Castaways

New Insights from the Metal Detected Brooches of Early Medieval Frisia

Marcus A Roxburgh

Title page and chapter illustrations are adaptations of images from the Julius work calendar now in the British Library, drawn by Marcus A Roxburgh.

All illustrations of brooches in this thesis are drawn by Marcus A Roxburgh.

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1. Introduction

Many hundreds of brooches from the early medieval period have been recovered by metal detector enthusiasts since the hobby became popular in the 1970's. Although much of this material remains in private hands, some of it has become available for study, either through purchase by the state, or by gracious individual loan.

Brooches from Frisia were chosen for this study for several reasons. Firstly and quite crucially was the availability of suitable collections for handheld XRF (hhXRF) analysis. Secondly the region has a particularly interesting early medieval past, especially in terms of its relationship to the North Sea economy and the Carolingian hinterlands, the results could therefore be compared against current historical and archaeological theoretical frameworks. Very little is known about the organisation of metalworking in the region at this time, a large scale compositional and morphological study could contribute to our understanding of trade, production and the subsequent use of these very personal items, subsequently providing a positive contribution to these debates. Typological studies of brooches also date back well into the 19th century and thanks to the dedication of the late Jurjen Bos, the typologies for two of the most numerous and important categories, the Equal-Arm and the Disc brooches were recently brought up to date (see Bos 2006b, 2006c), providing a solid starting point for my research. Finally, if successful, any results that were of merit could form the basis for future comparisons to other regions, further engaging with debate over the early development of Northwest Europe.

Although compositional studies have been routinely undertaken on many forms of copper alloy artefacts, using robust laboratory based protocols there has never been an opportunity to study such a large group of brooches from the early medieval period and especially not for those found in the early medieval region described today as Greater Frisia. This I would suggest has been primarily due to the not insignificant cost of transporting, sampling and analysing the results under laboratory conditions. That is assuming that the curators of such collections would have been willing to submit their artefacts to an unavoidably destructive sampling regime.

My research undertook the bulk analysis of over 600 copper alloy brooches by hhXRF and onsite morphological analysis at repositories in the north of Holland. Although hhXRF is still finding approval within the archaeological community the use was deemed justified as its non destructive nature combined with the fact that the brooch collections did not have to be moved from their normal repositories, made the project both cost effective and acceptable to their owners. Whilst this access was granted the opportunity to inspect and make an up to date record of the brooches morphologies was not to be missed.

This approach could be open to criticism for lacking laboratory based methodologies. In working outside this paradigm the potential to identify new avenues of research was deemed however to be worth the risk. Whilst the main aim was to find out more about the artefacts themselves the secondary and quite crucial questions about the techniques would have to be asked. For a range of early medieval brooches could these two relatively unproven techniques (hhXRF and detailed morphological analysis) be successfully deployed in this way?

The view that was subsequently taken was that this would be a reconnaissance, a first step in understanding if hhXRF could be of qualitative use in a large scale analysis of the metal (bulk) elements within the brooches. Morphological analysis, a technique initially developed for the study of prehistoric items such as flints and bone tools could also yield further information if the data was gathered within that context rather than from a typological one.

1.1 History of research

1.1.1 The development of medieval archaeology

Interest in what is today called medieval archaeology can be traced back many centuries, however the catalyst that boosted our modern preoccupations with trade, exchange and urbanisation can be credited to Henri Pirenne's acclaimed, but unfinished thesis, Charlemagne and Mohammed (Pirenne 2001, [1937]), in which he stated that long distance trade routes stayed in existence after the collapse of the Roman world and subsequently led to the revival of medieval urbanism (Hodges 2012, 3). Research into this period was mainly concerned with the social and economic factors that contributed to the rise of Western Europe after the end of the classical period (Brown 1974, 21).

This model was subsequently challenged in the 1960's by Georges Duby, who proposed an agrarian model for this medieval urban revival (1968, 1974). This model split academic opinions espousing the need to research the medieval rural society rather than just focusing on trade (Hodges 2012, 1). The debate then swiftly led to a new model proposed by Joseph Callmer (2007) suggesting the diverse roles of traders and craftsmen acted as economic facilitators to commerce and the revival of an urban society (Hodges 2012, 2).

Karl Polyani (1957) had already suggested that modern concepts of economic exchange were inappropriate for interpreting the role it played within past tribal societies (Hodges 2012, VIII). The concept of an economy influenced by exchanges in a religious or imaginary world was absent from these earlier more secular models (Theuws 2004, 121). A new model that in particular engaged with exchanges between the Christian and non Christian world was deemed necessary. For example, sceattas with non Christian motifs could have served as an interface between the Frankish economy (with explicitly Christian coinage) and the pagan north (Theuws 2004, 134).

The debate over how the early medieval economy developed was also divided between historical and archaeological points of view, with accusations being proposed that archaeology only contributed a minor role as an 'appendage' to historical research (Hodges 1982, 11). Too much emphasis was believed to have been put on embellishing historical 'facts' in the research designs of archaeological excavations.

Another criticism proposed by Frans Theuws (forthcoming) is that archaeological research into the daily lives of the people (the households of peasants for example), was overshadowed by an undue preoccupation with social elites (such as royal estates and monasteries). 'Centres of power' for example and their role in the social and economic structure of the early medieval period could be related (albeit on a sliding scale) equally to a farmstead as to a major urban centre (Theuws 2001, 158).

In light of these arguments the emphasis for the study of medieval archaeology has swung more towards understanding the roles of agency and human engagement with the material world (Hodges 2012, VII) and allows us to study the material culture through a framework beyond that espoused within the 'New archaeology' of previous decades; a framework that could be more suitable for the study of early medieval brooches.

The study of these brooches contributes to these debates by examining aspects of craft production, trade, workshop organisation and the subsequent relationships between the brooches and the people who wore them. This study also engages with everyday items of the ordinary people rather than those of the social elite.

1.1.2 The archaeology of early medieval Frisia

It is generally agreed that conditions for human habitation in the intertidal areas of what is now The Netherlands became favourable again during the pre Roman Iron Age. Many new farmsteads and settlements were established in Friesland, Groningen and as far south as the Maas and Rhine delta. But after a few hundred

years these conditions deteriorated once again due to a number of climatic factors including a new post Roman (Dunkirk II) transgression in the late third century. This changing landscape and water regime caused the gradual abandonment of many settlements, with the remaining peoples reverting to living on the raised dwelling mounds (terpen) that were to become a major feature of Dutch medieval archaeology. This terp dwelling defined the settlement pattern of the peoples living in these coastal regions until the dike building of the eleventh century which made it possible to occupy the region without resorting to living on raised earth mounds (TeBrake 1978, 8). After falling into disuse for many centuries these terps became the subject of intensive levelling during the 19th and 20th centuries (as their soil was used to enrich poorer land) until the historical damage was recognised with the remainder finally coming under the protection of the Ancient Monuments Act (Bos 2006a, 447).

The common themes surrounding the archaeology of early medieval Frisia are one of trade, mobility and migration (e.g. Jons 2009; Quast 2009; Galestin 2010). From the Roman period onwards many artefacts have been found in these coastal settlements that are evidence of long distance trade and contact with the wider world (Galestin 2010, 64). This abundance of exchange material in coastal areas around the North Sea has led to the suggestion that there were stronger cultural ties between these maritime groups than with the elite of the hinterlands (Loveluck and Tyr 2006, 162) and that this affinity to maritime travel lent itself to both trade and piracy.

By the 6th century AD Frisia had developed a key role in the politics and economics of Northwest Europe, as evidenced by the wealth of finds from this period (Heidinga 1999, 1). One of the challenges to Pirenne's trade model (see 1.1.1) was that the growth of the European economy was facilitated by the craftsmen and traders (such as the 'famed Frisians') of the time, who could be seen as the agents of economic change (Loveluck and Tys 2006, 162). Hodges (2012 VIII) goes further and makes comparisons to Bronislav Malinowksi's Argonauts of the Western Pacific (1922) regarding the determination of Frisian merchants to trade within the North Sea coastal areas and along the river Rhine.

New urban centres began to appear throughout Western Europe from the 7th century onwards. Emporia as they are now called have been located by archaeologists along much of the North Sea coastal areas stretching from Scandinavia, down as far as the westernmost English and continental coastlines (Callmer 2002, 125). These emporia have been the subject of much debate by archaeologists (e.g. Pestell & Ulmschneider 2003; Skre 2008; Hodges 2004), and have traditionally been studied through the trade model, as places of economic exchange, that were different to other types of settlement, the proceeds of which were controlled by the regional elite (Hodges 2012,IX). As early as the 1960's the debate had broadened to include 'central place theory' (Christaller 1966 [1933]), which was quickly adopted in medieval archaeology as a way of defining a wider network of settlements that had produced evidence of trade and craft working (Sindbæk 2009, 98). The trade and economic model underlying the definition of these central places was subsequently challenged and broadened to include concepts such as cosmological and religious exchange economies (e.g. Hedeager 2002; Theuws 2004).

The early medieval sites in Holland that fall within this central place definition include the important archaeological excavations at Dorestad, Domburg, Medemblik and Wijnaldum. For the purpose of this thesis however the two excavations that are both regionally and archaeologically important in this project are those at Wijnaldum and Medemblik. The interested reader however can be directed to several publications by W.A.van Es, (e.g. 1980, 2009) and T. Capelle (1976) respectively for the excavations at Dorestad and Domburg.

The emporia at Medemblik was excavated in the late 1960's under the directorship of J.C. Besteman, on behalf of the State Service for Archaeological Investigations and in conjunction with the Institute for Pre- and Protohistory (Besteman 1974, 43). The report proposes that the range of imported pottery and glass found at the site, confirmed its role as a centre for regional government and trade, linking Friesland with Scandinavia and through Dorestad to the European hinterland (Besteman 1974, 98). Unfortunately though, the report mentions no metal items and after making enquiries this proved to be the case. A suggestion for why no

metal work was found could be that the excavation was undertaken before the use of metal detectors in archaeological projects.

In contrast to Medemblik, the excavation at Wijnaldum was primarily undertaken because of a noticeable increase in the number of metal detector finds that were being recovered each year. The reason was attributed to ploughing which was increasingly eroding the archaeological layers. The opportunity also presented itself to further explore the notion that Tjitsma (a terp at Wijnaldum) had been an important central place, proposed by the discovery of a very large garnet inlayed, gold, Disc-On-Bow brooch in the 1950's (Tulp 2003, 221). The increase in metal detector finds was brought to the attention of the archaeological community by Jan Zijlstra, and Jurjen Bos, who subsequently recognised that although the terp was protected under the Ancient Monuments Act, the archaeology was being damaged by modern farming methods (Besteman et Al. 1999, VII).

The excavations revealed much valuable information including evidence of copper-alloy working including many objects associated with a smithy area. The conclusions drawn were that like Medemblik, Wijnaldum was involved in wide trade networks, however defining its regional importance was problematic as the Tjitsma terp was only partly excavated and was one of seven that make up the Wijnaldum group. With large numbers of metal detected items being recovered regionally, it is hard to put it into context (Tulp 2003, 231) as there could have been many similar terp sites. Archaeological studies of copper alloy based craft production and subsequently workshop organisation is therefore problematic because of this lack of knowledge.

1.1.3 The study of brooches

Ancient brooches are a common type of metal artefact, which provided the basis for typological studies and classification long before metal detector enthusiasts recovered them in the large quantities of recent years. For brooches belonging to the early medieval period a wealth of scientific research and publication can be traced back to the 18th century *(*Åberg 1926, III). For the early Germanic

typologies including Cruciform, Radiate and Square-Headed brooches the interested reader can refer to the publications by E.T. Leeds (1913, 1936 and 1970), E.Salin (1957) and Reichstein (1975). For the later periods including the Domburg, Equal-Arm and Disc brooches the following authors have also provided useful studies, Capelle (1976), Hübener (1972) and Frick (1992).

There are two further authors whose typologies presented the most useful references for the brooches in this project, Åberg (1926) for the early period, in particular his typology of Cruciform brooches found around the North Sea, and Bos, (2006b, 2006c) for the Equal-Arm and later Disc types. The Bos typologies are referred to extensively in this thesis as they represent the most recent assessment of finds from Frisia and also presented a robust way of cataloguing the hundreds of finds in the hhXRF analysis.

The literature presented up to now generally represents the publication of carefully researched catalogues, with particular attention being paid to creating chronological and morphological divisions. Studies undertaken beyond that include several large projects that analysed the composition of Bronze Age alloys, more of which will be explained in the next section. Recent research programmes using XRF on Roman copper alloys (including brooches) have produced dividends. The XRF analysis of 27 samples from a group of Roman brooches found in Romania by Ghisa et al. (2008) demonstrated the technique's ability to identify the bulk elements within the brooches and so aid their classification into types. A more recent project (Caspers 2010) analysed a 3rd century hoard of 1400 scrap copper alloy pieces with hhXRF and successfully matched fragments of cauldrons into typological groups, but unfortunately could not determine much about the level of recycled material present.

1.1.4 Metal detecting and 'Productive sites'

Metal detecting as we know it now has its origins in the mine detection technology developed during the Second World War, but it wasn't until the 1960's

that the equipment became commercially available and a new hobby quickly started thereafter (Addyman 2009, 52).

This hobby soon created friction between the archaeologists and the metal detector community, producing many conflicting claims such as those held by some archaeologists that detectorists are only interested in the cash that recovered items bring (showing little concern for the damage to historical sites), versus the detectorists view of archaeologists claiming to be the guardians of the public's heritage, on one hand (Redesdale 2008, IX), whilst being strongly associated with Indiana Jones and Lara Croft treasure hunting movies on the other. Over the subsequent decades the tensions between the two groups have remained high, with frequent criticisms of those who have attempted to work between the two sides (Thomas and Stone 2009, 1). But there has been some notable success when both groups have worked together. The field of numismatics for example has been transformed with a huge increase in the numbers of coins found from the early medieval period (Spencer 2009, 128). Metal detector enthusiasts have also been responsible for locating important archaeological sites. The identification of the Tjitsma terp at Wijnaldum and its subsequent excavation was made possible through a realisation of the importance of the metal detector finds being recovered there (Bos 2006, 447).

A similar example of this successful relationship can be seen in the identification of thousands of archaeological sites in England since the advent of the Portable Antiquities Scheme, a voluntary registration scheme for metal detector finds with an online catalogue of over 500,000 artefacts (www.finds.org.uk), all of which were initially relocated through the efforts of metal detectorists (Richards and Naylor 2010, 193). But this large number of new sites poses a problem in that very few sites have been excavated and therefore are difficult to interpret.

These 'productive sites' as they became known have been much debated (e.g. Pestell and Ulmschneider 2003; Richards 1999), with common proposals linking them to the main debates concerning markets, trade and central places. The near proximity of 'productive sites' to monasteries from the early Middle Ages has also been suggested as less than coincidental (Pestell 2003, 122).

The metal detector finds from Wijnaldum and Oud Naarden qualify them both as 'productive sites' in terms of the density of objects found, whereas Medemblik does not. This should serve as a warning that the overuse use of this classification without reference to other archaeological factors is problematic and should be avoided. I agree with Julian Richards therefore that it reflects a method of finds recovery more than evidence of actual historical events (Richards 2003, 155).

1.1.5 The development of compositional analysis and hhXRF

Copper is the most abundant element in this study and is suggested to be the earliest non-precious metal used by man in the production of small decorative items. It is also very malleable being able to be beaten and drawn into wire and flat sheets without cracking, making it very appealing to ancient craftsmen. However these ancient metals contain certain levels of impurities which can be intrinsic or deliberately introduced in the creation of alloys (Henderson 2000, 210).

The compositional analysis of these copper alloys has its beginnings in the late 18th century, with ‘great scientists’ such as Faraday, Davy and Klaproth developing the field of analytical chemistry and for the first time exploring the composition of copper alloy (a group of Greek and Roman coins), glass and pigments from ancient Rome and Pompeii (Pollard et al. 2007, 6). By the mid 19th Century scientific enquiry had moved on to explore the provenance and dating of archaeological material through the works of academics such as Wocel and Göbel. The first collaboration between archaeologists and chemists started at this time, for example the chemical analysis of Assyrian bronzes and Mycenaean amber beads being reported in the publications of Heinrich Schliemann’s ‘Mycenae’1878 and Austen H. Layard’s ‘Discoveries in the ruins of Nineveh and Babylon’ 1858 (Pollard and Heron 1996, 6).

Instrumental measurement techniques only became available in the early part of the 20th century of which optical emission spectrometry (OES) was the most common in archaeological applications. Large programs of metal analysis were

undertaken in Britain and Germany on Bronze Age artefacts with the aim of understanding the technology behind ancient bronze metalworking (Pollard et al. 2007, 8). However like most of these large projects of the time the technique fell into obsolescence around the 1970's superseded in the main by Neutron Activation Analysis (NAA) and then Atomic Absorption Spectroscopy (AAS). Unfortunately the large amount of 'legacy' data that these techniques generated proved incompatible with each other. Then in turn, towards the end of the 1980s and the 1990s AAS was replaced initially by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP- AES) and then Inductively Coupled Plasma Mass Spectroscopy ICP-MS (Pollard et al. 2007, 64-67) but unlike previous techniques a common data bank of at least the major elements could be created.

After the Second World War other chemical analysis techniques were developed including ones using X-Ray analysis. The most popular of these techniques since then has been X-Ray fluorescence (XRF) which started as a laboratory based technique that fires X-Rays at an atom which causes the ejection of an electron. The energy created from this strike can be measured and identified on an elemental basis and although not as sensitive as AES or X-Ray Photoelectron Spectroscopy (Pollard and Heron 1996, 44) is commonly used to investigate amongst others the bulk chemistry of metal alloys, ceramics, rocks, sediments, glass and pigments. Unlike the previously mentioned techniques a major benefit is that it can be non destructive. I.E. as long as the metal object could fit in front of the primary beam a sample would not have to be cut or drilled off the artefact. In these cases it is essentially a surface measurement technique with a penetration depth dependant on the surface condition of the object e.g. level of external corrosion and uneven surfaces (Frahm 2013, 1080).

In this technique the X-Rays are produced in X-Ray tubes which size wise facilitated the possibility of portable machines. The first uses of portable (as opposed to handheld) machines (pXRF) dates back to the 1960's in the mining industry (e.g. Bowie 1968; Bowie et al. 1965) and early archaeological uses have included archaeometalurgical reconnaissance projects in the Middle East. The term portable really describes the ability to disassemble a laboratory machine

(labXRF) to transport in a vehicle and then reassemble at the site of use. These portable ‘benchtop systems’ were intended for use at museums where they have been successfully used in artefact conservation, authentication and art history studies. These pXRF systems have also been used on archaeological excavations typically being stationed in the onsite finds cabin (Frahm and Doonan 2013, 1426).

With increasing miniaturisation over the last 20 years the development of hhXRF led for the first time to a ‘point and shoot’ technique that was free from laboratory constraints. By comparison to labXRF this new generation of apparatus sacrifices performance principally in lower wattage levels of the X-Ray tube. However these hhXRF analysers weighing only around 2kg can easily be brought and deployed as a reconnaissance tool on an archaeological site, identifying activity areas through chemical traces for example (Frahm 2013b, 1447).

There is however quite some debate over the use of hhXRF within the archaeological community. Frahm and Doonan describe it as a technological revolution enabling the analysis of archaeological materials in the field (2013, 1425). Opponents of the technique propose issues of validity and reliability in the use of internal fundamental calibration software and an overall lack of scientific rigour in application (Speakman and Shackley 2013). Proponents of the technique counter with suggestions that established laboratory based community is struggling with Kuhnian paradigms in trying to force this new apparatus to conform to decades of lab based protocol and that as Shackley puts it they are ‘not necessarily prepared for it intellectually’ (2010, 17). What is needed according to Frahm and Doonan (2013, 1425) is the development of new methodological and theoretical frameworks to take advantage of this opportunity.

1.2 *Theoretical orientation*

1.2.1 Philosophy

The idea of a biographical approach to the interpretation of artefacts rose to prominence in the mid 1980's with Kopytoff's proposal that artefact studies could be treated in a similar way to that of humans in terms of exploring their cultural past (Kopytoff 1986). This cultural biographical approach gained popularity over the following decades as artefact studies turned increasingly towards an anthropological orientation towards the study of material culture and the technologies behind it (Van Gijn 2012, 275). Lemonnier (1986), in particular, expressed a view that the choices past people made in reacting to the wide range of technological options that were available to them, were influenced by the socio-cultural system in which they lived. This advancement in thinking, I believe, allows those engaged with artefact studies to move beyond the typical relationships between form and function as espoused by the processual approaches developed in the 'New Archaeology' of the 1970's. I agree with Van Gijn (2012, 279) that a biographical approach can significantly contribute to our understanding of many categories of material culture, including those of the early medieval period such as the Merovingian and Carolingian period brooches which are the subject of this thesis. The argument for these changes was set out by Wylie (1989) in her critique of Lewis Binford's processualist approaches (e.g. Binford and Binford 1968; Binford and Sabloff 1982). She employed Kuhnian theory to suggest that scientific progress, as an accumulation of previously accepted facts and theories, failed to allow for new avenues of innovation (Wylie 1989, 97). Wylie then went on to challenge the epistemic limits of Binford’s approach, by suggesting that his anti ethnographical stance (in favour of socio-cultural systems) rejected the potential for the archaeological record to accommodate new variables (e.g. those created by past beliefs and ideologies). It was argued that the limits to his systems of enquiry were a function of his own conceptions, that the paradigms he created could not be validated by objectivist claims underpinned by empirical data, as they ignore the factors presented by inadvertent human acts. In conclusion

she proposed the use of ‘limited objectivism’ as the way forward. Rather than a search for ‘truth’, a use of inferred levels of probability would be more beneficial.

Warnier (2009) went on to argue, two decades later, for a theoretical approach that extended the study of techniques as efficacious actions on materials and artefacts to the human as a ‘subject’. He suggested a unified approach that would enable stronger engagement with topics such as magic and ritual which when considered as ‘techniques of the self’ become efficacious. This stance strongly opposed the original anthropological view of ritual being ‘inefficacious’ and therefore separate from useful technical acts. Whilst supporting the works of Lévi-Strauss and Mauss (e.g. Lévi-Strauss 1958; Mauss 1936) he suggested that this separation was due to a move towards more Marxist approaches that parted technique from both ritual and symbolism. He therefore offered an updated set of concepts and vocabulary based on Maussian theory where the relationship between the technologies of the human ‘subject’ and of material objects, were dynamically interwoven.

Both of these influential authors proposed a freedom of interpretation that I could not have expected to engage with in past theoretical frameworks. Wylie's challenges to past perceptions of epistemic limits and Warnier’s call for more interpretation allow an engagement with the empirically organised museum collections in a richer, more biographical way. This richer ‘storytelling’ approach, in my opinion, engages more readily with the general public, an activity I believe should be encouraged.

