically just called an edge. See also weighted edge.

Unweighted network: Defined as a set of nodes and a set of unweighted edges.

Valued network: See weighted network.

Vertex: See node.

Walk: A walk between a pair of nodes is defined as any sequence of nodes connected through edges which has that pair of nodes as endpoints.

In contrast to a path, nodes and edges can be repeated in a walk. For example, in figure 1b a walk between nodes 2 and 3 could be 2-3-4-2-3.

Weakly connected component: Defined as a connected component in a directed network where the directionality of edges is ignored.

In a directed network a connected component is always either strongly or weakly connected. For example, in figure 1b there are two weakly connected components: node 5, and nodes 1, 2, 3, 4.

Weak tie: See strong tie.

Weighted edge: Defined as an edge with a value associated to it.

These values are often real numbers but they can also be any concept connecting the end nodes of the edge. The definition of an edge weight depends on the research context. Weights could be represented as an attribute of an edge. Thresholding can be applied to select a subset of edges with a given edge weight.

Weighted network: Defined as a set of nodes and a set of weighted edges.

APPENDIX 6

(Approval and Permits)



Michel L'Hour
Conservateur général du Patrimoine
Directeur du D.R.A.S.S.M.

à

Monsieur Enrique Aragon Nunez
Department of Archaeology
Flinders University
Sturt Road, Bedford Park, South Australia, 504
GPO Box 2100 Adelaide SA 5001

Marseille, le 27 avril 2017

Direction
générale
des Patrimoines

Département
des Recherches
Archéologiques
Subaquatiques et
Sous-Marines

Affaire suivie par
Marie-Pierre Jézégou
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2016 – M.P./J.

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OBJET : votre demande de prélèvement d'échantillons sur le mobilier métallique de l'épave des bronzes de Rochelongue (*Rochelongue 1*)

Monsieur,

Conformément à la convention de dépôt des collections du site *Rochelongue 1* auprès du Musée de l'Éphèbe au Cap d'Agde, établie le 21 décembre 2015, et suite à l'accord donné par le Conservateur de cet établissement le 28 mars 2017, je vous autorise à faire procéder, par le laboratoire Moïra Conservation, au prélèvement de 94 échantillons sur l'ensemble de la collection à savoir 800 kg de cuivre en lingots et 1700 objets manufacturés. Ces prélèvements seront réalisés selon le protocole ci-joint qui détermine la méthodologie et l'inventaire des objets échantillonnés.

Une fois l'étude achevée et publiée, le DRASSM sera destinataire des résultats de ces analyses, d'un exemplaire de la thèse de PHD que vous réalisez à l'Université de Flinders et de la publication éventuelle de cette thèse.

En vous souhaitant un vif succès dans ces recherches, je vous prie de croire à l'assurance de mes sentiments distingués.

Le Directeur du Département des Recherches
Archéologiques Subaquatiques et Sous-marines



Michel L' HOUR

CONVENIO DE COTUTELA DE TESIS

Convenio de cotutela de tesis entre:

The University of Flinders
Sturt Road, Bedford Park, 5042 South Australia (Australia)
(en adelante referida como "Flinders").
Representada por el Vicerrector de Investigación, D. Robert Saint.

y

La Universidad de Cádiz
C/Ancha, 16, 11002 Cádiz, España
(en adelante referida como "Universidad de Cádiz")
Representada por el Vicerrector de Planificación, D. Miguel Ángel Pendón Meléndez

FLINDERS

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Persona de contacto	Emily Davis 08 8201 2130 emily.davis@flinders.edu.au		

UNIVERSIDAD DE CADIZ

Nombre	Universidad de Cádiz		
Dirección Postal	Vicerrectorado de Planificación Hospital Real	Cód. postal	11002
Persona de Contacto	Águeda Gutiérrez Egea +34 956 015 284 secretariado.doctorado@uca.es		

DOCTORANDO

Nombre Enrique Aragón Núñez

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Fecha de inicio 30 de julio de 2016

Periodo de duración 3 años

Título de la tesis *Conexiones Marítimas y repercusiones culturales en el Oeste de Languedoc, Francia (Siglos 8-6 a.c).*

1. CONSIDERACIONES GENERALES

La Cotutela de tesis es una modalidad de realización de la tesis doctoral en la que dos universidades o instituciones de educación superior, en este caso, la Universidad de Flinders y la Universidad de Cádiz, en virtud de un convenio específico firmado al efecto, se comprometen a supervisar el desarrollo de una tesis doctoral, mediante la dirección conjunta de la misma por un profesor de cada una de las dos universidades, así como a reconocer la validez de la tesis defendida y a expedir el correspondiente título de doctor.

Las partes acuerdan colaborar en el desarrollo completo de la tesis en cotutela en los términos y condiciones que se recogen en el presente convenio.