1.2.2 Memory and Learning

In the archaeological study of skills it was argued that a more multidisciplinary approach was necessary (e.g. Bamforth and Finlay 2007; Tehrani and Riede 2008), incorporating concepts from cognitive anthropology and learning psychology. This multidisciplinary approach aligned itself with trends in post processual theory where the individual and the choices and actions thereof, become more central to the debate. This was opposed to the processual approach

whereby systems within societies where thought to override individual decision making. Bamforth and Finlay, as well as Tehrani and Riede, recommended wider ethnographical studies of the ways in which skills can be learned (and in fact defined). They argued that these studies should be undertaken to correct the general criticism of previous archaeological theoretical constructs (having methodological and interpretive issues), lacking modern anthropological validation. Both of these influential papers offered a combined anthropological and archaeological approach into looking at how cultural traditions in past societies could have been maintained over one generation to the next.

Through an exploration of skills utilised in flint knapping, Bamforth and Finlay (2008) argued for a broader range of situations and contexts to be examined, than archaeologists had previously accepted, especially in the definition, recognition and interpretation of archaeological items. It was also proposed that past studies concentrated on technically expert pieces, the merit of which was criticised as being based on modern subjective judgements (with a tendency to ignore less perfect pieces), with the levels of learned competency they imply.

The assumption that flint knappers worked at a maximum skill level was argued as not being reflective of the wider range of complexities involved. A more general analysis tried to assess the overall levels of skill, but was considered impressionistic and selective, with little systematic attention being given to the ethnographically diverse ways skills could have developed. Archaeologists were therefore accused of presenting craft learning models as tried and tested theoretical constructs.

This contrast between the skills utilised on technically expert pieces versus less perfect ones can be commented on in the past studies of brooches in this thesis. The early medieval, gold and garnet encrusted Disc-on-Bow brooch, found at Wijnaldum, has received a lot of attention, generating much debate surrounding its elite nature and the subsequent importance inferred on Wijnaldum due to it (e.g. Besteman et al.1999; Bos 2006a; Tulp2003) even though it may well have been there as scrap for recycling . Whilst this may only represent the personal

item of one individual, the many hundreds of contemporary copper alloy brooches found in the region have received less attention (e.g. Bos 2006b). The study of the craft skills required to produce the Wijnaldum brooch (Nijboer and van Reekum 1999, 203), in my view is limited in terms of extending our knowledge of the socio-cultural system from which it came. An equivalent study of the ways in which skills could have been employed in manufacturing the hundreds of morphologically diverse, copper alloy brooches of the time could, I believe, tell us more.

Tehrani and Riede (2008) advocated the growth of social learning theory in interpreting patterns of continuity and change in the archaeological record. Archaeologists were accused of poor discrimination between specific types of cultural transmission and subsequent variation. These authors made an important distinction between imitation and emulation in emphasising the role of active teaching in the transition of certain skills. The role of teaching, according to Tehrani and Riede, has often been neglected in the study of artefacts and they argued that imitation alone was insufficient to ensure accurate skill transfer. They went on to propose that identifying quantifiable relationships between lengths of time teachers spend with pupil's, verses the stability of traditions, could be a useful approach, suggesting further that teaching was probably an important mechanism for material culture transmission. The archaeological record cannot see these skill processes, but organisational chains of actions may point to their presence and hence the ability to suggest something about the learning that took place.

The application of this theory to further understand craft organisation, perhaps in relation to the early medieval workshop models proposed by Söderberg (2004), could be very rewarding. How would learning take place for example amongst itinerant artisans, free to travel from place to place, compared to those living a more sedentary lifestyle at a Royal estate or monastery?

1.2.3 Cross-Craft Interaction

There are two influential papers that relate to this subject. The first by Knapp relating to artefact studies of the Bronze to Iron age changes on Cyprus (Knapp 2012), the second by Tsoraki (2011), relating to her stone studies of Neolithic Maknyalos.

Both papers engaged with theoretical frameworks that attempt to explain cultural change. The study of mobility, trade and exchange is a component of these discussions, especially in terms of understanding 'inland seas' such as the Caribbean, the North Sea and the Mediterranean. Past island life, external communication and the movement of people present the opportunity to explore cultural change through the assemblages and settlement sites they left behind.

They went on to suggest that trends in technology studies have seen a shift away from static artefact analysis to one of attempting to understand the practices and social structures underpinning these technological processes. The authors presented two distinct methodologies but with the same joint goal of demonstrating the effectiveness of studying the interrelationships between crafts (cross-craft Interaction), their entanglement with and emergence of new social identities.

Knapp challenged past methodologies as being driven by historical scenarios and subsequently introduced the concept of hybridisation to elucidate how transcultural entanglements contributed towards the emergence of new social identities. The main proposition was that peoples and cultures are perennially engaged in conversation with other cultures and peoples. If one accepted this, he proposed that hybridisation naturally follows.

By examining the 'contexts of consumption' and 'objects in motion' of exotic imports he further suggested that they could be viewed as active transmitters of social change. Taking a new look at imported goods he claims that hybridisation is evident, influencing objects being produced locally with non local ideas,

designs and meanings. Knapp concluded therefore that indigenous and immigrant peoples transformed the materials and social practices of both.

Tsokoraki in her studies of Aegean Neolithic technology agreed with Knapp, arguing for greater emphasis on the social aspects of the production and consumption of material culture.Ground stone technology studies had previously been seen as interpretively inferior to those of other materials. Also chaîne opératoire, a methodological tool developed by the French archaeologist André Leroi-Gourhan (e.g.1982; 1993) was previously criticised for producing isolated sequences of events. But when applied across many categories (multi-chaîne opératoire), its role in elucidating socio-economic entanglements becomes useful.

She suggested therefore that technological acts were not performed in a social vacuum and a conceptual framework identifying these social relationships should be utilised. Tsokoraki's investigation of cross-craft interaction within ground stones technology, their 'toolkits' and networks (of entanglement) promoted larger settlements as hubs of knowledge sharing and social memory. She concludes (and I believe rightly) that interplay between crafts is visible in the tools and techniques behind them, seeing technology therefore as a 'socially transmitted body of knowledge'.

The 'fluidity of meaning' in Knapp's study of Cypro-Aegean bronzes also compares favourably to the early medieval brooches in this thesis, especially as there are such a diverse range of morphologies and motifs present amongst the categories. A very interesting point of study would be the transition between pagan and Christian motifs, linked with the new technologies evident in the changes in morphology of brooches at this time. The introduction of Christian motifs and the technology behind them could also be seen to be socially transmitted.

Tsoraki's cross-craft theories could also be applied to the production of early medieval metal work and may also shed light on the itinerancy or otherwise of the artisans who made them. For example, how flexible were the social entanglements

of an itinerant artisan, between one community and a next? Could these entanglements be broken easily and reformed as needed or did they require a higher level of engagement (perhaps by an elite) to make them work when operating across different socio-cultural boundaries? Even more interestingly could entanglement theory capture the ‘invisible’ cosmological strands that could ‘artificially’ emancipate or enforce social traditions, perhaps hidden in the 8th century transition to brooches bearing overtly Christian motifs? Entanglement theory as utilised in Tsoraki's arguments remains a very engaging subject and relevant to my area of interest, especially in terms of mobility, trade and exchange around the North Sea.

1.2.4 Reuse and Recycling

The way past peoples thought, their lifestyles and their world views would have been radically different than today and constructing interpretive frameworks of study is a significant challenge to archaeologists.

Caple (2010) in his paper on ancestor artefacts argues that the composition of objects may have had significantly greater cultural meaning than previously thought and proposed that there may be ‘fragments’ of earlier objects deliberately placed within newer objects and that these could be distinguishable from normal recycling. Ancestor artefacts as he puts it were previously defined as being far older than their finds association. Through several examples he argued that artefacts act as mnemonics that communicate a past story through recreation or retention and proposed that we should look past modern concepts of consumption and recycling to a past laced with veneration and ancestral meaning. The benefit of doing so would enable closer engagement with artefacts from a cultural perspective, especially dealing with metaphors and embodiment of past objects. The approach advocated by Caple in principle defines a framework to research objects that retained a special meaning to past peoples.

The issue of trying to conceptualise the past in a non western way is apparent in Dibbles (1984) challenge to stylistic, culture historical frameworks of study. His paper challenged the established classification system created by François Bordes suggesting that variability in Mousterian scraper typologies was the result of different steps in a sequence of modification and reduction, not uniquely functional or stylistic in nature. Using the scraper population from the Bisitun cave assemblage he creatively used the statistical analysis of operational sequences to build his case. Subsequently no statistical evidence could be found supporting morphological classification. Therefore the explanation of continued modification and reduction was a better fit. Bordes typologies were therefore artificial, demonstrating the need to understand the processes of tool making and intensity use within a wider research framework. It is not my intent to challenge the existing classification systems for the early medieval brooches contained within this study. However Dibbles success was partly in keeping an open mind to different scenarios during a typological analysis. Brooches for example do not seem to be result of variations in the production process itself, but more a result of conscious choices to utilise different production processes, which is quite different. This open mindedness is essential, I believe to the success of the morphological phase of my research.

I also agree with Caple that by defining concepts for veneration and heirlooms, compositional analysis may recognise previous artefacts that have been re-melted into new ones. This could be present in Carolingian period brooches for example, if they were shown to comprise of alloy compositions more popular in previous centuries. However this has to come with a caution that in reuse or recycling, economic values may still have outweighed ancestral ones. Finally he proposes that ancestor materials can inform us about past societies through the relationships between craftsmen and their customers, and that archaeologists and scientists should look for this. Again this argument is very convincing and these concepts are engaged with in more detail in the morphological analysis in chapter 6 of this thesis.

1.3 Problem orientation and research questions

The study of early medieval artefacts recovered by metal detector enthusiasts, have traditionally limited themselves to identification, usually by an assignment to a typological group within an existing or soon to be published catalogue. This ongoing work of this 'preservation by record' of items that have been lost through ploughing (or other disturbances from the soils in which they sat) should I believe be encouraged as it can only build trust between amateur enthusiast and professional researcher. Good typological identification, especially in relationship to dating evidence, from items found in unequivocal archaeological contexts, are also essential if future researchers are to apply new techniques that further elucidate their relationship, to the people who once made and owned them.

The study of metal detector retrieved items has also been problematic due to tensions between archaeological community and metal detector enthusiasts. Part of which is a result of the professionalization of archaeology and subsequent belief in the need to control access to archaeological resources by other interested groups (Redesdale 2008, IX). This, I believe, led to a slow realisation by the archaeological community of the valuable research potential these displaced, metal detected items have. These items, which were recovered by people considered to be a 'terrible threat to the scientific exploration of the past' by many in the profession (Thomas 2009, 1), are gaining more interest.

Putting aside any paradigm limits set by debates regarding the morality of the recovery methods or a perceived inferiority of the material due to a lack of archaeological context, my goal was to apply new techniques that in turn would tease out new information about how these items were manufactured and used.

Whilst it is accepted that there was a broad array of garments in use during the early medieval period, the historical evidence for the way brooches were worn is mainly based on surviving literature from the later centuries, with much research undertaken by language specialists in attempting to associate old descriptions with garments from earlier periods (Owen-Crocker 2004, 3). These sources are inevitably concerned with the preoccupations of the secular and ecclesiastical elite

and therefore contribute little in my opinion to our understanding of the everyday use of brooches and their associated garments, by the majority of the people.

The evidence from archaeology and in particular that from many hundreds of excavated cemeteries, has been more rewarding (see for example Lucy 2000, and Owen-Crocker 2004) with brooches playing an important role in untangling the way garments were worn in funeral contexts. From a survey of burial excavations in Germany, Frick (1993, 245) suggests that brooches based on their locations in graves were mainly worn on cloak-like garments. However there is contradictory evidence from England whereby brooches in graves were found in association with purses or pouches rather than from cloaks (Hinton 2005, 78). Whilst it is suggested that these brooches were not made specifically for funeral events (Frick 1993, 245) and therefore constituted items that were indeed worn in daily life, this tells us little else about them, just as it is problematical to relate gender, ethnicity and identity to grave goods, the apparel that makes up the costume of a deceased may not be representative of their dress in daily life. Lucy gives an example of a burial where the dress accessories associated with a young girl in an Anglo-Saxon period grave were much too large for her and exhibited much evidence of wear and repair. This suggested more association with the inclusion of family heirlooms than with her own daily clothing (Lucy 2000, 173).

The problem therefore returns to the question of what a large group of metal detector recovered brooches can tell about the daily lives of the people who wore them. Did brooches serve different functions as with different items of clothing? For example if there was a difference in winter versus summer clothing, associated with warm and cold, wet or dry conditions, the functionality of a brooch could also be different? Also if some garments were set aside for special occasions such as religious festivals could people have owned more than one brooch? One, being set aside for special occasions whilst others, perhaps in use daily exhibiting much more wear and repair than their more valued possessions.

The chance to study the composition of a large group of brooches also presented both opportunities and problems. It would be unrealistic to apply traditional laboratory based techniques due to time and cost limitations plus a potential

unwillingness of the guardians of these collections to have then subjected to a program of destructive testing. The solution had to lie in techniques that could be applied in the field, where the collections normally reside. If the alloys of such a large group could be compared then the following questions could be asked of the data.

a) Is there evidence for chronological changes in alloy use from the end of the Roman period to the beginning of the Middle Ages?

b) Also is there evidence for the deliberate control of metal composition, perhaps between different types of brooches?

c) A further question that naturally follows is can regional differences in composition be seen (perhaps eluding to the availability or otherwise of raw materials)?

d) Furthermore can hhXRF identify other techniques employed in brooch manufacture such as fire gilding or soldering?

The answers to these questions could then be related to the theoretical models described in 1.1.1 and 1.1.2. These questions also provide a basis for future studies, for which hhXRF was chosen as an initial method of investigation. Although this would be somewhat experimental it still provided a non destructive method of analysis, free from laboratory processing costs that could easily be transported to the locations housing the collections. Whilst gathering the hhXRF data, limited morphological analysis could be undertaken onsite, to further maximise the time and costs of the visits. The following question would therefore also be asked

e) Can a detailed morphological study of data gathered in parallel to the hhXRF analysis contribute to our understanding of the cultural biographies of these artefacts?

Both exercises in conjunction could be viewed as a reconnaissance for future research depending of course on the outcome of the analysis.

The following chapters present the methodologies employed in answering these questions which precedes the results and subsequent conclusions. The methodology chapter is broken into two sections. Firstly the principles deployed for hhXRF use are presented against a background of lively debate concerning its suitability for use in archaeological applications. Subsequently, a methodology is proposed for the analysis of early medieval brooches that will withstand the scrutiny of this debate and if successful in application provide data to answer the research questions presented above.

The second half of the chapter proposes the principles and method for a large scale morphological analysis to run alongside the collecting of the hhXRF data. This method is therefore designed to take advantage of the opportunity to visually inspect particular aspects of construction and use and to identify potential for future research, but within a timeframe dictated by the hhXRF data gathering phase.

The next chapter introduces the collections that were accessed in this project. The five collections all come from the North of Holland. Friesland and Groningen provinces provide the bulk of the brooches but with the inclusion of a small privately owned collection from a site near Naarden some 150km south of the main collections. Having introduced the collections this chapter goes on to present illustrations of the main brooch typologies to orient the reader with the quite varied range of classifications and morphologies present in this very interesting period.

The hhXRF results are presented in the following chapter. They are presented both chronologically and by typological groups, with scatter plot diagrams being used almost exclusively to demonstrate differences (if any) between compositional readings. The first section presents a limited comparison of some brooches that were swept into the project from the Roman period, with brooches from the subsequent 5th to 8th centuries. Both chronological and typological differences are presented in these results in order to answer questions a) to c) presented above.

These questions are again asked in the following section of the brooches from the 5th to 8th centuries before a comparison is drawn between the brooches of the 8th to 12th centuries, again relating to the research questions a) to c). The next section presents the results of the hhXRF analysis for techniques of the trade. Rather than concentrating on the bulk metal elements this exercise concentrates on trace elements such as gold and mercury and is again presented using scatter plot diagrams (engaging with research question d).

An interpretation of these hhXRF results is offered next in the following chapter by drawing comparisons to medieval historical and archaeological theoretical models. The chapter is divided into two sections, the 5th to 8th centuries and the 8th to 12th centuries and within them explanations of the results are put forward that engage with these medieval theoretical frameworks.

The thesis then turns the reader's attention towards the detailed morphological analysis that was undertaken alongside the hhXRF analysis. This chapter presents the results of this exercise on a case by case basis, presenting topics relating to daily use, heirlooms and venerated items, as well as explanations for the disproportionate amount of breakages found in some brooch groups. Through presenting these results on a case by case basis this chapter engages with the research question set out in e) as presented above.

The concluding chapter draws the thesis together with a summary of the results and a review of the effectiveness of the overall project.

2. *Methodology*

This chapter presents the methodologies employed in the project which will be discussed in two sections, to reflect the separate processes involved. During the onsite analysis it was found that two people working together could form an efficient team. One person would open the storage containers and pass the brooches through the hhXRF stages of the analysis whilst the second would gather the morpological data before returning the items back to their containers. One person could perform both tasks but in this case with such a large number of items to process the best approach was to produce batches therefore alternating between the hhXRF and the morpological stages of the data gathering phase.

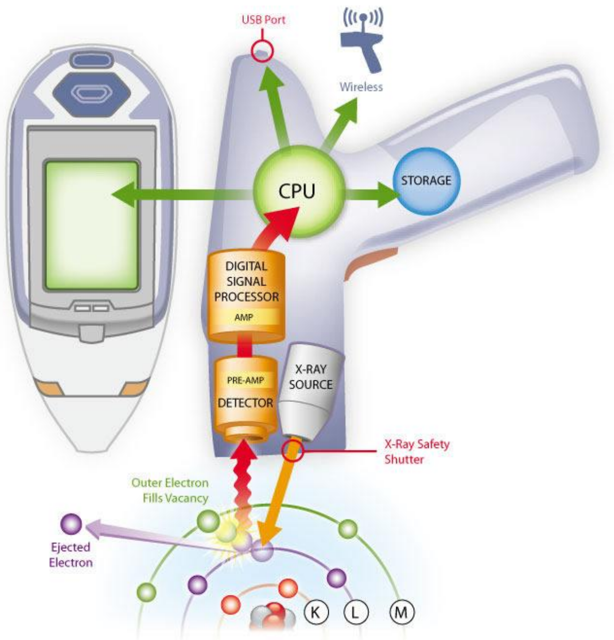

Figure 1: Diagrammatic principle of hhXRF, (www.Niton.com)

2.1 hhXRF

2.1.1 The principles of hhXRF

Although hhXRF works at a lower wattage than labXRF the principles are essentially the same. An X - Ray tube with a silver anode fires a primary X- Ray beam at the object of interest. This beam subsequently causes the atoms in the object to become excited, resulting in the release of secondary radiation in the form of electrons that are freed from their place within the normal atomic structure (see fig. 1). The energy that this movement gives off can be measured by the detector and as it is unique for each element can be characterised and the amounts in proportion to other elements ascertained.

This energy dispersive (edXRF) system is employed as a surface generating technique with penetration depths on metals of around 1mm. In order to get good results the ideal operating conditions are on samples with flat, highly polished surfaces (Caspers 2010, 31). This is certainly truer for quantitative analysis, but less important for the quantative approach (with potentially low accuracy but good precision) adopted in this project. In any case it is inconceivable that the many hundreds of brooches examined in this way could be subjected to such a destructive treatment.

2.1.2 The debate concerning archaeological applications

As stated in 1.1.5 there is quite some debate over the use of hhXRF within the archaeological community. Frahm and Doonan describe it as a technological revolution enabling the analysis of archaeological materials in the field (2013, 1425). Opponents of the technique proposed issues of validity and reliability in the use of internal fundamental calibration software and an overall lack of scientific rigour in application (Speakman and Shackley 2013). Shackley went further and suggested that most recently published portable XRF (pXRF) orientated articles ignore the decades of protocol developed for laboratory XRF

analysis (2010, 18), the effect being that mistrust had developed due to this perceived lack of scientific standards (Grave et al. 2012, 1674).

Proponents of the technique countered with suggestions that established laboratory based community was struggling with Kuhnian paradigms in trying to force this new apparatus to conform to years of lab based protocol and that as Shackley puts it they were ‘not necessarily prepared for it intellectually’ (2010, 17). What was needed according to Frahm and Doonan (2013, 1425) is the development of new methodological and theoretical frameworks to take advantage of this opportunity.

A problem concerning accuracy was recently proposed by Speakman and Shackley (2013, 1439). hhXRF is a surface penetrating technique that does not take a reading from deep within an artefact. To do this you need labXRF and have to drill a hole into the object to remove a sample. The results of surface corrosion would prevent the technique from producing an accurate compositional reading of the core material. Also copper alloy can also be inhomogeneous, especially mixes containing high lead levels, so an hhXRF reading could only be representative of a small surface area of the whole object. Frahm replied to these arguments with an analogy to a set of bathroom scales. The user knows that they may not be accurate in the sense of the exact weight, but used over time differences in the user’s weight can still be observed. Frahm proposes that hhXRF is similarly good for discerning differences in groups of artefacts (2013, 1444). This is the view that I take and it is central to my methodology.

A question was also raised over the machines internal fundamental parameters calibration software. This software is not new but has been criticised as a feature of these instruments even though it has been used in laboratory and subsequently hhXRF for the past 20 years. Before this calibration software the researchers had to manually adjust their results to compensate for variability in readings. These adjustments were based on the experience and judgement of the operator to prevent inappropriate calibrations (Frahm and Doonan 2013, 1427). The criticism of fundamental parameters calibration seems therefore to be a little unfair, in fact the ability to eliminate an operator’s subjective judgement seem to outweigh the

accusation of poor reliability. These hhXRF instruments using the manufacturers internal calibration settings offer various metals, soil, and plastics modes and I agree with Frahm and Doonan that they should be suitable enough to generate accurate data over a range of compositions (2013, 1427) and therefore fit for purpose.

The key to this is therefore in the research design. Some approaches could obviously employ either labXRF or hhXRF interchangeably and these should operate within the intellectual paradigms of laboratory based techniques. But my thesis research includes the application of XRF outside of laboratory protocols and as such could be considered ‘subversive’ (Kuhn 1970) to the established paradigm. Frahm and Doonan suggest that hhXRF will be most successful in providing new data for existing studies into craft production and household organisation through approaches that link material culture patterning to space and context (Frahm and Doonan 2013, 1432).

I suggest therefore that my non destructive sampling of several hundred depot and museum-based artefacts (with a regional wide distribution pattern) should be considered novel and innovative, but also engage with current studies of craft production and workshop organisation. The methodologies employed if successful will hopefully contribute to the broader acceptance of hhXRF.

2.1.3 The methodology for brooches

The device used for the analysis was a Niton XL3t GOLDD XRF analyser, which was factory calibrated for metals and alloys. It also has a silicon drift detector with optimised geometry. The analyser was also mounted in its bespoke test bench for all the measurements. This provided a fixed distance between the analyser and the objects (thus improving accuracy) and enabled a quick and efficient data recording process to be employed.

The electronic metals mode was selected for the analysis and used throughout the data gathering phase. This mode was designed to detect the compositions of copper alloys, solder (lead, tin) and precious metals.

The measurement time for each reading was set at 30 seconds. This was sufficient to determine an elemental count of 10ppm. It also took two spectrum readings per 30 second interval, the first for the main range of elements at 50kV (Cu-K to Ba-K, and Au-L to Pb-L) and the second for the low range at 10kV (Al-K to Cu-K).

A further external calibration of the completed dataset was undertaken by dr. Bertil van Os at the Cultural Heritage Agency who is their qualified technician for their hhXRF device (which was loaned to me for the duration of the project). These calibrations corrected for the distribution of the light elements which would be present due to contamination from soil residues (such as sand, clay and iron hydroxides). These elemental concentrations were normalised on a light elements (Si-Fe) free basis.

As mentioned earlier this device is considered to be a surface measurement technique. To reduce the opportunity for corrosion and patina to influence the bulk element ratios care was taken to take readings from the least corroded areas and with the least attached soil. That said, many objects were still totally patinated, which could risk skewing the results if care is not taken with the interpretation.

The resulting hhXRF dataset was then analysed qualitatively using scatter-plot and ternary diagrams produced by Grapher 9, which is a technical graphing software program that produces publication quality graphs.

Rather than develop a series of descriptions for the ratios of alloys produced by the study, the terminology from J. Bayley's (1998) analysis of brass production in ancient times was adopted. This was to facilitate easier comparison to other studies (e.g. Caspers 2010). The best manner in which to present this terminology is as a ternary diagram (fig. 2).

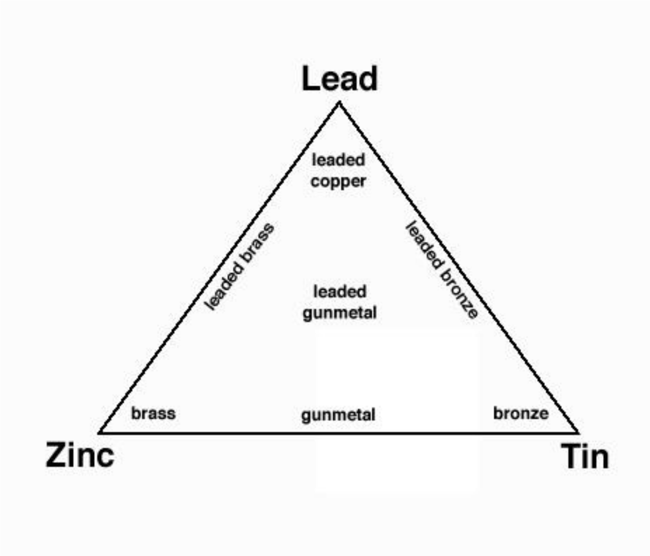

Figure 2: Compositional Terminology (after Bayley and Butcher1998,113)

The term Bronze will be used for copper alloys containing over 5% tin. Brass will be used for alloys containing over 10% zinc and gunmetal will describe alloys that contain a mixture of both, also as many items contain a high proportion of lead, the terms leaded bronze, leaded brass and leaded gunmetal will be used.

2.2 Morphological Analysis

2.2.1. The Principles of morphological analysis

A major component of reconstructing a cultural biography of an artefact is the need to understand the steps taken during its manufacture and the changes that affect it during its subsequent relationship with humans. The steps involved in an object's manufacture can be studied through an analysis of the operating sequences or chaîne opératoire as it is more commonly referred to (see for example Leroi-Gourhan 1993 and Soressi and Geneste 2011). These operational sequences can be extended beyond the manufacturing phase to encapsulate the supporting activities (such as supply of raw material, fuel for fire, workshop facilities and even food and clothing) and to elucidate the relationship that the

artisans could have had with the society in which they lived. These 'cross-craft' interactions (e.g. Miller 2007, 237) could form the basis for further studies starting with a better understanding of an object's composition.

Subsequent modifications such as those required to extend an object's functional life including repairs and cleaning activities could also add to the 'life history' of an object. This engages with concepts such as veneration and inalienability, as objects take on a cosmological or religious significance. The large amount of Christian symbolism on these brooches enables us to engage with discussions about relics as commodities in early medieval Europe. Being 'found' rather than being 'made' (Appadurai 1986, 23) in the eyes of the owners, perhaps relating to instances of artificially created wear (such as in Pseudo Coin brooches, discussed further in chapter 6.4.1) could elucidate how aspects of community life were constructed, particularly in relationship to ecclesiastical control and commodity exchange.

2.2.2 The morphological method for brooches

An important principle for this method was that data would only be gathered at the repositories of the collections and not under laboratory conditions. From a micro-wear perspective it was not considered practical due to time and cost limitations to conduct a microscopic examination (of hundreds of items) at this stage. The potential for further studies would however be assessed, especially in relation to more detailed laboratory work such as use-wear analysis and more accurate (but destructive) compositional testing. The main intent of this exercise should be seen as a reconnaissance mission to gather more readily available information and to assess the suitability for future biographical research. The measurements that were subsequently taken and recorded into the Excel 2007database are as follows:

a) Weight (g),

b) Length, width and thickness, or diameter (mm),

c) Gap between pin holder and retaining shoe (mm)

d) Diameter of pin hole in holder (mm)

e) Pin orientation to the motif (in degrees)

f) Pin housing design (after Frick 1993, 248)

A notes column was also used to record visual observations such as evidence of re-use and repair. The data could then be analysed for trends and compared against known typological assumptions and where appropriate the newly gathered hhXRF measurements. The results would then be presented in two sections.

a) Morphological observations from the onsite visits

b) Future opportunities for laboratory based micro-wear analysis

These observations would then be synthesised with the results of the hhXRF analysis in the concluding chapter.

3. The Collections

The data gathering phase of the project was fairly predictable in that it would be full of uncertainties in terms of accessibility to suitable artefacts, in sufficient quantities that would prove useful. The first collection to be made available was the Oud Naarden collection, released from the owner into the care of dr. Jan van Doesburg, a specialist in medieval research at the Dutch Heritage Agency (Rijksdienst voor het Cultureel Erfgoed). The core of this collection contained a group of Carolingian-Ottonian period brooches, for which comparisons were sought from other collections in order to build up a sufficient number of measurements.

The obvious choice was the collection of early medieval metal finds at the Fries Museum in Leeuwarden. Unfortunately access turned out to be problematic as the museum was closed to the public whilst in the process of moving to new premises. After some delay one of the Fries Museum collections became available for study but upon inspection did not include a comparative range of Carolingian-Ottonian period brooches. Subsequently access to the collections housed at the regional archaeological storage depot (Noordelijk Archeologisch Depot) in Nuis was requested. This access brought the Zijlstra, Regtop, and Hallum collections into the project and with them a different set of logistical problems.

The data gathering phase of the project had now extended itself to January, but presented the opportunity to gather data on well over a 1000 early medieval copper alloy artefacts. So despite very bad wintry conditions the decision was

taken to access the collections immediately and gather as much data as possible within a strict 2 week timeframe driven by the broader project time plan and limited finances.

The following sections present an overview of the collections and the items that were included in the hhXRF analysis including a breakdown of the quantities. The typologies created by Bos (2006b, 2006c) for the Equal-Arm and Disc brooches from Friesland are utilised where appropriate. This is mainly due to the large number of subgroups occurring in these two categories, which are necessary to aid organisation and identification.

Lastly this chapter presents a selection of drawings from some of the more popular groups in order to orientate the reader with some typical morphological differences. The interested reader should refer to the relevant typological publications (listed below) for more information as it is beyond the scope of this project to repeat much of this earlier work.

3.1 Zijlstra

This collection is by far the largest in the study (table 1) and came about through the dedication and enthusiasm of Jan Zijlstra who has spent years collecting and researching the hundreds of early medieval items unearthed by metal detector enthusiasts in Friesland. In particular he is credited with rediscovering the early medieval site at Tjitsma, and having recognised the importance of the metal finds continued to provide a supporting role to the full scale excavations subsequently undertaken by the Universities of Groningen and Amsterdam (Besteman et al. 1999, VII). He then went onto privately publish several reports on these stray finds, including interpretations as to their regional importance (See Zijlstra 1990, 1991, 1992, 1993b). Although bearing several different numbering systems most of the finds are identified and recorded in these reports and they were used as a first reference point before the item descriptions were updated and converted into English. Zijlstra also published an article on the Carolingian-Ottonian period Disc brooches in their own right (1993a).

Table 1: Brooches used from the Zijlstra collection

5th – 8th Century		No.
Cruciform	x	54
Square-headed	x	8
Small-Long	x	15
Radiate	x	13
Disc-On-Bow	x	3
Bird	x	5
Long	x	2
Pennanular	x	1
Triangular-headed	x	4
Domburg (Bos 1.1)	x	45
Equal-Arm, heavy bows (Bos 1.3)	x	11
8th – 12th Century		
Equal-Arm, with ribbed bows (Bos 1.5)	x	4
Equal-Arm, with circular elements (Bos 1.6)	x	1
Equal-Arm, paddle-shaped (Bos 1.8)	x	27
Equal-Arm, miscellaneous 'bow-type' (Bos 1.9)	x	6
Equal-Arm, miscellaneous (Bos 1.10)	x	2
Disc, circles & dots or concentric circles (Bos 2.1)	x	155
Disc, convex central boss (Bos 2.2)	x	2
Disc, central cloison (Bos 2.3)	x	40
Disc, pseudo cloison (Bos 2.4)	x	5
Disc, one or more crosses (Bos 2.5)	x	127
Disc, pseudo coin (Bos 2.6)	x	44
Disc, human or animal figures (Bos 2.7)	x	30
Disc, rectangular (Bos 2.9)	x	14
Disc, crescent-shaped (Bos 2.10.4)	x	1
Disc, cross-shaped (Bos 2.11)	x	3
Disc, miscellaneous (Bos 2.12)	x	2
Trefoil	x	2
		532 Total

3.2 Regtop

This collection (table 2) is the result of another dedicated enthusiast and is formed again by stray metal detector finds collected or bought from other enthusiasts in the province of Groningen. It is currently being researched at the University of Groningen, with a paper due to be published later in 2013 (Groenendijk et al. Forthcoming).

Table 2: Brooches used from the Regtop collection

5th – 8th Century		No.	
Small-Long	x	1	
Domburg (Bos 1.1)	x	1	
Cruciform	x	1	
8th – 12th Century			
Equal-Arm, paddle-shaped (Bos 1.8.1.4)	x	1	
Disc, circles & dots or concentric circles (Bos 2.1)	x	2	
Disc, central cloison (Bos 2.3)1 x Disc, (Bos 2.4)	x	8	
Disc, one or more crosses (Bos 2.5)	x	23	
Disc, pseudo coin (Bos 2.6)	x	13	
Disc, human or animal figures (Bos 2.7)	x	8	
Disc, unidentifiable (Bos 2.8)	x	2	
Disc, rectangular (Bos 2.9)	x	3	
Scandinavian	x	2	
		64	Total

3.3 Oud Naarden

This is a private collection of metal detector finds recovered from the shoreline of the Gooimeer just north of the town of Naarden a few kilometres east of Amsterdam (table 3). As such it is isolated geographically from the northern collections by approximately 150km. Olaf Langendorff, the collections' owner,

published an article about the brooches, including an interpretation of the reason why so many brooches have been found in such a small location (Langendorff & Schaftenaar 2010). It was then placed on loan for further study to Jan van Doesburg through whom it was made available for hhXRF analysis. As part of this exercise the brooches were assigned unique finds numbers and subsequently classified using Bos' Disc brooch typology.

Table 3: Brooches used from Oud Naarden collection

8th – 12th Century		No.
Disc, circles & dots or concentric circles (Bos 2.1)	x	3
Disc, central cloison (Bos 2.3)	x	3
Disc, one or more crosses (Bos 2.5)	x	17
Disc, pseudo coin (Bos 2.6)	x	3
Disc, human or animal figures (Bos 2.7)	x	4
Disc, unidentifiable (Bos 2.8)	x	2
Disc, rectangular (Bos 2.9)	x	2
Disc, cross-shaped (Bos 2.11.9)	x	1
Disc, cross-shaped (Bos 2.12.2)	x	1
		36 Total

3.4 Hallum

The Hallum collection is a group of finds recovered during commercial archaeological excavations conducted by Archaeological Research & Consultancy (ARC) b.v. (table 4). These are available for further study in the ARC-Publicaties 205 (Tuinstra, et al. 2011, 164). This collection was initially included to provide a post depositional contrast between finds found in dateable archaeological contexts and metal detected items in the plough soil. The small number of brooches, and the wide variation in types, subsequently made this comparison less valuable to study.

Table 4: Brooches used from Hallum collection

5^{th} – 8^{th} Century		No.
Cruciform	x	5
Small-Long	x	2
Equal-Arm	x	2
Square-Headed	x	1
Domburg (Bos 1.1)	x	1
		11 Total

3.5 Leeuwarden

The Leeuwarden assemblage (table 5) comes from a fairly eclectic group of copper alloy items in the Fries Museum's collection. This group entitled 'terp culture' also provided a diverse range of items and alloys for the hhXRF analysis but subsequently only four brooches went through to the final study (the museum collections containing brooches became unavailable due to logistical issues). This database does offer opportunities to compare alloys in future studies and also a group of hair pins were subsequently compared against brooch compositions (see 4.5.3).

Table 5: Brooches used from Leeuwarden collection

5^{th} – 7^{th} Century		No.
Cruciform	x	1
Pennanular	x	2
8^{th} – 12^{th} Century		
Disc – Miscellaneous (Bos 2.12)	x	1
		4 Total