En nombre de la Universidad de Flinders:

En nombre de la Universidad de Cádiz:

Firmado:

D. Robert Saint
Vicerrector de Investigación

Firmado:

D. Miguel Ángel Pendón Meléndez

La directora de tesis en la Universidad de Flinders:

El director de tesis de la Universidad de Cádiz

Firmado:

D^a. Wendy Van Duivenvoorde

Firmado:

D. Lázaro Lagóstena Barrios

El doctorando

Firmado:

D. Enrique Aragón Núñez

2. VALIDEZ

Este documento comenzará a tener validez en la fecha de inicio consignada en el mismo y tendrá validez por el plazo convenido, a menos que sea rescindido por acuerdo de las partes.

3. ASPECTOS ADMINISTRATIVOS

1. El doctorando se inscribirá en las dos universidades participantes en la cotutela, abonando los derechos de matrícula en la Universidad de Flinders y siendo exonerado del pago de los mismos en la Universidad de Cádiz.
2. Esta doble matrícula será renovada anualmente durante el tiempo de desarrollo de la tesis, que será de tres años. Podrá concederse una prórroga de ese plazo de acuerdo con las legislaciones vigentes en las universidades firmantes del presente acuerdo, mediante la firma de una cláusula adicional al convenio.
3. El doctorando debe estar inscrito en la Universidad de Cádiz por el periodo de duración de los estudios de doctorado a tiempo completo, debiendo completar un mínimo de 6 meses de investigación, incluyendo la propuesta de tesis con aprobación de la Universidad de Flinders, antes de serle otorgado el permiso para iniciar cualquier investigación en la Universidad de Cádiz.
4. Si el doctorando decide abandonar la cotutela, deberá contar para ello con la autorización de ambas universidades, y podrá continuar con el desarrollo de su tesis en la modalidad normal.

4. PREPARACIÓN DE LA TESIS

1. El tiempo de desarrollo de la tesis estará repartido entre la Universidad de Cádiz y la Universidad de Flinders, con un mínimo de 12 meses de estancia en cada institución. Los últimos 12 meses del estarán dedicados a la redacción de la tesis en la Universidad de Flinders.
2. La duración de los periodos de estancia del doctorando en cada una de las Universidades está prevista como sigue:

Universidad de Cádiz: Desde 1 septiembre 2016 a 1 septiembre 2017

Flinders: Desde 1 septiembre 2017 a 23 febrero 2019.

Cualquier modificación de esos periodos se realizará sólo por motivos excepcionales y por acuerdo de ambas universidades, en el plazo de los doce meses siguientes a la firma del convenio.

5. SEGUROS, ALOJAMIENTO Y MANUTENCIÓN

1. Con carácter previo a su inscripción, el doctorando acreditará ante la Universidad de Flinders que durante todo el tiempo de su estancia, dispondrá de:
 - (a) Cobertura médica y sanitaria.
 - (b) Seguro de responsabilidad civil.
 - (c) Seguro de viaje.

- (d) Suficiencia financiera, que podrá demostrarse mediante acreditación de subvención, empleo y/ o compromiso de una tercera persona para el mantenimiento económico del doctorando.
- (e) Acreditación académica y prueba de nivel de inglés.

6. REGISTRO DE LA TESIS

El doctorando ha sido autorizado a matricularse en el doctorado en la Universidad de Cádiz y en Flinders mediante la acreditación de la realización de los siguientes estudios:

- Licenciatura en Historia
- Master o equivalente

7. SUPERVISIÓN DE LA TESIS

La dirección de la tesis estará a cargo

En la Universidad de Cádiz, de:

Dr. D. Lázaro Gabriel Lagóstena Barrios
Profesor Titular de Universidad

En Flinders, de:

Dra. D.^a Wendy Van Duivenvoorde
Senior Lecturer Marine Archaeology

Ambos doctores se comprometen a ejercer, de forma plena y conjunta, la dirección de la tesis y a asumir las responsabilidades que de ello derivan

8. DEFENSA DE TESIS

La tesis, que será reconocida por la Universidad de Flinders y la Universidad de Cádiz, será presentada y defendida en La Universidad de Flinders.

La tesis será redactada y defendida en inglés, y se completará con un resumen oral y escrito en español.

El tribunal de tesis será propuesto, al menos, dos meses antes de la fecha prevista para la defensa. Estará compuesto por representantes de la Universidad de Flinders y de la Universidad de Cádiz en idéntica proporción, e incluirá a un mínimo de dos miembros ajenos a esas instituciones. Se contempla la posibilidad de la participación por videoconferencia, en caso de imposibilidad de comparecencia de alguno de los miembros.

La financiación de los gastos en que incurran los doctores que formen parte del tribunal será compartido por las dos Universidades.

9. EXPEDICIÓN DEL TÍTULO

1. Aprobada la tesis, ambas universidades se comprometen a expedir los correspondientes títulos de Doctor, de conformidad con la legislación aplicable en cada país.
2. Las condiciones del depósito de ejemplares, régimen de los derechos de autor y la eventual reproducción de las tesis en el ámbito universitario serán las establecidas por la legislación vigente en cada país. La firma de este documento por las partes implica necesariamente el compromiso de respetar esa eventual publicación y difusión de los trabajos de investigación.
3. El título de Doctor que se expida en cada caso recogerá la información que señale que la tesis ha sido desarrollada en régimen de cotutela.