3.6 Illustrations of main typological groups

3.6.1 Cruciform

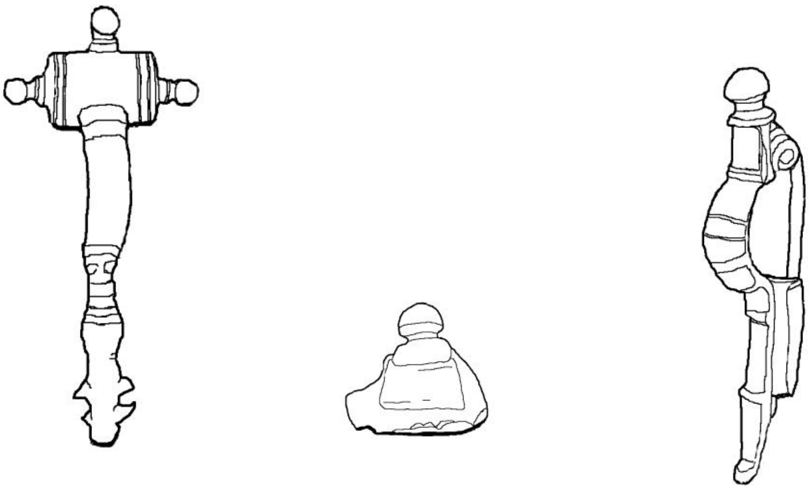

Figure 3: Cruciform brooches

3.6.2 Square-Headed

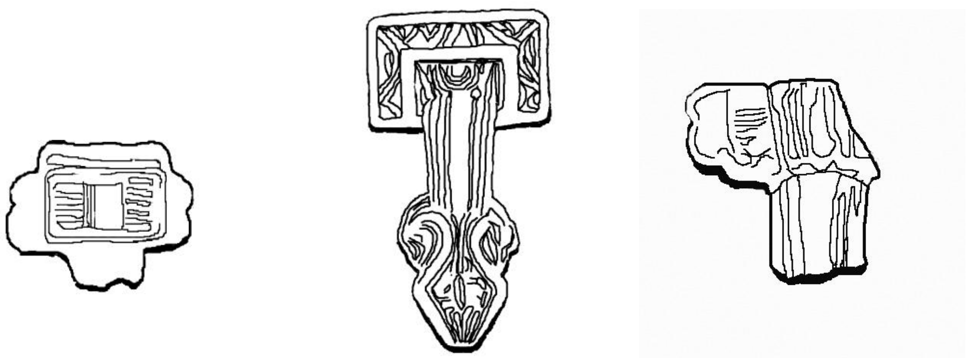

Figure 4: Square-Headed brooches

3.6.3 Radiate-Head

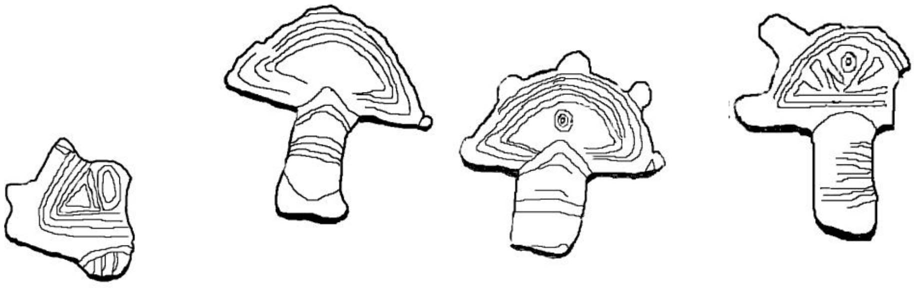

Figure 5: Radiate-Head brooches

3.6.4 Equal-Arm

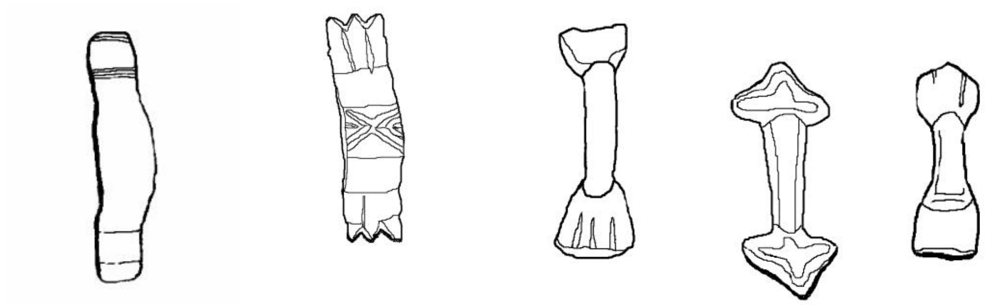

Figure 6: Equal-Arm brooches

3.6.5 Small-Long

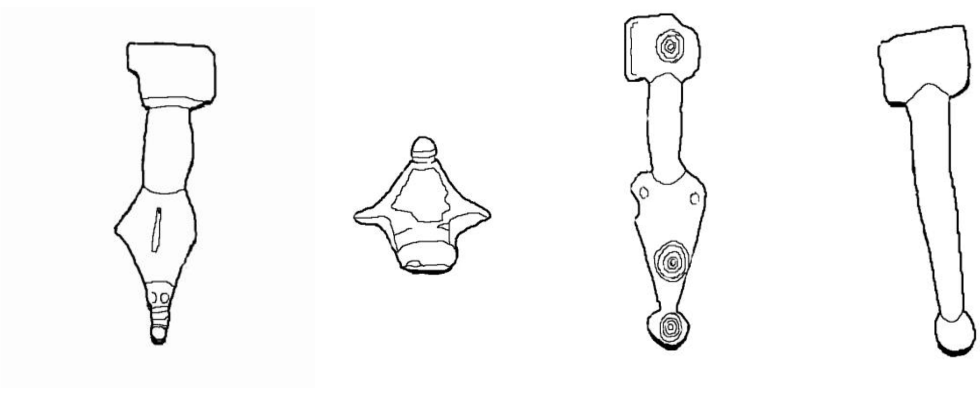

Figure 7: Small-Long brooches

3.6.6 Domburg

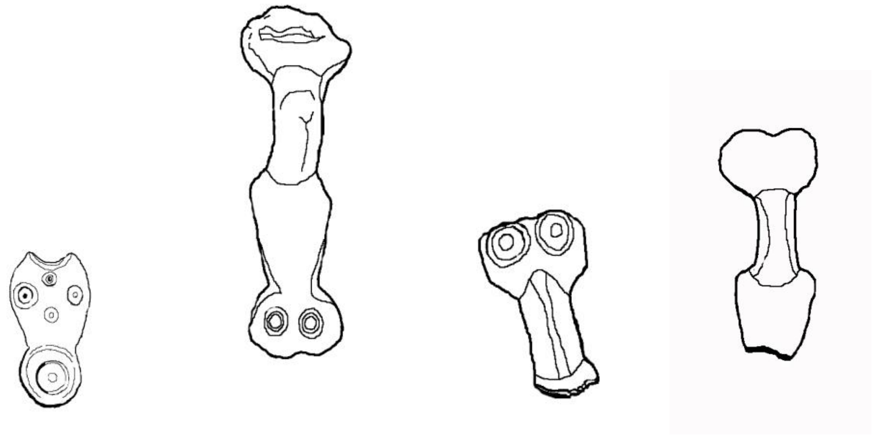

Figure 8: Domburg brooches

3.6.7 Pseudo Coin

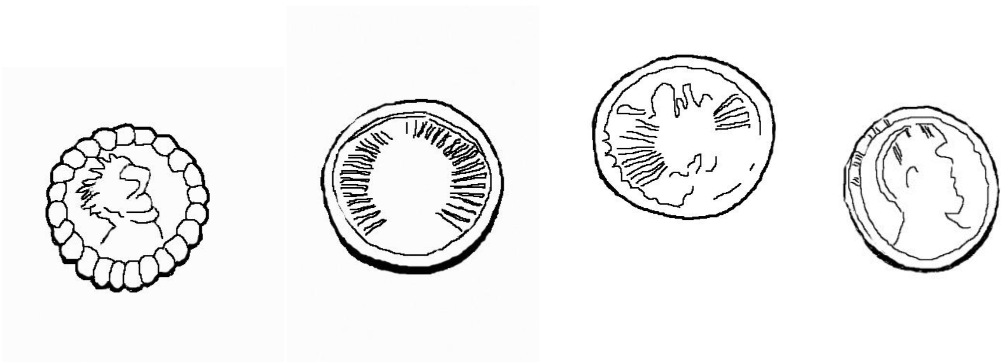

Figure 9: Pseudo Coin brooches

3.6.8 Human & Animal figures

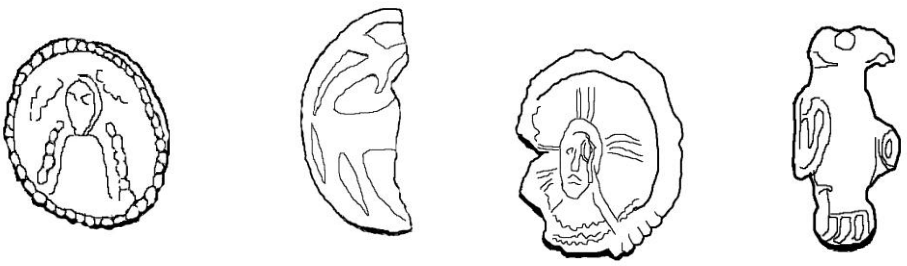

Figure 10: Human & Animal figure brooches

3.6.9 Disc

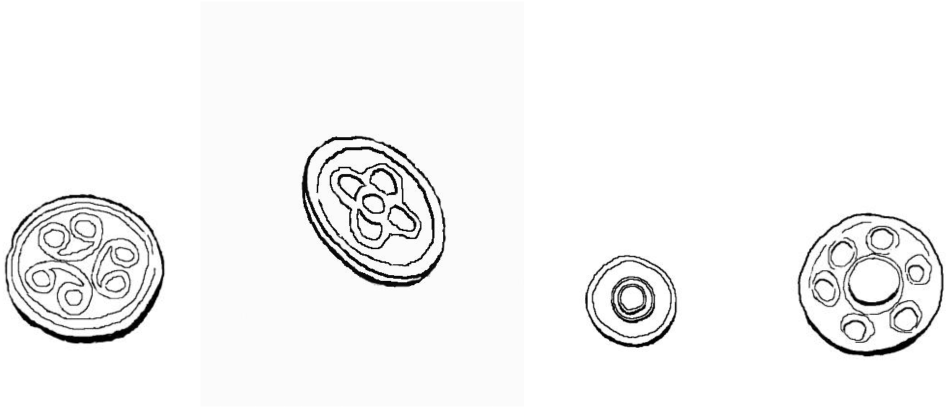

Figure 11: Disc brooches

3.6.10 Rectangular

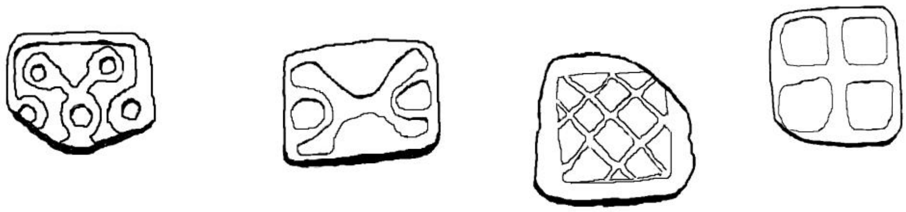

Figure 12: Rectangular brooches

3.6.11 Disc with crosses

Figure 13: Disc brooches with crosses

3.6.12 Saints

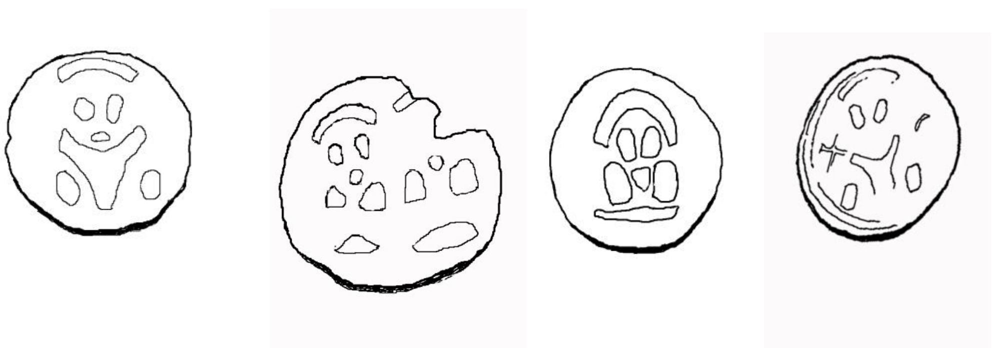

Figure 14: Saints brooches

4. The hhXRF Results

This chapter presents the results of the hhXRF analysis, the data gathering phase of which yielded nearly 1100 measurements. This reduced to 946 after removal of non brooch items, subsequently resulting in measurements on 688 actual brooches. The non brooch items (e.g. mounts, hairpins, bracelets) that were included in the initial analysis have been allocated to a separate dataset and with the exception of the hairpins do not contribute further to this project

The purpose of this research was to look for differences in metal composition over as large a group of items as practicably possible. Scatter diagrams were used to analyse these differences and therefore they have also been used in the presentation of the results. Some types of brooches such as the enamelled Carolingian groups required more than one measurement to be taken. A reading from the front of the brooch and a secondary reading on the rear was taken when necessary, to gather data on the effects of enamelling and gilding and to test the hhXRF equipment's ability to "see" the difference. All the elemental ratios were compared using scatter plot diagrams within the analysis phase of the project. However to present such large group of diagrams within a results section would make it unmanageable therefore selected examples have been used to illustrate the results. The interested reader will find a larger range of scatter plot diagrams in Appendices 1 and 2. A full list of the brooches from the study can also be found in Appendices 3 and 4.

The first group of results examines the distribution of the different collections. The Oud Naarden collection was gathered from a location over 150 km south of the modern provinces of Friesland and Groningen. The Regtop collection was gathered from the province of Groningen which neighbours Friesland and as such could provide insights into differences in alloy compositions if present.

The next section presents a chronological look at the data starting with the small group of Roman period brooches broadly categorised as 1st to 5th Century. The subsequent 5th to 8th Century section incorporates such important groups as the Anglo-Saxon and other Germanic typologies as well as a large group of ‘Domburg’ brooches and as such reflects changes in alloy composition during the migration period and Greater Frisia’s time as an independent realm with its own kings and Utrecht as its capital.

The 8th to 12th centuries are presented in the next section. The beginning of this period sees significant extinctions of earlier typologies with the rise of Equal-Arm brooches and Disc brooches which are so typical of the Carolingian period. The alloys of this time are presented against a period of significant change. The conquest and annexing of Greater Frisia by Charlemagne into the Carolingian empire also introduced Christianity, the motifs of which dominate these later groups. The presence of Scandinavian material is also discussed in this section.

The last section of this chapter deals with the miscellaneous group of technological questions. Many brooches exhibited signs of surface treatments such as those that were enamelled or fire gilded. By comparing readings of the front faces to those taken on the rear of the brooch, could these differences be seen in the hhXRF data? Also how does the composition of brooches compare to other classes of metal items? The readings from the hair pins, the largest non brooch group from the initial data gathering phase are compared here.

4.1 A comparison of the regional distribution

4.1.1 Oud Naarden in a Frisian context

Is there any similarity between the Oud Naarden collection compositionally to the collections found in the Northern provinces some 150km away? The following scatter plot diagrams elucidate the results of this analysis. There are 87 readings taken from 37 brooches, all of which date to the Carolingian-Ottonian period. As is typical for this period, a large proportion of the brooches were enamelled, hence additional readings were taken of front and rear to compare the differences. These differences will be presented in section 4.5.1.

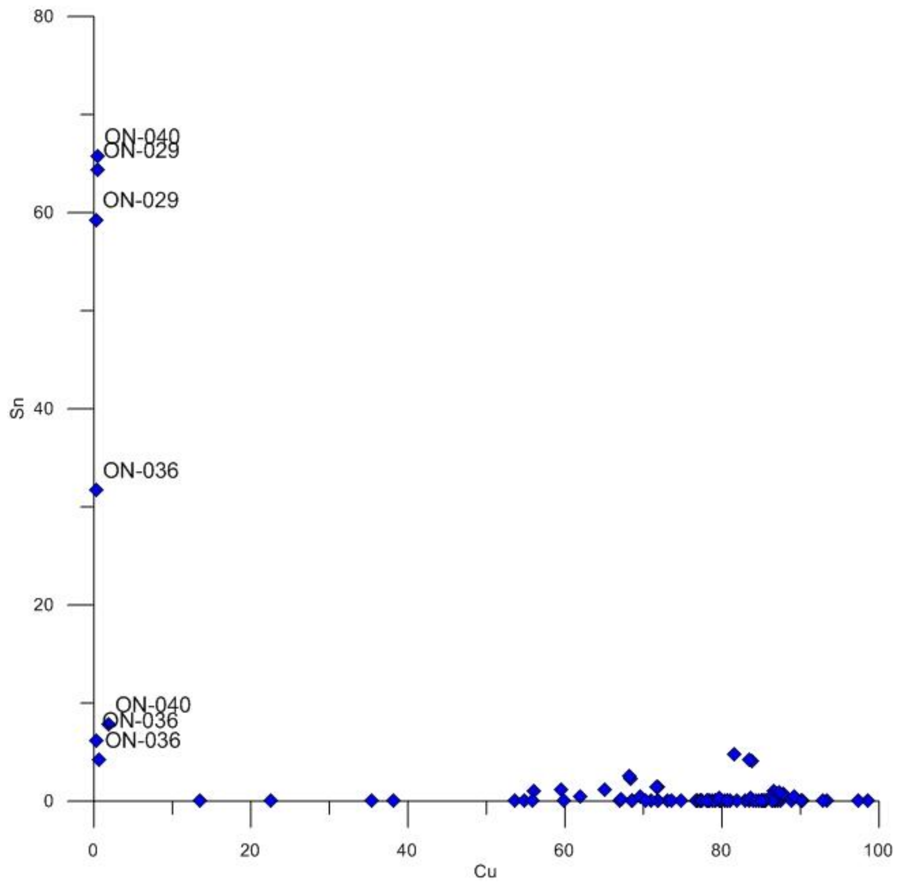

Figure 15: Oud Naarden brooches, Cu – Sn

The bulk of the Oud Naarden alloys comprise of leaded brass. Only nine readings were of leaded copper and just four were of leaded tin (the copper content being

less than 5%). The first scatter plot (fig.15) shows the ratios of copper to tin in these alloys. The grouping is very noticeable with the bulk of the collection containing very low levels of tin. The outliers display a strong contrast by having tin but low copper levels. The outlier ON-040 is a Disc brooch portraying a face in front of a cross (Bos type 2.7.2.2) in a leaded tin alloy possibly from the 11th – 12th century. ON-029 is a unique Disc brooch which has a comparison in the English Portable Antiquities Scheme (CAM-D3BC91) and may be 9th – 11th century Anglo-Saxon or Anglo Scandinavian again in a leaded tin alloy. But there are none in the northern collections or regional typologies. ON-036 is questionable as a brooch but was left in the dataset. Again it is a leaded tin alloy with no local typological comparisons. It may in fact be a later medieval mount.

The rest of the measurements including the ones with low copper values (which belong to brooches that have additional readings containing higher copper levels) can be considered to be from the main 8th - 12th century group.

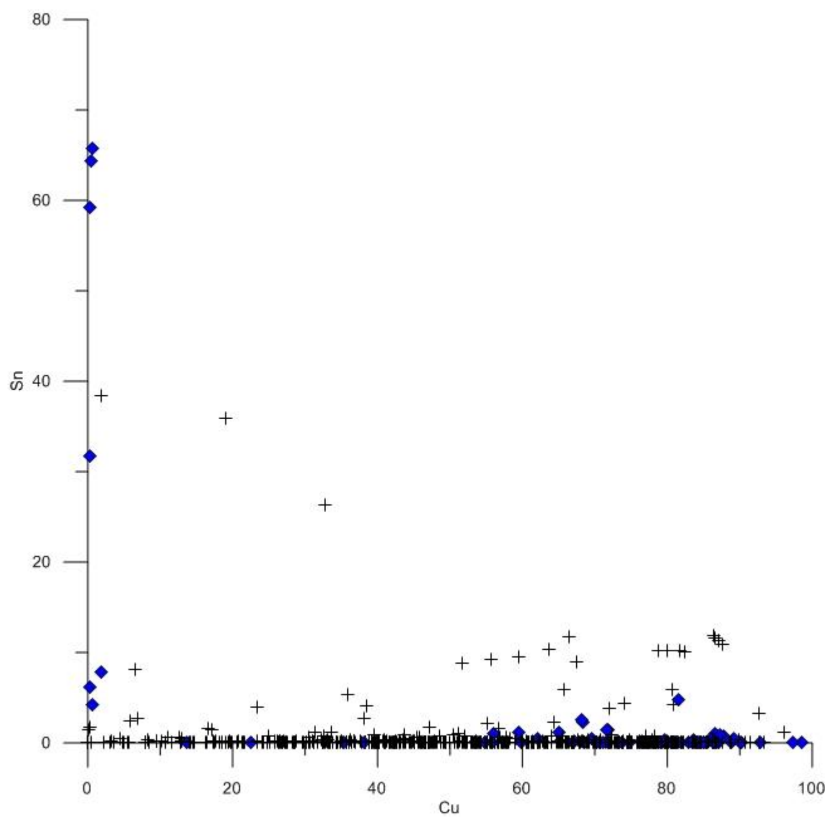

Figure 16: Oud Naarden collection (blue) vs. all Carolingian Disc brooches, Cu – Sn

If this group is then compared to the full Carolingian period results (fig.16) it can be seen by comparison to fig.4 that for low tin content the group conforms quite well, almost disappearing amongst the bulk of the northern Carolingian period material. But if you compare the ratios of lead to zinc then the results are different as shown in fig. 17.

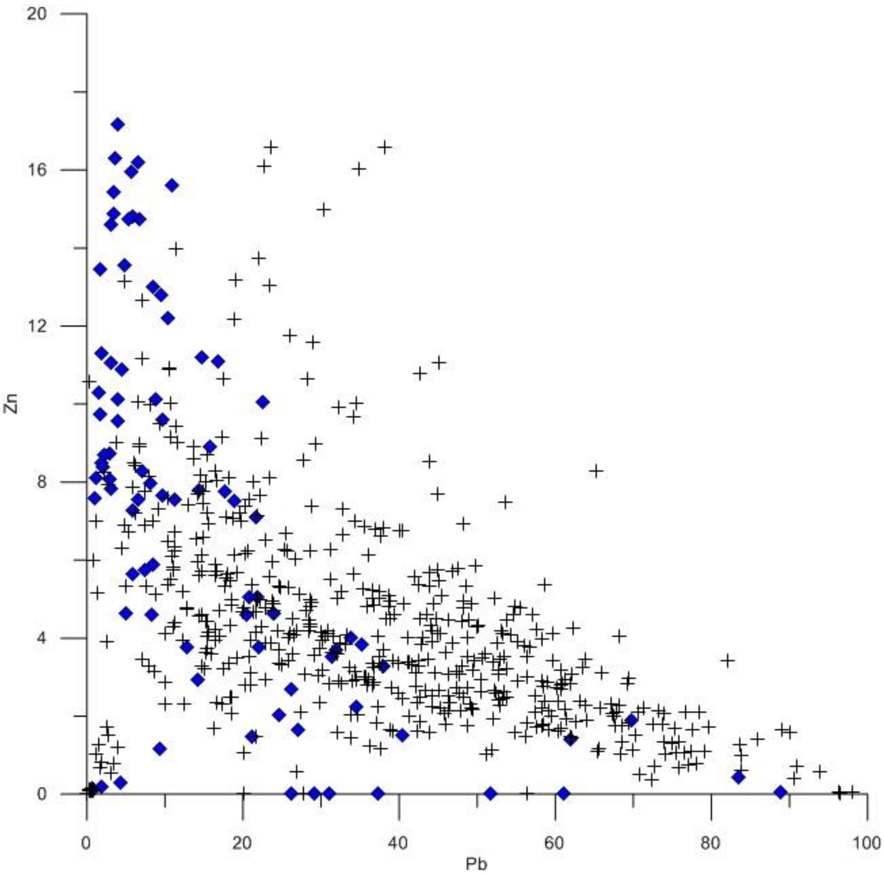

Figure 17: Oud Naarden collection (blue) vs all Carolingian Disc brooches, Pb - Zn

The Oud Naarden collection exhibit noticeably higher zinc and conversely lower lead content than the brooches from the Northern provinces. Although there is some overlap the Oud Naarden collection forms a distinctive group in fig.17. The difference in volumes for both of these elements is made up by copper. This difference can clearly be seen on the plot of zinc versus copper (fig.18). Most of the Oud Naarden collection therefore is leaded brass rather than leaded copper.

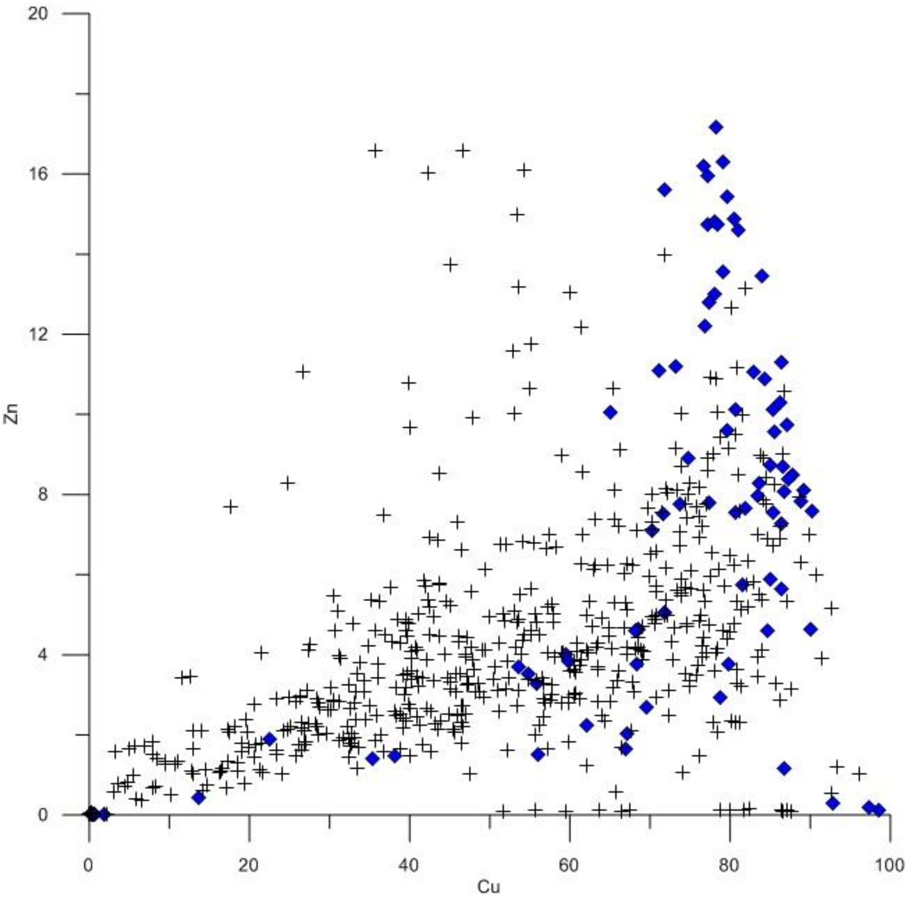

Figure 18: Oud Naarden collection (blue) vs. all Carolingian Disc brooches, Cu - Zn

4.1.2 Groningen versus Friesland, the provinces compared

The Groningen brooches are drawn from the Regtop collection and as there was only one Equal-Arm brooch available for study only the Disc brooches can be compared. They comprise of 60 measurements from 59 Carolingian period brooches broadly dating from the 8^{th} – 12^{th} centuries. The Friesland measurements are drawn from the Zijlstra collection, (plus two from the Leeuwarden assemblage). They contain a further 479 readings from 327 brooches. The question addressed here is whether the Regtop collection gathered from the Groningen region is compositionally different to that of Friesland? The bulk of both collections comprise of leaded copper, followed by leaded brass, with a very small group of leaded bronze.

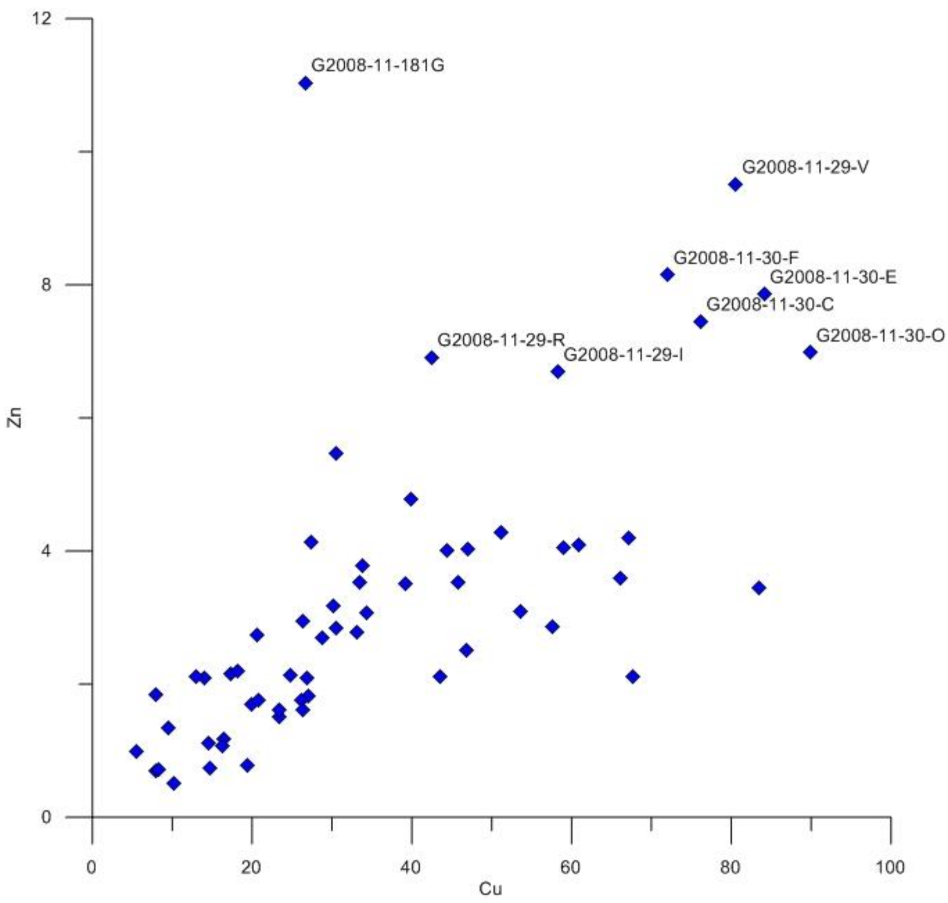

Figure 19: Regtop collection Carolingian Disc brooches, Cu – Zn

This scatter plot (fig. 19) shows the ratio of copper to zinc within the Regtop Disc brooches. The outliers or possibly second group contain the highest measurements of zinc and are listed below (table 6).

Table 6 The Regtop Disc brooches

G2008-11-29-I Disc, complex double cross	(Bos 2.5.1.14)
G2008-11-30-F Disc, cross made of four kidney shaped cells	(Bos 2.5.3.4)
G2008-11-30-O Disc, eight dimples, star in circle	(Bos 2.5.2)
G2008-11-30-E Disc, Maltese cross on raised circle	(Bos 2.5.1.30)
G2008-11-30-C Disc, Maltese cross	(Bos 2.5.1.6)
G2008-11-29-R Disc, seven dimples, central setting, green stone	(Bos 2.3.1.8)
G2008-11-181G Pseudo Coin, beaded rim	(Bos 2.6.4.1)
G2008-11-29-V Pseudo Coin? (Worn)	(Bos 2.6.5.1?)

There seems to be nothing typologically significant to separate these brooches from the main group. When you compare the scatter diagram for zinc verses lead then the same brooches stand out (see fig. 20).

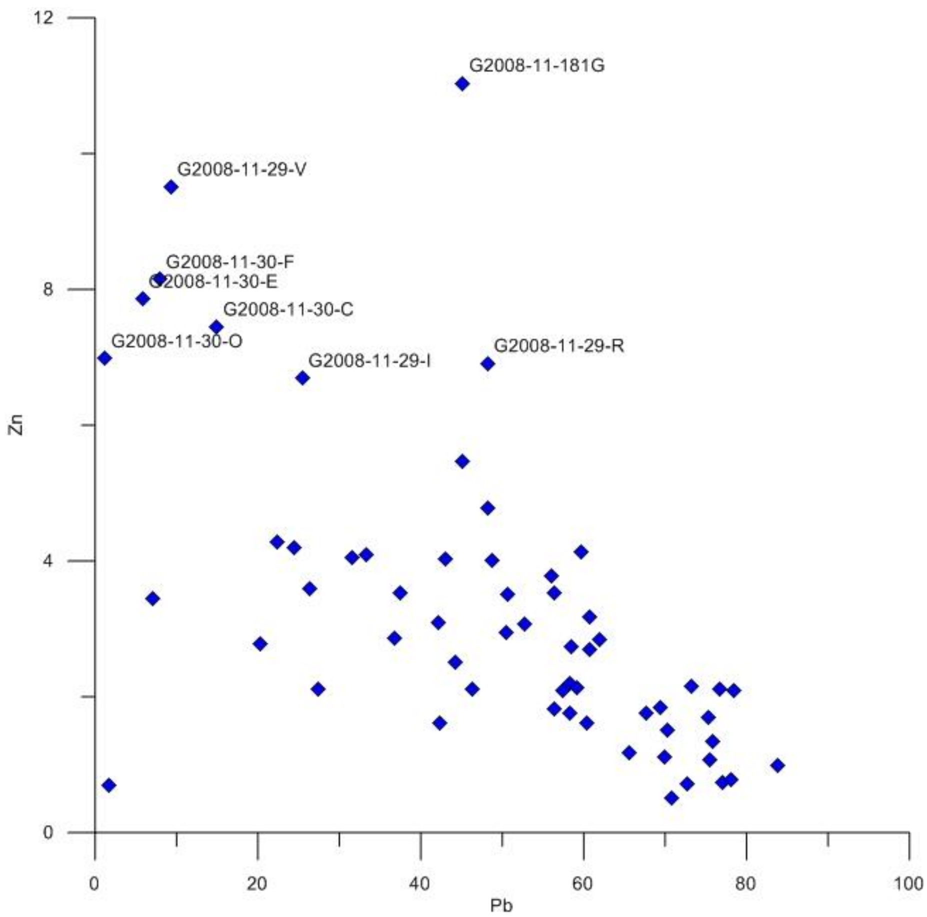

Figure 20: Regtop collection Carolingian Disc brooches, Pb – Zn

When compared to the Friesland material the copper versus zinc ratios follow each other closely (see fig.21). There is some concentration of readings towards the lower end of the scale however but they may link to a large subgroup such as the pseudo coin brooches and therefore will be explored further in section 3.4.2. The same is true when looking at the lead verses zinc ratios in fig. 22.

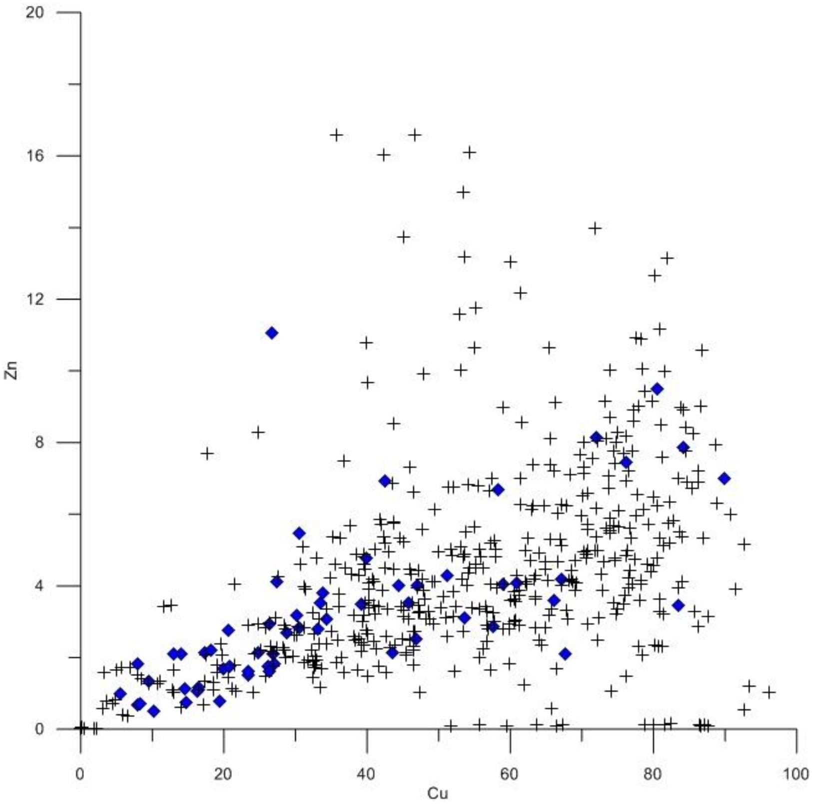

Figure 21: Regtop collection (blue) vs. Friesland Disc brooches Cu – Zn

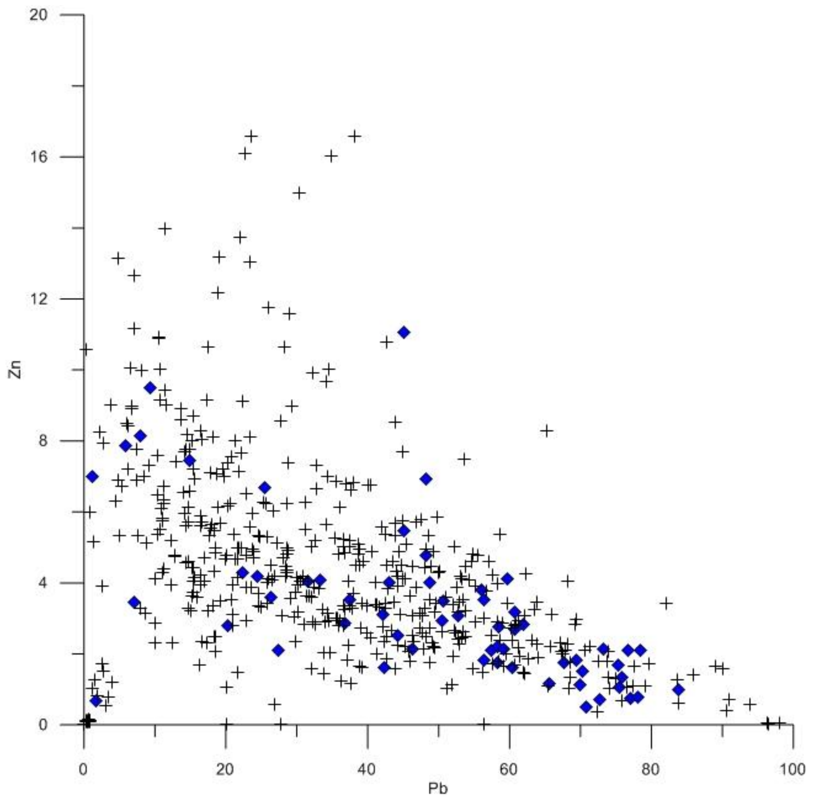

Figure 22: Regtop collection (blue) vs. Friesland Disc brooches, Pb – Zn

4.1.3 Summary

The Oud Naarden and Regtop collections only contained Disc brooches from the Carolingian-Ottonian period and therefore comparisons could only be sought within it. The brooches from the province of Groningen seem to follow the same composition as that from Friesland in that they are leaded copper, leaded brass then leaden bronze. But those analysed from Oud Naarden are different in that they exhibit noticeably higher zinc levels (more leaded brass) than those of the Northern provinces.

4.2 The 1st to 5th Centuries: Setting the stage

This section explores the relationship between Roman age brooches and the rest of the collection. Firstly it presents this material against the full chronology of brooches before concentrating on the 5th – 8th century groups. Although the orientation of this analysis is aimed at identifying correlations broadly within the early medieval period, the Germanic migration period (of which the Anglo-Saxon material forms an important part) and the end of the Roman Iron Age are problematical in that they overlap. The Anglo-Saxon Cruciform brooch for example has its origins in the late 4th or early 5th century.

Once the comparison between Roman period brooches and the medieval dataset was undertaken, the brooches that have been categorised as Germanic were analysed to see if they correspond to later Germanic alloys or indeed had a different composition.

4.2.1 A comparison of the Roman and early medieval periods

The Roman age dataset contains 45 hhXRF measurements from 38 brooches, nine of which are considered Germanic in origin comparing the typologies. The earliest of the Anglo-Saxon brooches is also included in this count (FM 1995-XII-1.321)

possibly dating to the 4th – 5th century. The group contains 26 Bow brooches and four Disc brooches which form the largest subgroups.

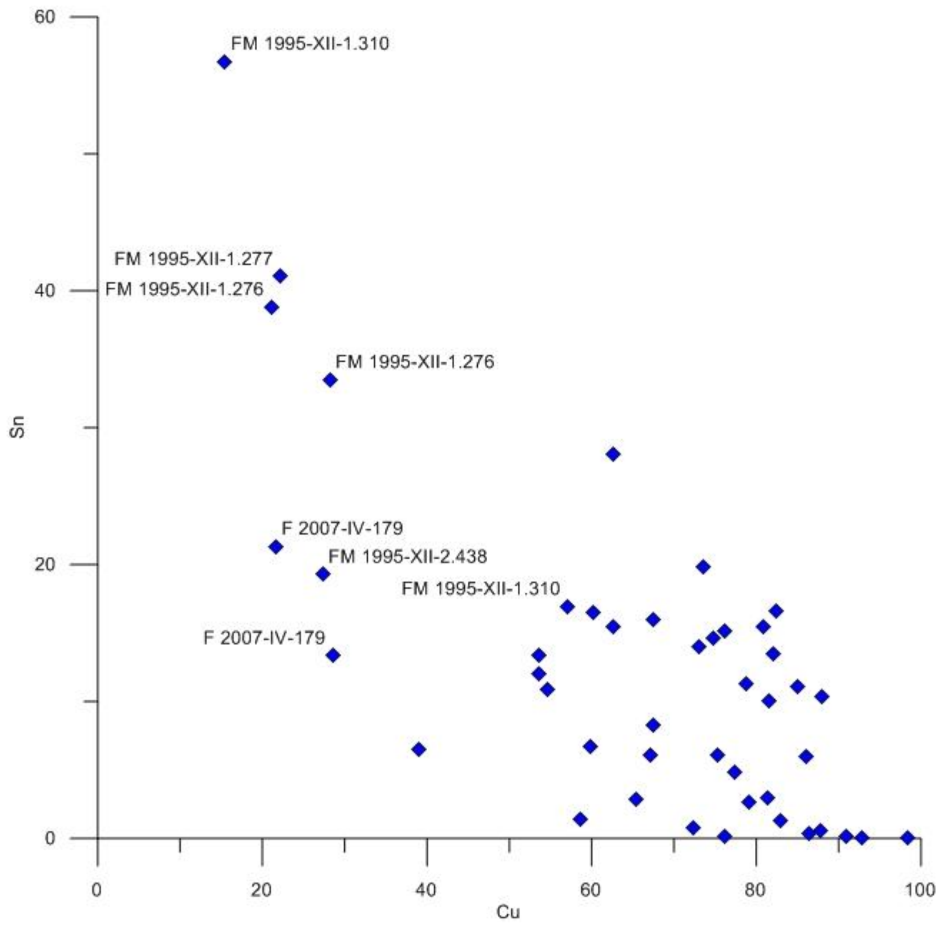

Figure 23: Roman period brooches showing outliers, Cu – Sn

Working from the highest tin content downwards (fig. 23), the plot furthest away from the bulk of the readings is for FM 1995-XII-1.310, a tentatively assigned 'button' brooch; as such it should be considered with caution and is unique to this group. The high tin content value is from the front of the brooch and therefore may be from a surface treatment. FM 1995-XII-1.277 and FM 1995-XII-1.276 are both identical Bow brooches but no typological comparisons have been found. Tentatively they date from the 1st to 7th century.

F 2007-IV-179 is a Disc brooch enamelled in the millefiori technique and is unique, dating to the 2nd-3rd century. Then FM 1995-XII-2.438 is another unique Disc brooch, again enamelled but with concentric rings and a hole through the centre, broadly dated to the 1st – 4th century. These outliers remain independent when scatter diagrams for copper versus lead and versus zinc are also considered.

The next scatter diagram (fig.24) presents the Roman period material against everything in the database before the 8th century. This allows us to see how it sits against the Anglo-Saxon and other Merovingian period material.

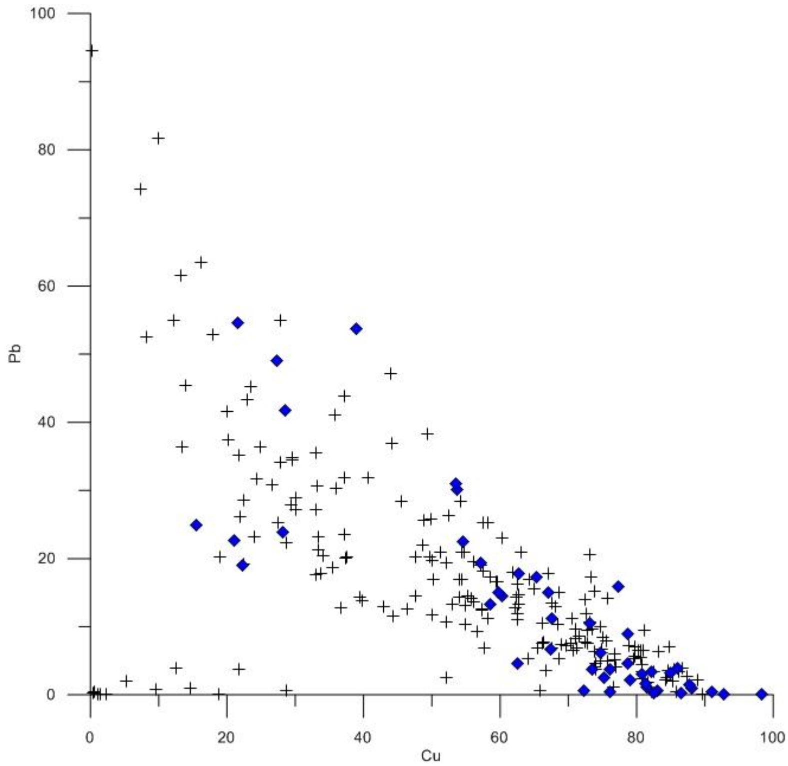

Figure 24: Roman period (blue) vs. 5th – 8th Century, Cu – Pb

The lead to copper ratio suggests that the Roman period brooches contained less lead than the following centuries but looking at the copper to tin and copper to zinc ratios the Roman period material seems to generally follow the same mix as for the 5th to 8th centuries.

A comparison with the brooches from the 8th to 12th Century is considered next. This includes the largest groups of typologies within the study, including the Equal-Arm and the Disc brooches. The scatter plot diagram of lead to copper (fig.25) shows these relationships.

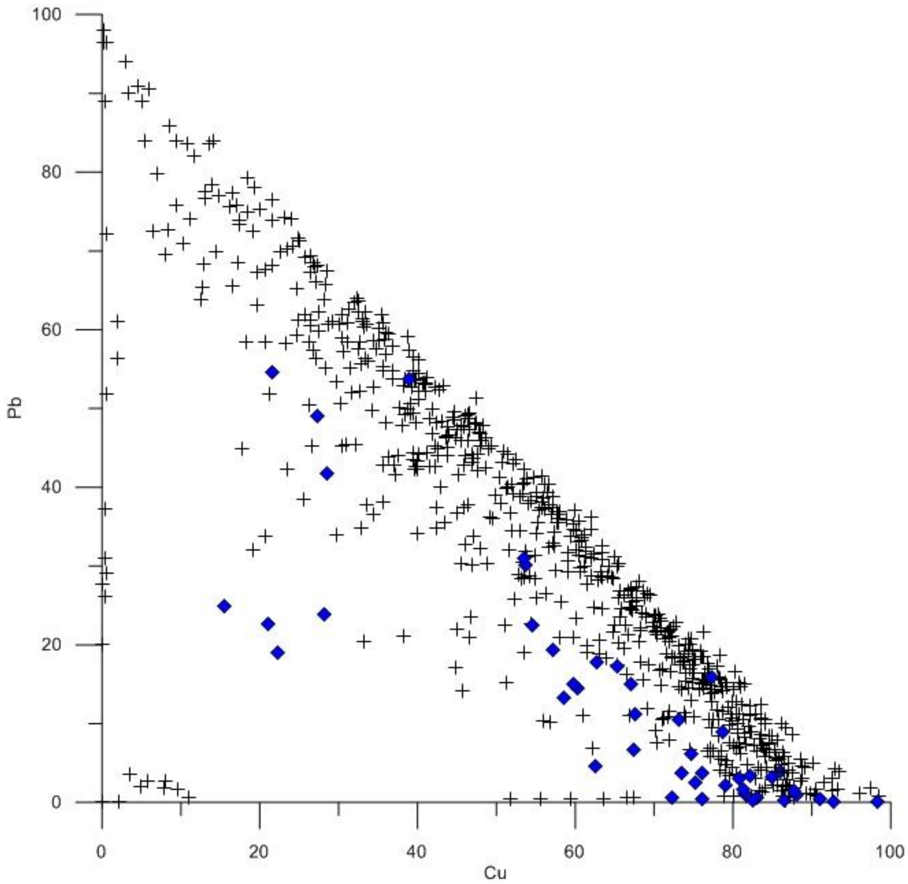

Figure 25: Roman period (blue) vs. 8th – 12th Century, Cu – Pb

ratio in order to demonstrate the marked difference between the Roman and Carolingian period alloys. The final scatter diagram in this section (fig.26) shows the full chronological sequence. The copper versus lead ratios shows the distinction between the Roman period and much later Carolingian alloys. The Roman alloys generally group with the 5th to 8th century material and are a mixture of bronze, leaded bronze and leaded gunmetal. What is also noticeable is the lack of leaded copper in use during these periods.

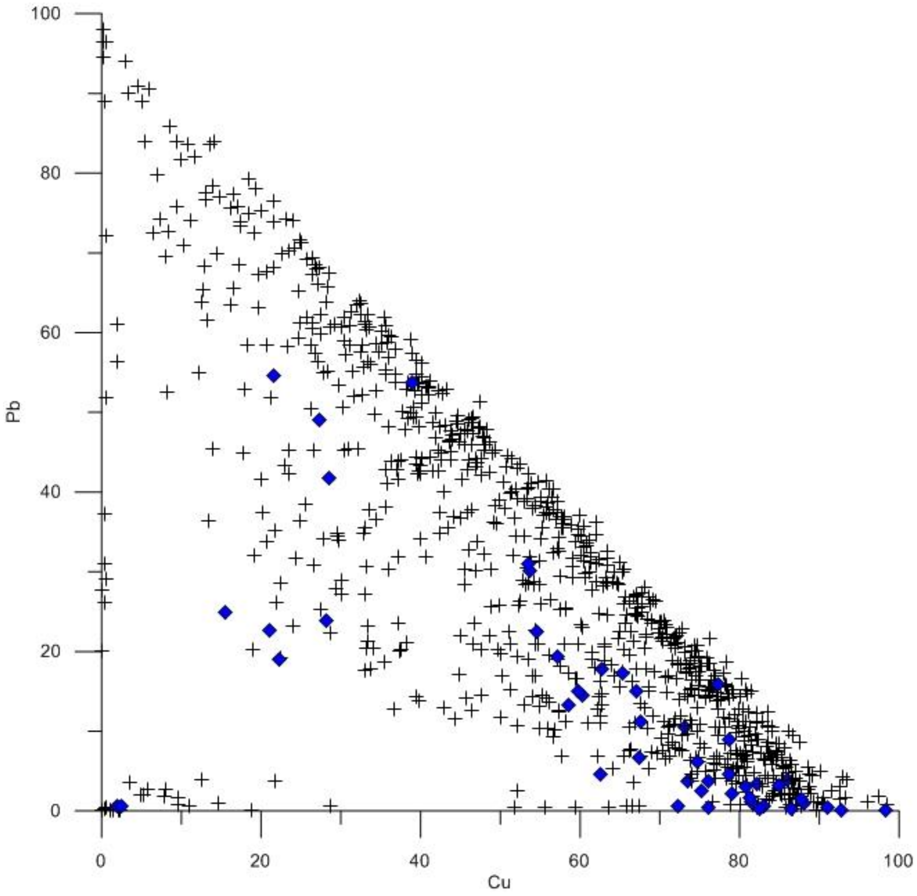

Figure 26: Roman period (blue) versus full chronology, Cu – Pb

4.2.2 Germanic groups contextualised

Having presented the relationship between the broader Roman period alloys against the centuries that followed, this next section explores differences between brooches categorised as Germanic in origin. There are 45 measurements in this group of which twelve are from nine brooches that could be of a Germanic type. Two brooches are of the Stützarm, Saxon type and another appears to be a very early Anglo-Saxon Cruciform type. Two further Bow brooches could date from the 1st – 2nd and the 3rd – 4th centuries and the remaining 4 Bow brooches have a similarity to Almgren type 162 from the 3rd – 5th century. Initially the Germanic measurements were compared to their Roman period counterparts, then subsequently to the much larger "Germanic" dataset from the 5th -8th century.

The first scatter diagram (fig.27) identifies the position of the Germanic material within its wider group. Note the outliers amongst the non Germanic material have already been discussed earlier (fig.23). There is little to distinguish between the two subgroups, possibly due to the small number of measurements in the study. Worthy of mention are two Bow brooches (F 2007-IV-181 and FM 1995-XII-1.176) dating from the 3rd – 5th century, that contain higher levels of Zinc than the rest (see fig 28). Of the rest of the material that has been categorised as Roman in date, there are a number of 1st - 2nd century pieces including four 'Legionnaires' brooches. Their positions within the scatter plots are also unremarkable (Appendix 1: fig.1) in terms of looking for non Germanic material.

The next scatter diagram presents the Roman period Germanic material against the known early medieval equivalents from the 5th to 8th century (fig.29). This includes 99 measurements from Anglo-Saxon brooches and a further nine from what have been generally termed Germanic brooches. Four outliers are worthy of note in as shown in fig.29. All of them have only been tentatively assigned to typologies. FM 1995-XII-1.170 and FM 1995-XII-1.173 are an unusual pair of headplates with 3 knobs each and lacking better information have been designated as fragments of two Germanic Small-Long brooches. FM 1995-XII-1.269 is a Bow brooch from the Roman period but a more exact categorisation is unsure. The last is FM 1995-XII-1.306, a fragment of what might be an early 5th century Anglo-Saxon brooch.

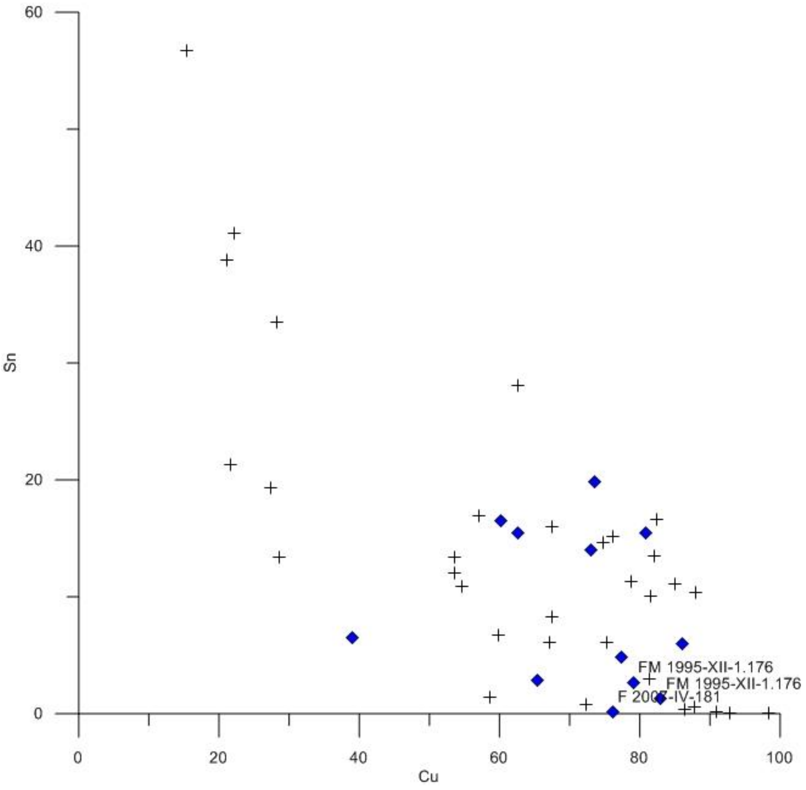

Figure 27: Germanic brooches (blue) vs. Roman period, Cu – Sn

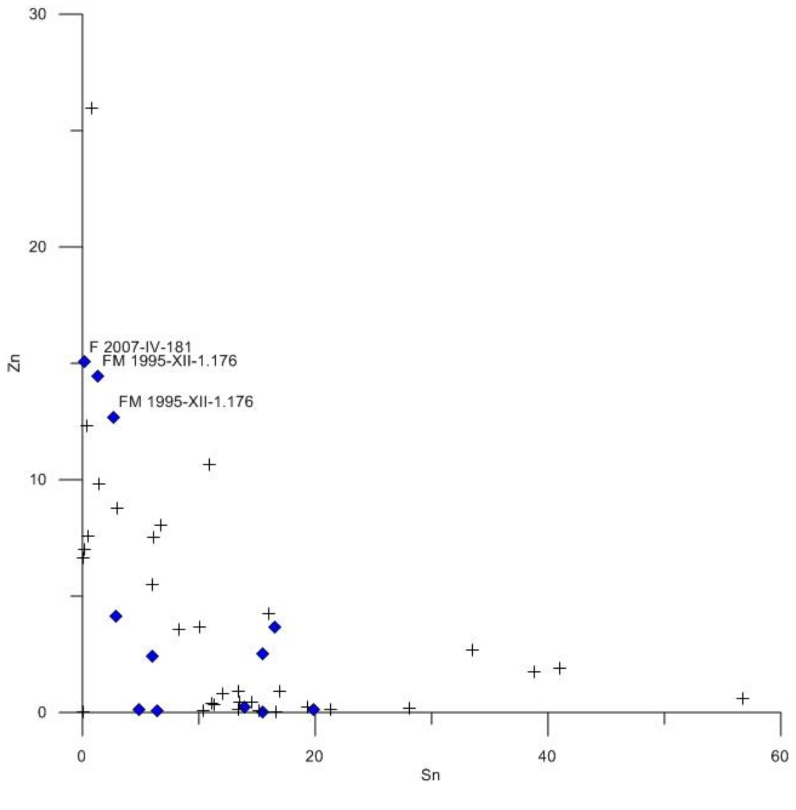

Figure 28: Germanic brooches (blue) vs. Roman period, Zn – Sn

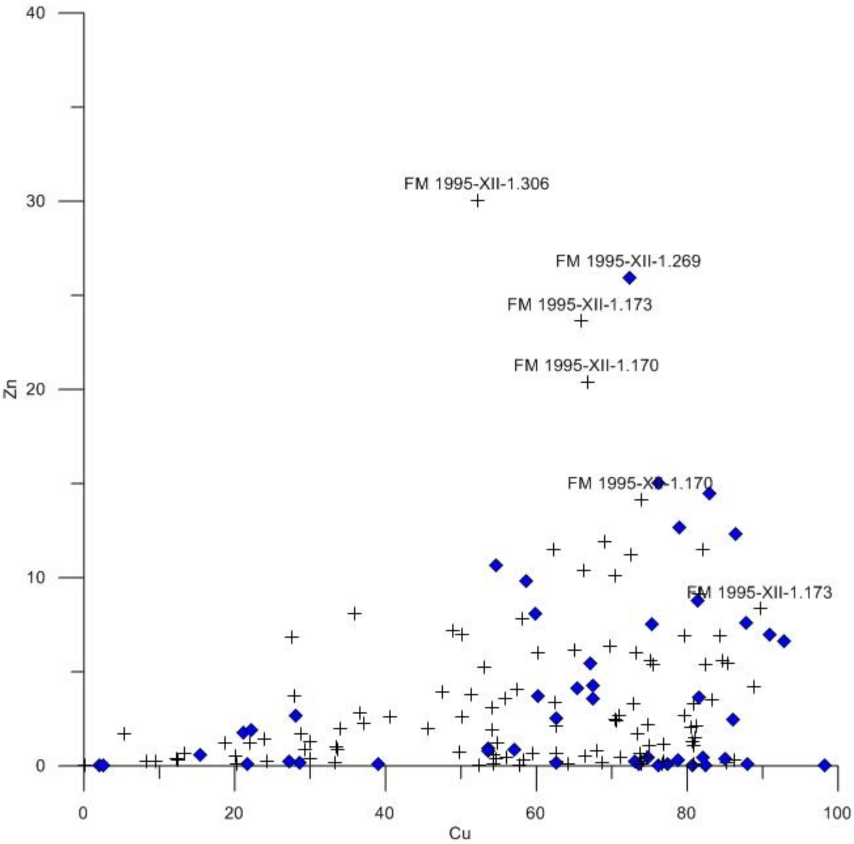

Figure 29: Roman (blue) vs. medieval period Germanic Cu – Zn

4.2.3 Summary

It was never the intention to gather information on Roman period brooches, but more of an inevitable consequence of gathering information on such a large collection of artefacts. The 38 brooches swept up into this research provided an opportunity to look at the transition between the classical world and the medieval. As a small group of brooches containing diverse types it was only possible to see that they generally matched brooches from the 5th to 8th century. When compared to the 8th to 12th centuries though, the Roman brooches clearly present themselves as a separate group.

The nine Germanic brooches did not distinguish themselves from the rest of the 1st to 5th century material. The group compared quite favourably though with the Anglo-Saxon and Germanic brooches from the 5th to 8th century. One point to

note was that the outliers in this exercise all corresponded to items with an uncertain classification. The alloy compositions set these items apart from the bulk of the material with good typological provenance.

4.3 The 5th to 8th Centuries: Migration and a Frisian Kingdom

This next section explores the compositional relationships between several well established typological groups. It is generally accepted that towards the end of the Roman and the beginning of the early medieval periods, Frisia was being settled by various Germanic tribes. The large volume of Anglo-Saxon material in this dataset reflects this. The next largest group for study is the 'Domburg' type which is generally thought to be a regional style and dates to the time Greater Frisia was a separate Kingdom to its Frankish neighbour. Amongst the rest of the dataset there are some brooches that are categorised as Frankish which could provide evidence for non local alloys if visible in the scatter diagrams.

4.3.1 Anglo-Saxon and Germanic groups

For the Anglo-Saxon group there are 100 measurements taken on 85 whole or fragments of brooches. The Cruciform type accounts for 59 items, then the Small-Long type at 17, followed by seven Square-Headed types and lastly two Long brooches. It is generally assumed that although a lot of them are fragments that they still represent individual brooches. During inspection very few if any could be considered separate fragments of the same brooch.

The rest of the Germanic material comprises 13 measurements on eight brooches. The earliest two are Stützarm Saxon types, followed by the rest that are either classified as Bow or Small-Long brooches all with distinctive 3 knob triangular headplates.

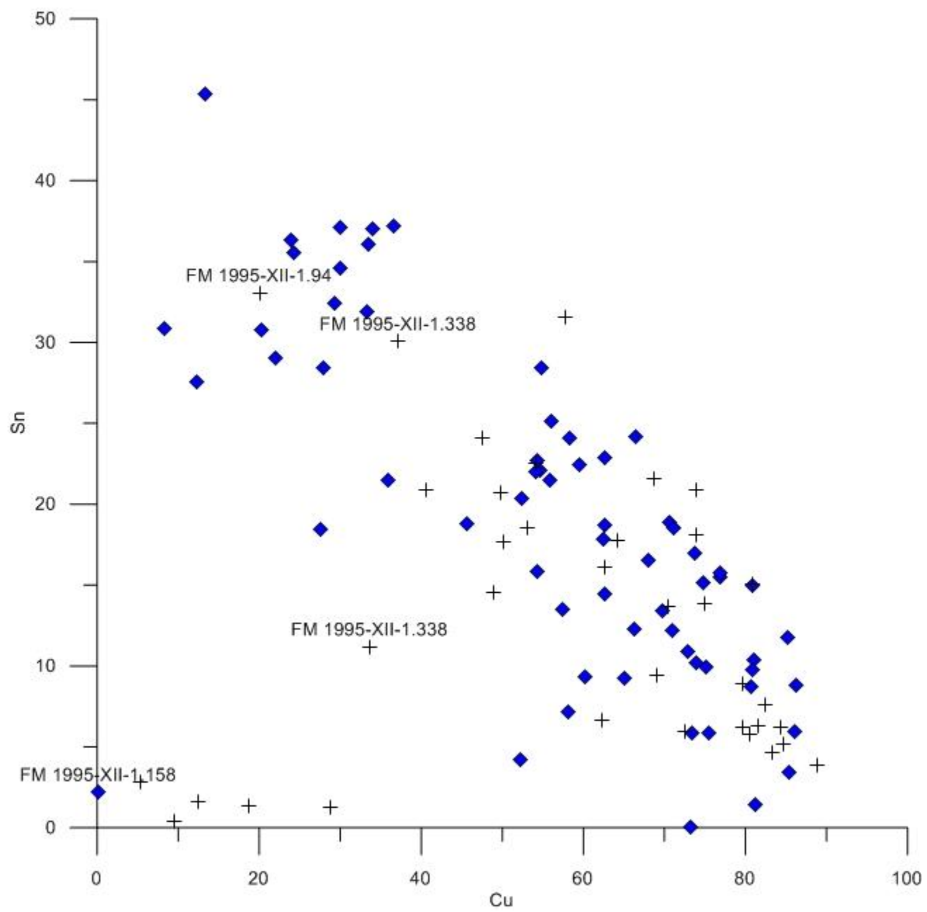

Figure 30: Anglo-Saxon Cruciform type (blue) Cu – Sn

4.3.1.1 Cruciform brooches

The first scatter diagram (fig.30) presents the relative positions of the Cruciform brooches within the group. Starting with the copper versus tin ratio the assemblage divides into three. The group characterised by high tin and low copper values comprises of 16 brooches only two of which are not the Cruciform type, with an additional outlier (FM 1995- XII- 1.118) giving the highest tin reading on the diagram. The non Cruciform types are a gilded Square-Headed fragment (FM 1995-XII-1.338) and a Small-Long brooch with an unusual footplate (FM 1995-XII-1.94). The rest do not stand out typologically from the subset.

The much smaller group characterised by small copper and tin contents comprises of four brooches, only one of which is a Cruciform type (FM 1995 XII -1-158). This is a footplate fragment with an animal head with scrolling nostrils. This Åberg type 3 fragment is the only definite one of its kind in the group. Examples of this 6th century group have been found infrequently in Holland, Denmark and Norway, but they are much more commonly found in England *(*Åberg 1926, 39*)*.

Within the non Cruciform type a complete Square-Headed brooch from Hallum is represented (07HALV000339) together with another fragment of a similar, Square-Headed brooch from Friesland (FM 1998-IV-6.5). Both are 6th century in date. Finally the headplate and bow section of a Small-Long brooch is represented (G2008-11-20), the only example from the Groningen region.

The copper to lead ratios give a similar result to the copper to tin ratios. The small group of non Cruciform outliers showing very low lead and copper are the items already identified above. The Small-Long brooch (G2008-11-20) in fact has an 80% iron value, as does the Hallum Square-Headed brooch (07HALV000339). These results are likely to have been distorted by the remains of an iron pin. The Square-Headed brooch FM 1998-IV-6.5 upon inspection has very high silver and gold values hence its position in the scatter diagrams.

The Åberg type 3 fragment (FM 1995 XII -1.158) is once again an outlier. This time demonstrating that it is over 90 % lead. Two more cruciform values also contain high lead to low copper ratios FM 1995 XII -1.127 and FM 1995 XII -1.128. Both are early Åberg type 1 the first uniquely with a saltire type cross decorating the headplate. These date to the first half of the 5th century and are common to the Frisian terp area (Åberg, 1926, 33). Both these brooches are of a lead tin alloy composition with little copper and next to no zinc. Other than these outliers the rest of the brooches group quite well (fig.31).

When comparing copper to zinc ratios there is only one outlier from what appears to be a single group. FM 1995 XII -1.305 has a zinc value twice as high as the rest of the group. This item was tentatively assigned to the Cruciform category as possibly a very early example. This may be the case, or its compositional value

may indicate that it is from another group. Generally speaking the majority are leaded bronze but with several being made of leaded gunmetal.

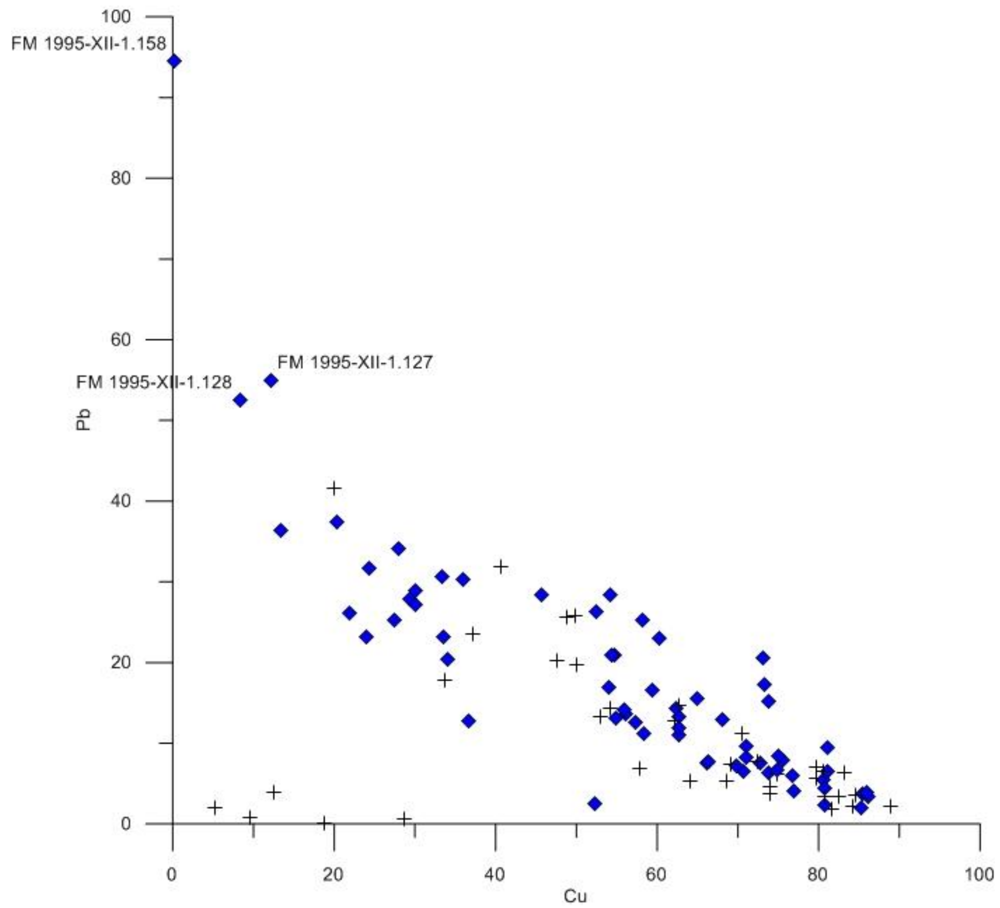

Figure 31: Anglo-Saxon Cruciform type (blue), Cu – Pb

4.3.1.2 Small-Long brooches

Small-Long types account for 17 of the Anglo-Saxon brooches in this dataset and broadly sit within the 5th – 8th centuries. The analysis of the bulk element ratios shows that this subgroup sits well within the larger corpus of Anglo-Saxon material. The ratio of copper to tin is worth comment as the Small-Long brooches seem to demonstrate more control of the elements present in the alloys (fig 32). The mixing line (if you draw an average line between the blue plots) seems to head towards a 40% upper limit as opposed to a combined upper limit of 50% tin.

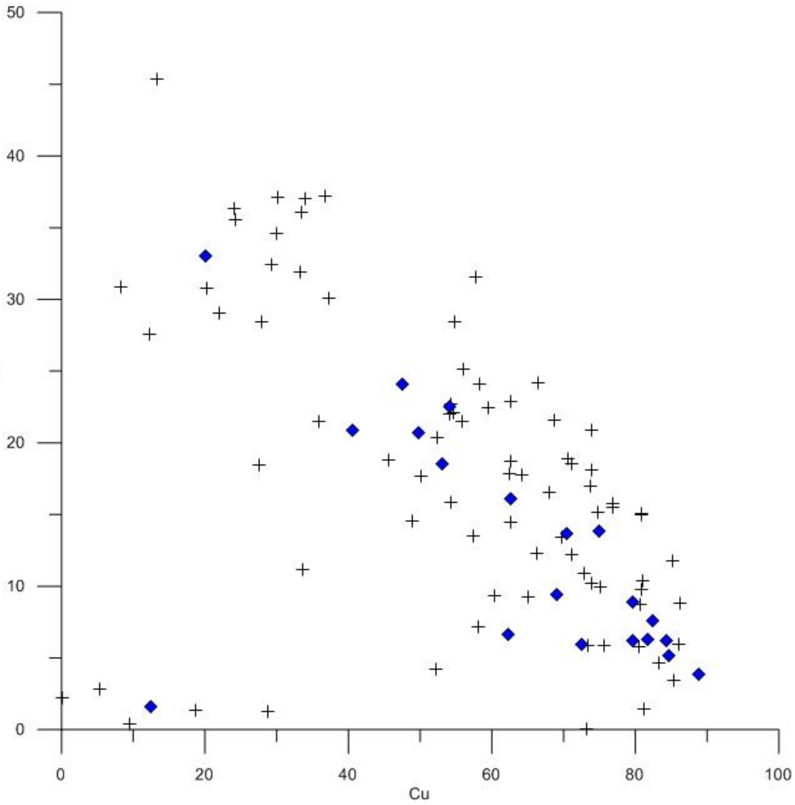

Figure 32: Anglo-Saxon Small-Long type (blue), Cu –Sn

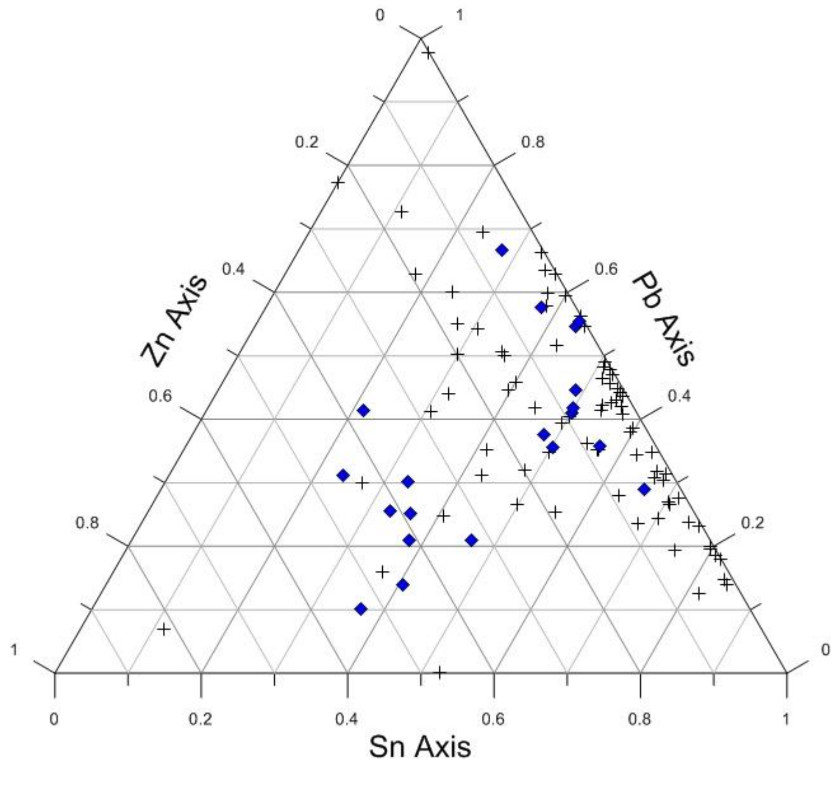

Figure 33: Anglo-Saxon Small-Long type (blue), Sn–Pb-Zn

The ternary plot of tin, lead, zinc ratios displays the presence of two possible groups (fig.33), one of leaded gunmetal and another of leaded bronze. Nine measurements form a more central group to the rest of the material. They represent eight out of the 17 Small-Long brooches. Three of these brooches would be unique to this group (07HALV000141, 07HALV000440, FM 1998-IV-6.7) as they exhibit elongated or pointed footplates. Another is completely unusual (FM 1995-XII-1.92) as it has a ribbed bow and is concave to the rear (suggesting a different casting process). FM 1995-XII-1.93 is a tentatively assigned item comprising a unique paddle shaped headplate and a narrow bow (but with the footplate missing). The three other Small-Long brooches (FM 1995-XII-1.327, FM 1995-XII-1.45, FM 1995-XII-1.83) are present but are not dissimilar to the other group.

A point to note though is that the other group contains significantly more ring & dot decoration than this one. Only one brooch FM 1995-XII-1.83 has this decoration. In the other group (containing nine brooches) six of them bear ring and dot decoration.

4.3.1.3 Square-Headed brooches

The alloy ratios for the seven Anglo-Saxon Square-Headed brooches will now be presented in more detail. Firstly it must be noted that some of this group contain values with high amounts of gold and silver as noted in some of the observations concerning the outliers in fig.19. Also there are a couple of readings containing very high iron values. The likelihood is that at least four of these brooches have received surface treatments. This group therefore will appear in more detail in section 4.5.2 Fire Gilding. From a bulk metals perspective however the group sit well within the Anglo-Saxon material. They could be seen as an inner group considering the low zinc and lead ratios (fig.34), but it is the high values of precious metals and iron that is skewing these plots. The rest of the plots of this small group show no significant grouping although they do sit within the bulk of the Anglo-Saxon measurements.

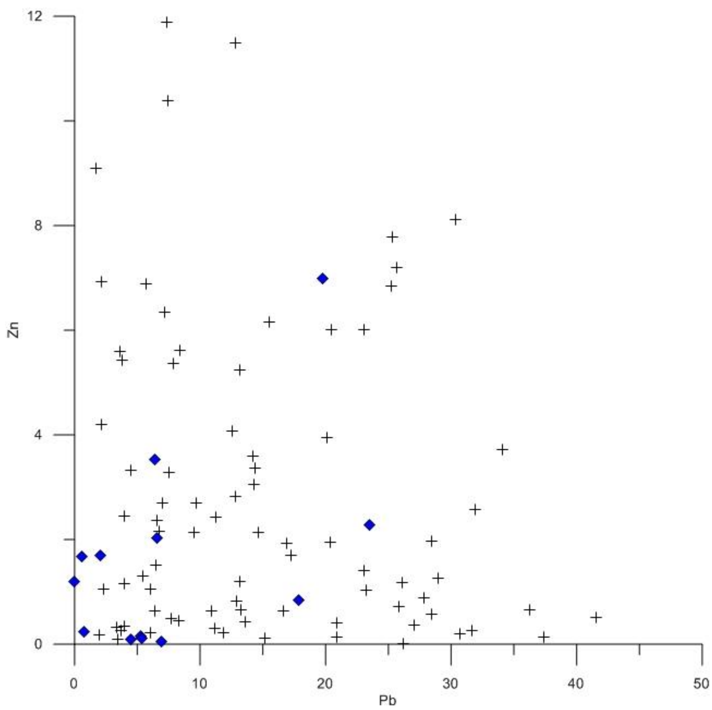

Figure 34: Anglo-Saxon Square-Head type (blue), Zn –Pb

4.3.1.4 Other Germanic brooches

There is a small group of Small-Long brooches that are loosely categorised as Germanic as opposed to Anglo-Saxon. Their headplates are decorated by three protruding knobs in a similar way to the Anglo-Saxon Cruciform types. There are nine measurements from seven brooches broadly dating from the 5^{th} – 8^{th} century. Three of the brooches stand out from the Anglo-Saxon material due to their high zinc values. These can be seen clearly as brass in the ternary plot of tin, lead, zinc (fig.35). FM 1995-XII-1.170 and FM 1995-XII-1.173 are typologically similar having the same notch cut decoration but morphologically differ to the Anglo-Saxon types. FM 1995-XII-1.345 is however a triangular headplate and bow fragment. It could possibly associate with the other two or with the main group.

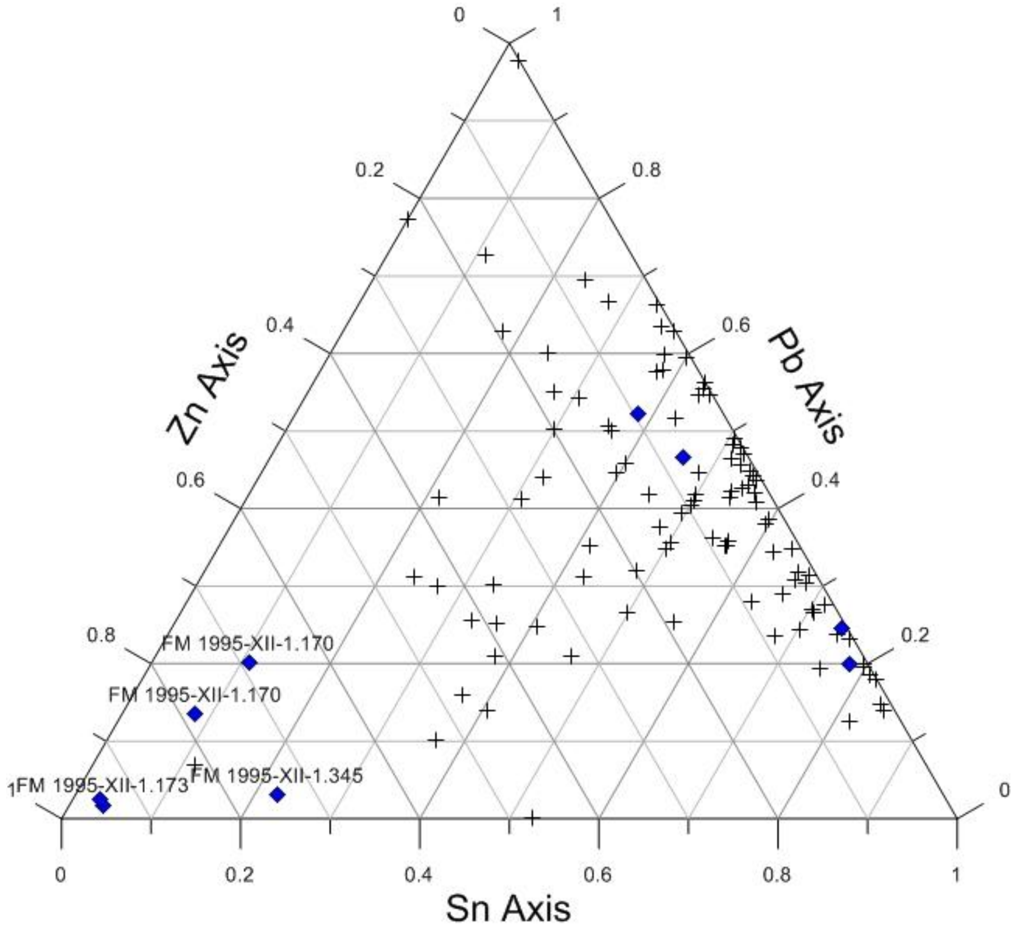

Figure 35: Other Germanic brooches (blue), Sn-Pb-Zn

4.3.2 The Domburg Group

The Domburg group consist of 49 measurements from 47 brooches (or fragments of), broadly dating to the 6th and 7th centuries. Unlike the Anglo-Saxon brooches there are no subgroups presented here although variations in decoration, bow and footplate shapes are present. The majority of this collection (80%) comprise of broken parts. After inspection they do seem to represent individual brooches rather than fragments of each other, although in some cases the broken ends are too worn to match together.

Because of the lack of typological subgroups the first results offered are aimed at addressing the subtle differences in decoration and shape versus differences in

alloy composition. Subsequent scatter diagrams will then address how similar the group is to the earlier but relatively contemporary Anglo-Saxon measurements.

Starting with a ternary diagram of tin, lead, zinc (see fig.36), there appears to be a division above and below the 4% lead to 6% tin line even though the bulk of the brooches are leaded bronze. Typologically speaking the groups above and below this line do not differ to a noticeable degree. Ring and dot decoration is common between the two as is the volute style on the kidney shaped headplates.

The small cluster of measurements around the 30% lead, 10% zinc division represent five headplates (FM 1995-XII-1.50, FM 1995-XII-1.59, FM 1995-XII-1.62, FM 1995-XII-1.71, G2008-11-21) and a footplate (FM 1995-XII-1.325). On visual inspection the kidney shape to the headplates of these fragments appears very identical with a noticeable v shaped midpoint making them more heart shaped than many of the others. The cross-sectional shape of the bow also appears very similar.

At the 50% lead to 50% zinc division appears another closer group of measurements. These comprise of eight headplate and four footplate fragments. Again like the rest of the Domburg group they contain kidney shaped headplates with ring and dot decoration, and volutes. The only two footplates bearing a ‘nostril shape’ end are within this smaller group of measurements (FM 1995-XII-1.98 and FM 1995-XII-1.63). Unlike the previous subgroup, the kidney shape of the headplate varies somewhat as does the carving of the volutes. The thickness of the bows also varies.

Another observation is that the exercise of highlighting measurements from footplate fragments (in blue), versus headplate fragments, may help associate them with their most likely counterparts. This is on the assumption that the alloy measurements from two halves of a broken brooch would be very similar.

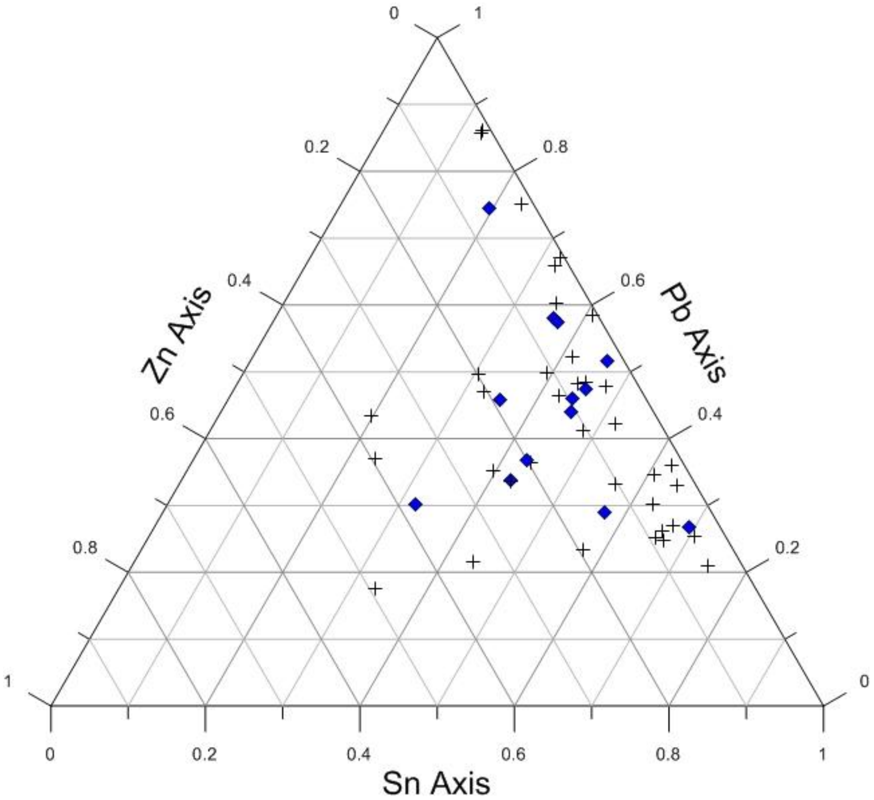

Figure 36: Domburg brooches (footplate fragments in blue), Sn-Pb-Zn

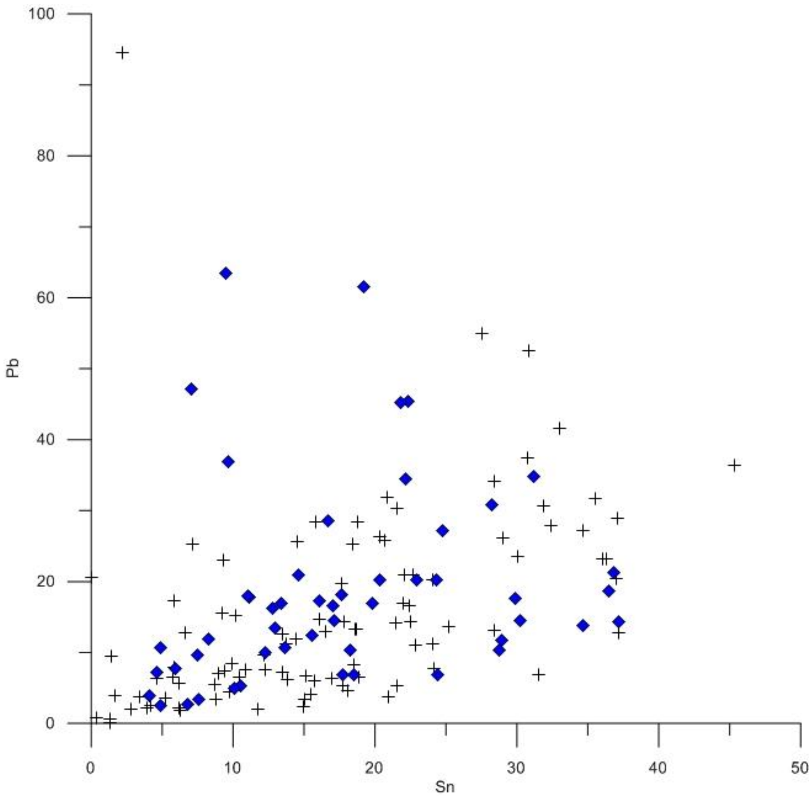

Figure 37: Domburg vs. Anglo-Saxon brooches Sn –Pb

4.3.2.1 Domburg versus Anglo-Saxon

Having looked at the Domburg measurements in isolation, the next scatter diagram presents them against the large group of Anglo-Saxon brooches in order to establish any similarities.

The comparisons of copper to tin and to lead are somewhat unremarkable as both Domburg and Anglo-Saxon measurements mix very closely as leaded bronze or leaded gunmetal. The copper versus zinc ratio is the same with the exception of one outlier (07HALV000266, a complete Domburg brooch from Hallum with large flaring nostrils on an elongated footplate), that has the highest zinc content in the Domburg group. There are six outlying measurements in the lead to tin scatter plot (fig.37), with higher lead content than the rest of the combined group. Typologically however there is nothing to distinguish between them. The ternary scatter plot of tin, lead and zinc (fig.38) also reveal nothing other than that the alloys are broadly similar to each other.

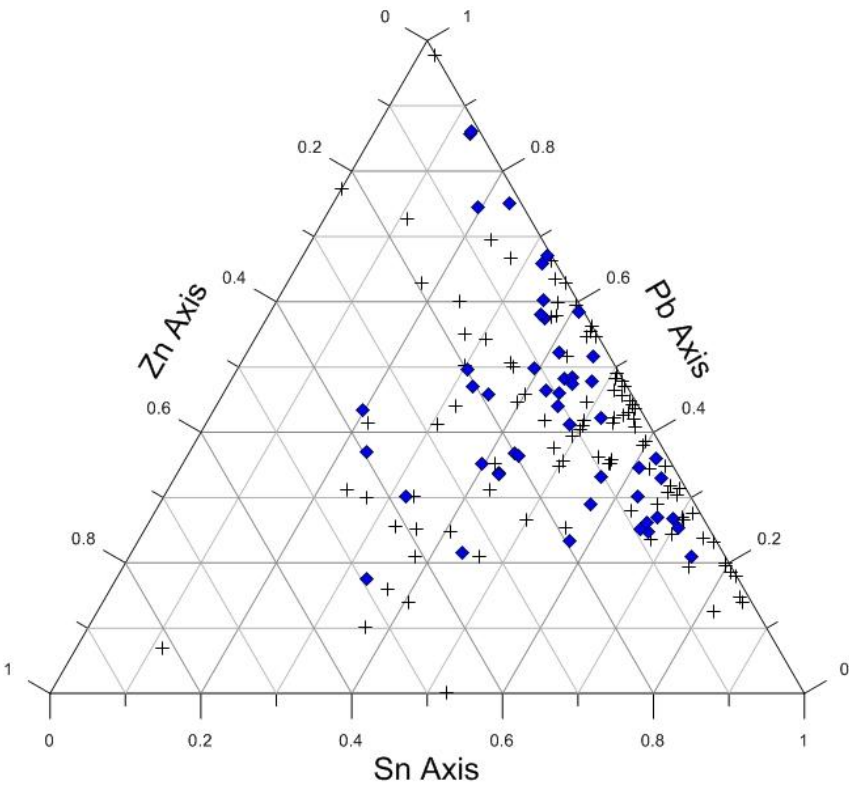

Figure 38: Domburg (blue) vs. Anglo-Saxon, Sn-Pb-Zn

4.3.3 The Frankish Group

There are 30 measurements in the dataset that associate with Frankish or Merovingian culture. Typically dating from the 6th to 7th centuries they include five brooches in the shape of birds, and 13 are fragments of Radiate types. The Radiate type had two readings taken (front and back) but both sets will be presented in the scatter diagrams rather than make an arbitrary choice.

The position of the Bird brooches will be considered first as they represent a very different morphology to the Radiate type. Two of the birds F 2007-IV-138 and F 2007-IV-139 are similar in having their wings folded and are more lifelike than the others. The other three are more two dimensional with the bird image being rendered through carving than casting. The following scatter diagram of copper versus zinc (fig.39) shows the lack of correlation between these techniques. The diagram also demonstrates a reduced level of zinc values compared to those of the radiate brooches, overall though the Bird brooch alloys sit loosely within the same compositional mix as the Radiate alloys.

The measurements for the Radiate brooches included front and rear values, the relationship between these can be seen in the next scatter plot diagram (fig. 40). Three of the brooches exhibited very low base metal values (FM 1995-XII-1.339, FM 1995-XII-1.163 and FM 1995-XII-1.337), instead displaying high gold and silver (40% +) readings. They will be dealt with in section 4.5.2 and have been removed from this analysis. The whole group however displays silver content and a further one FM 1995-XII-1.341 has a 10% gold value on its front face. This makes grouping of the base metals within this small selection more problematic. What is more important is the presence of these precious metals. The zinc values suggest a slight grouping though, with four brooches exhibiting higher zinc to copper ratios than the rest (fig. 41). That said they appear unremarkable when typologically compared to the others.

Finally the Frankish material can be compared with the rest of the Anglo-Saxon and Domburg results (fig. 42). The Frankish material generally exhibits the same

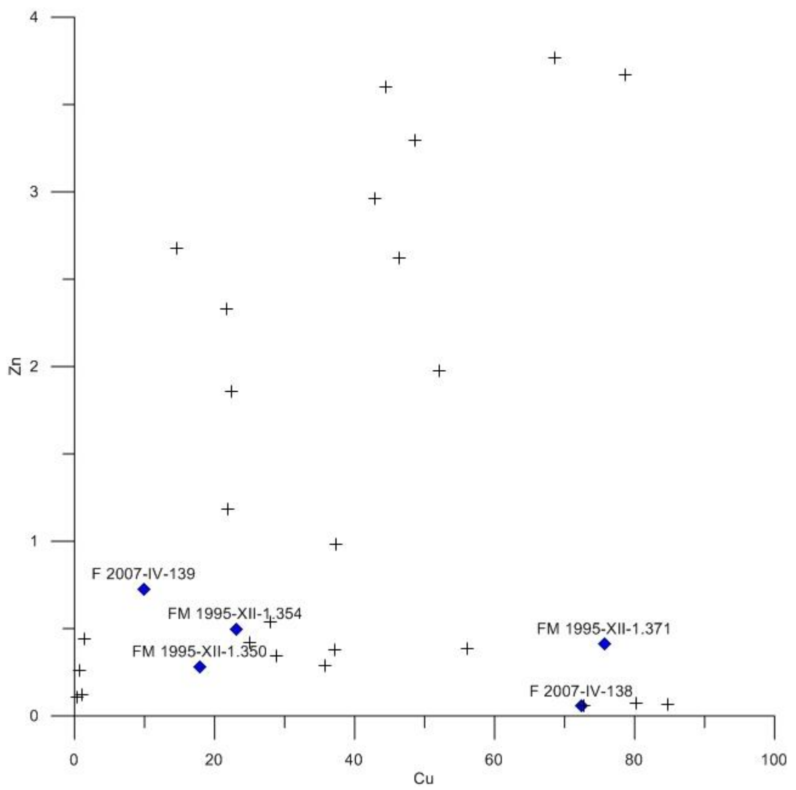

Figure 39: Frankish Birds vs. Radiate brooches, Cu-Zn

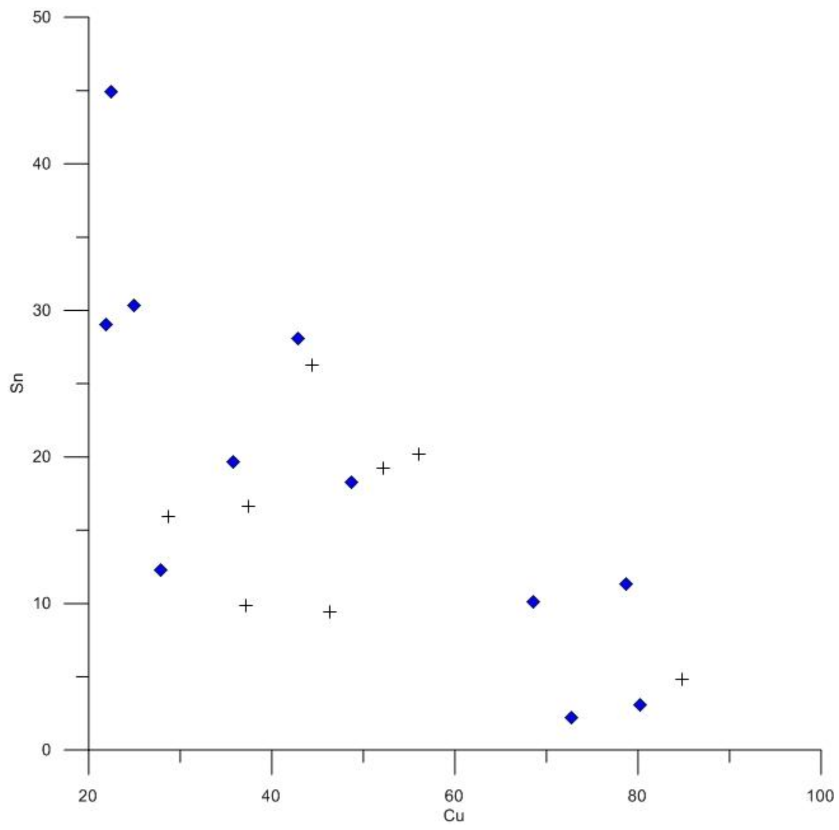

Figure 40: Frankish Radiate brooches (front in blue Cu-Sn)

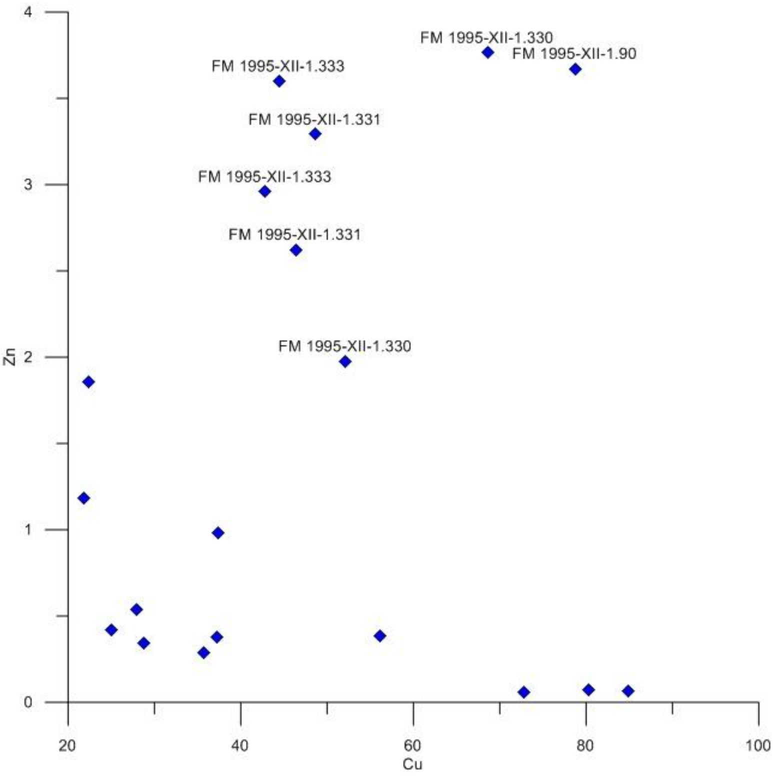

Figure 41: Frankish Radiate brooches, Cu-Zn

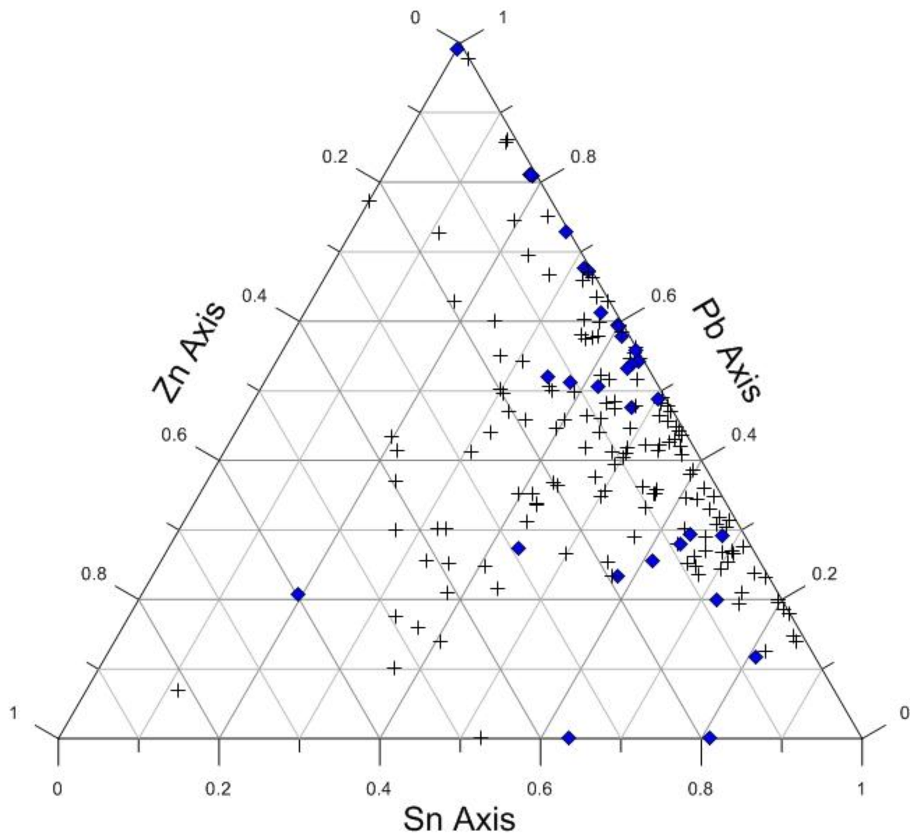

Figure 42: Frankish brooches (blue) vs. Anglo-Saxon & Domburg, Sn-Pb-Zn

mixing ratios as the rest of the 5th to 8th century material. What is noticeable in this diagram is the possibility of two groups existing, one below 50% and the other above the 70% zinc division. Typologically speaking this grouping remains unclear.

4.3.4 Summary

This section presented the results of the hhXRF analysis from the 5th to the early 8th century. The Anglo-Saxon Cruciform brooches have their origins in the last century of the Roman period but last well into the 6th and 7th century. The alloy measurements for these brooches may split into two groups (fig.30) however the reason for this is typologically unclear. The comparison of the outliers to their typologies produced good results in that brooches with questionable or unique attributes matched their outlying alloy values. The relationship therefore between the secure typologies of the main group and their alloy measurements seems good.

The Small-Long category of brooches sits well within the broad Anglo-Saxon body of results, to the extent that they seem to exhibit a tighter level of control in terms of tin content (fig.32). There may also be two groups present, one of which has significantly more ring & dot decoration than the other. On the other hand the Square-Headed brooches were less defined from a bulk alloy perspective. Although they sat within the broad spectrum of Anglo-Saxon measurements their high gold and silver values made them hard to compare. Unfortunately there where only seven of this type which also did not help.

The additional small group of brooches simply labelled as Germanic produced three outliers with notably higher zinc than the Anglo-Saxon group. The outliers again proved to have clear typological differences that set them apart from the main body of Anglo-Saxon and Germanic material.

The larger Domburg group containing 47 whole or fragmented brooches did not produce any grouping along typological lines. There does seem to be a division around the 50% lead to tin ratio (fig.36) which may be the same division being noted in other categories. As there were a lot of broken fragments in this group, the scatter plot analysis may form a new way of matching broken footplates to

their chemically similar headplates. This would enable a more confident assessment of headplate to footplate morphology when assessing typological variation. When the Domburg group was compared to the Anglo-Saxon material little was noted other than both merged into one larger compositional group.

Finally the Frankish collection containing Radiate and Bird brooch groups again display a possible division into two leaded bronze alloy groups, one of them being above the 50% lead, tin ternary line (fig. 42), the other below. The typological meaning remains unclear, as does the alloy composition of the quite individual Bird brooches with their different manufacturing techniques. The Bird brooches set themselves apart from the Radiate group due to reduced zinc levels. The Radiate brooches were found to contain levels of silver and gold that also set themselves apart from the other groups and like the Anglo-Saxon Square-Headed brooches will be reconsidered in the fire gilding section (4.5.2). Other than that they appear to be well within the broader Anglo-Saxon and Domburg distribution.

4.4 The 8th to 12th Centuries: Invasion and a new God

The 8th century sees the end of the 'kingdom' of Frisia. It is generally accepted that after a series of decisive battles resulting in the death of the last Frisian king, the region becomes incorporated into Charlemagne’s Frankish empire. This change also sees the introduction of Christianity to an area that had previously resisted conversion. From this point (broadly speaking) Christian symbols become a very popular motif on brooches and from this time onwards Equal-Arm and Disc brooches replace the styles of the previous centuries.

This section presents by far the largest group of measurements, 694 in total from 478 brooches. The 64 Equal-Arm brooches will be presented first before turning to the much larger group of 425 Disc brooches. The analysis presented here focuses on the group types (of which there are many) that contain a large enough number of specimens to make grouping assessments worthwhile. Also these 8th to 12th century groups demonstrate a clearly different level of compositional control to the previous centuries (fig.43), through a much reduced tin content. Having

identified this division the following results only concern themselves with measurements from the 8th century onwards.

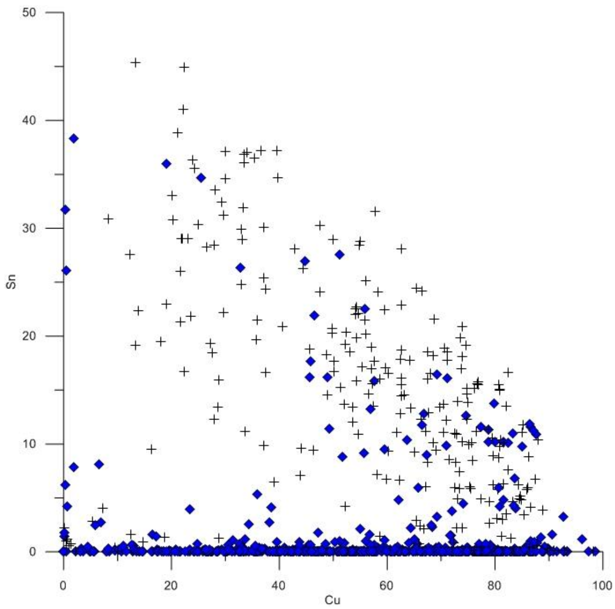

Figure 43: 8th – 12th Century brooches (blue) vs. previous Centuries, Cu-Sn

4.4.1 Equal-Arm brooches

Of the 64 brooches in this category (dating from the 8th to 10th century) the biggest group are the paddle shaped brooches with square ended terminals (Bos 1.8.1.2) numbering 18 in total, followed by a group of 13 with heavy bows (Bos 1.3). There are an additional eleven subgroups represented but as the numbers of brooches present only range from one to four each they were not analysed in their own right.

The first diagram presented in this section (fig.44) contrasts the Equal-Arm alloys against those of the contemporary Disc brooches. Having analysed the different element ratios, a large number of Equal-Arm brooches are leaded bronze and leaded gunmetal as opposed to the Disc brooches leaded brass and leaded copper.

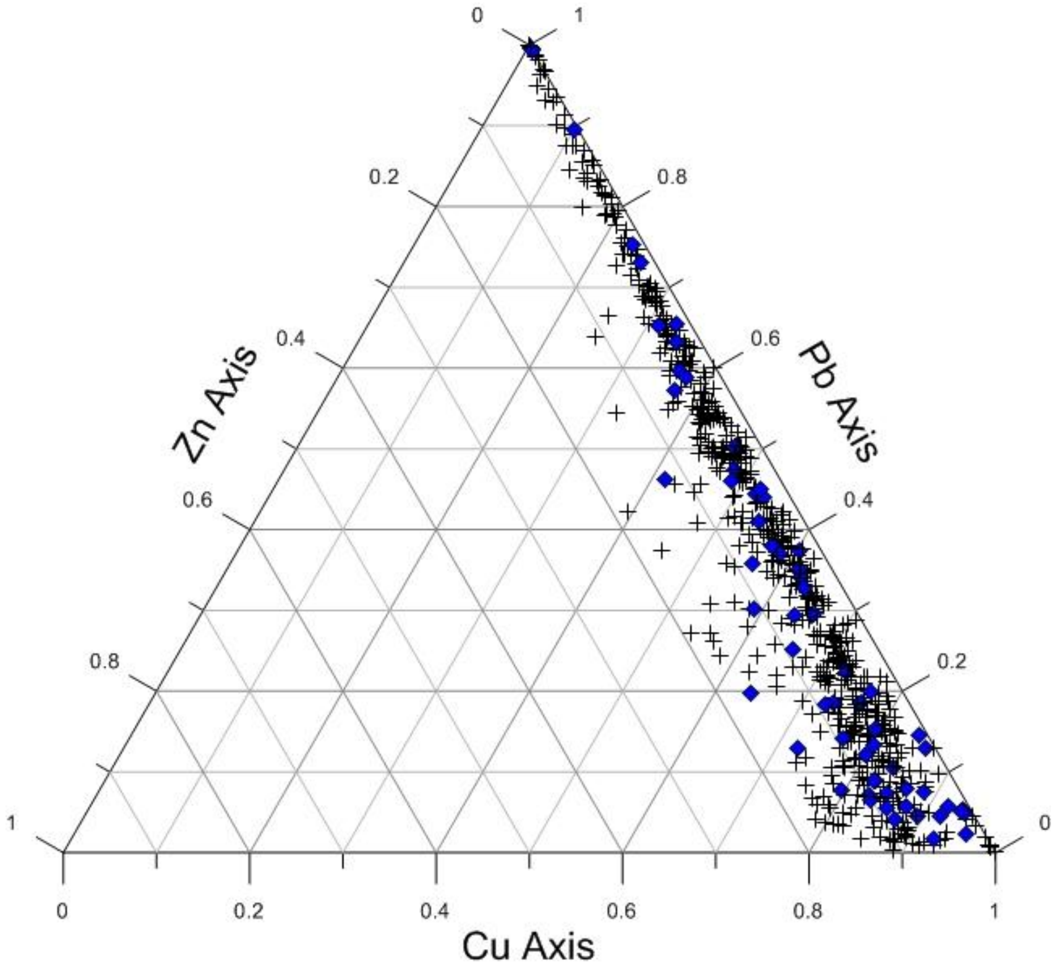

Figure 44 Equal-Arm brooches (blue) vs. Disc brooches, Cu-Sn-Pb

4.4.1.1 Paddle Shaped brooches (Bos 1.8.1.2)

This subgroup of brooches, (the ‘Bow Tie’ type) is by far the most common of the collection and the alloys appears to be either leaded brass or leaded copper. It is typified by square ended terminals with grooves that resemble bow ties. As noted earlier in the chapter the tin levels in the alloys of this period are very low. This is the case for this ‘bow tie’ group. This exercise however highlighted a large number of outliers (22 out of 63 measurements) that did contain tin and looking at their position bear more resemblance to the alloys from the 5^{th} – 8^{th} century (fig.45). This outlying group, seen as the scattering of black crosses, contain eleven out of 13 of the Heavy Bow type (Bos 1.3) that will be discussed in the

next section. The others include four miscellaneous brooches (Bos 1.9 and 1.10) and two from the square ended terminal group (Bos 1.8) of which one is a 'Bow Tie' type. The last is the only 1.6 type containing cross decorated circular terminals.

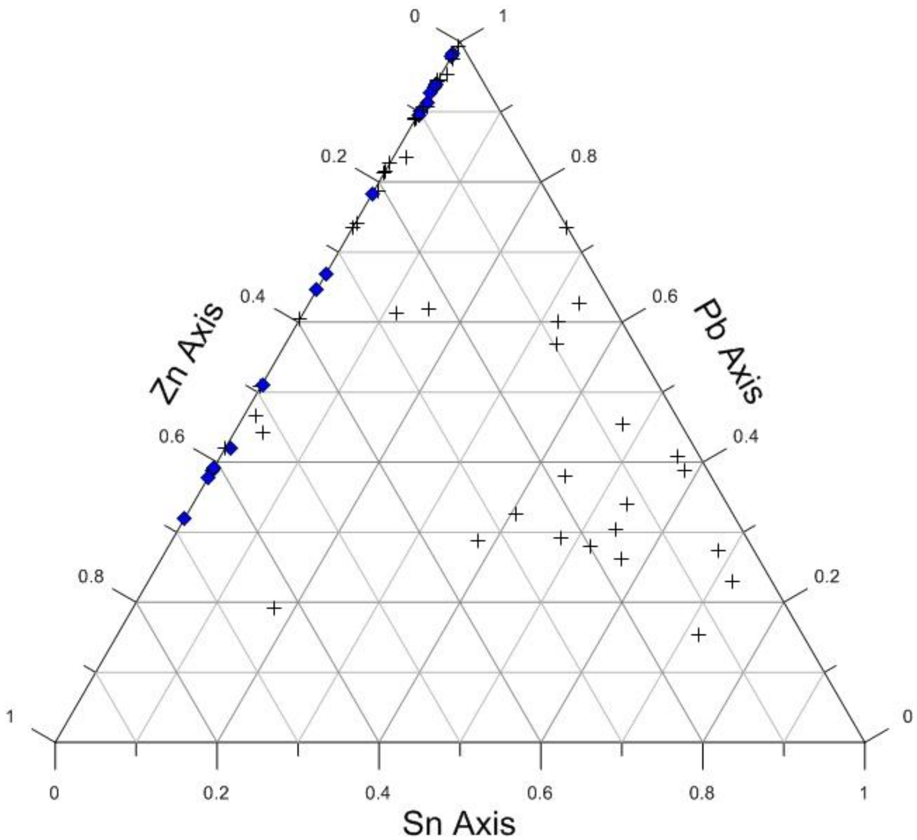

Figure 45 'Bow Tie' type (blue) vs. Equal-Arm brooches, Sn-Pb-Zn

4.4.1.2 Heavy Bow type (Bos 1.3)

As mentioned in the last section, this type does not associate with the larger 8th – 12th century but more with that of the earlier centuries. The following diagram (fig.46) demonstrates this relationship in appearing to have a leaded bronze or leaded gunmetal composition.

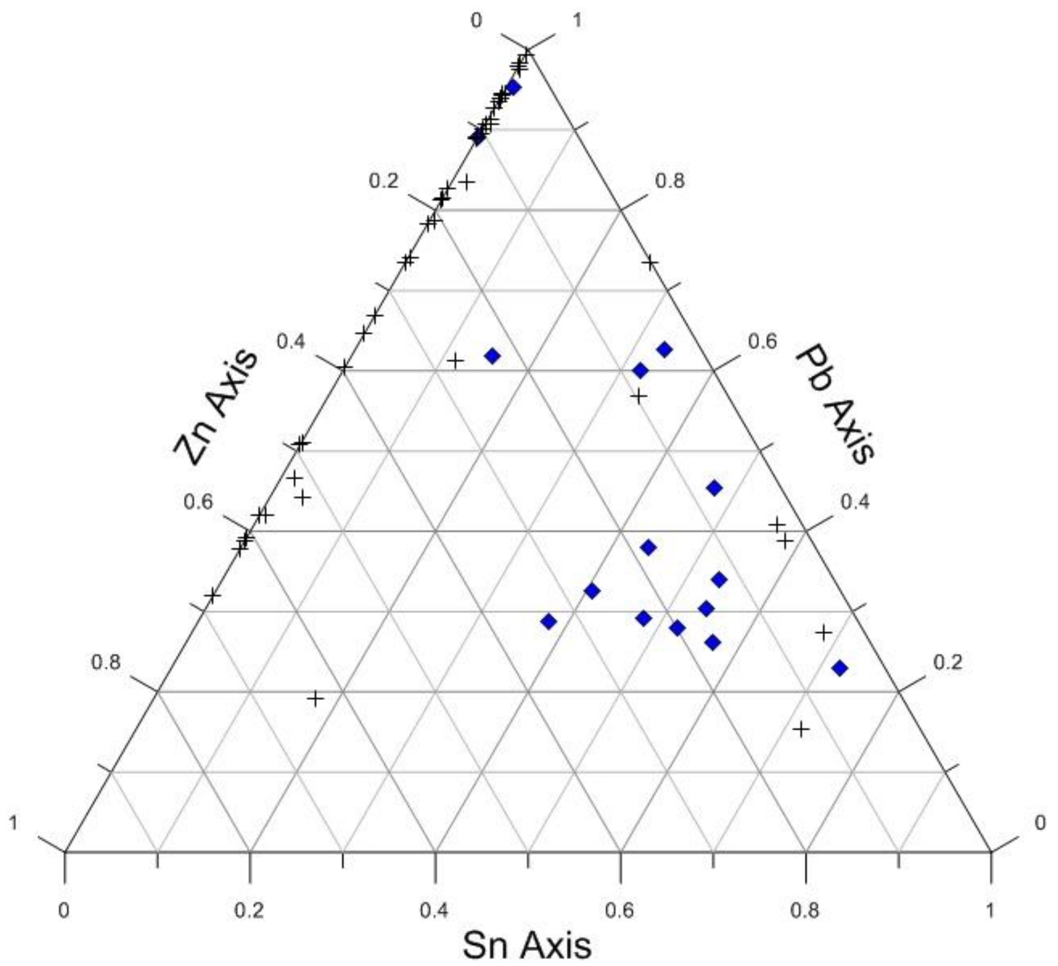

Figure 46 Heavy Bow type 1.3 (blue) vs. Equal-Arm brooches, Sn-Pb-Zn

The group of measurements between the 0.2 and 0.4 divisions on the lead axis comprise the measurements from eight brooches from the Heavy Bow type 1.3.2.1 to 1.3.2.3. The differences being decorative, Bos offers that some archaeological examples have been dated to the 6th – 7th centuries (Bos 2006, 459).

4.4.2 Disc brooches

The results of the Disc brooch analysis will be presented next. This is the largest type encountered in my research comprising of 425 individuals. This presents the opportunity to use the hhXRF measurements look at alloy control in larger typological groups. The brooches were classified by the typology created by Bos

(2006) and associate themselves with over 90 of his categories. To present the results of all of these groups on an individual basis would be lengthy and due to the small numbers present in each case would not necessarily contribute more information at this point. The groups that will be presented are those with large numbers of brooches assigned to them and are as follows in table 7.

Table 7 Disc brooch typologies with largest quantities

		No.	
Pseudo Coin (Bos 2.6)	x	60	
Button or Nabenemailscheibenfibeln (Bos 2.1.2.1)	x	51	
Maltese Cross (Bos 2.5.1.1)	x	35	
Saints or Helligenfibel (Bos 2.7.1)	x	22	
		168	Total

The small number of Scandinavian brooches will be submitted last as a contrast to the local or more southern association, inferred in the bulk of this Carolingian period material.

4.4.2.1 The Pseudo Coin brooches (Bos 2.6)

There are 106 measurements from the Pseudo Coin type relating to 60 actual brooches. This is because two readings were typically sought, one on the front and one on the rear. The corrosion on the front face of many of these brooches was noticeably different to that of the back (especially on the Regtop brooches which still had a lot of dirt attached to the front faces). These brooches divide into nine sub groups which are divided by small differences in decoration on the front face (table 8).

Table 8: Pseudo Coin subgroups

		No.
Pseudo Coin, double bead rim, 2 smooth circles (Bos 2.6.1)	x	3
Pseudo Coin, single beaded rim (Bos 2.6.2.1)	x	2
Pseudo Coin, double bead rim (Bos 2.6.3.3)	x	4
Pseudo Coin, beaded rim (Bos 2.6.4.1)	x	4
Pseudo Coin, 'hair & bust', beaded rim (Bos 2.6.4.3)	x	10
Pseudo Coin, double beaded rim (Bos 2.6.4.4)	x	1
Pseudo Coin, 'Louis the pious' (Bos 2.6.5.1)	x	10
Pseudo Coin, 'Louis the pious', beaded rim (Bos 2.6.5.2)	x	13
Pseudo Coin, 'Louis the pious', double beaded rim (Bos 2.6.5.3)	x	4
Pseudo Coin, legend, multiple beaded rim (Bos 2.6.6.2)	x	3
		54 Total

Initially the comparison of the whole Pseudo Coin category versus the 8th – 12th century assemblage will be presented followed by a closer look at alloy compositions of these subgroups themselves.

4.4.2.2 Pseudo Coin brooches versus the 8th – 12th century

As is typical of the 8th – 12th century material the Pseudo Coin brooches contain very low levels of tin. Also comparing the zinc levels against copper there appears to be little to differentiate them. A ternary scatter plot graph of lead to zinc in relation to the copper levels indicates some grouping but not as an individual typology. The grouping matches a broader pattern present in the 8th – 12th centuries (fig. 47) where the results seem to be divided into three large groups. The first is below the 30% lead division, the second is from the 30% to the 45% break, the third is above this value.

The analysis of the central group gives a very strong correlation between the taking of front and rear measurements. This central group comprises of 24 measurements of which 15 are taken from the rear face. The front values that pair to these sit in the other groups. That said, these rear values still group due to a similarity in alloy values (fig. 48), but there is nothing typologically to link them further, nor do the find locations on the terps suggest anything more.

4.4.2.3 The Pseudo Coin Subgroups

The 3 largest of these groups (2.6.4.3, 2.6.5.1 and 2.6.5.2) were compared to the larger dataset but did not exhibit any noticeable grouping. They are essentially leaded brass or leaded copper.

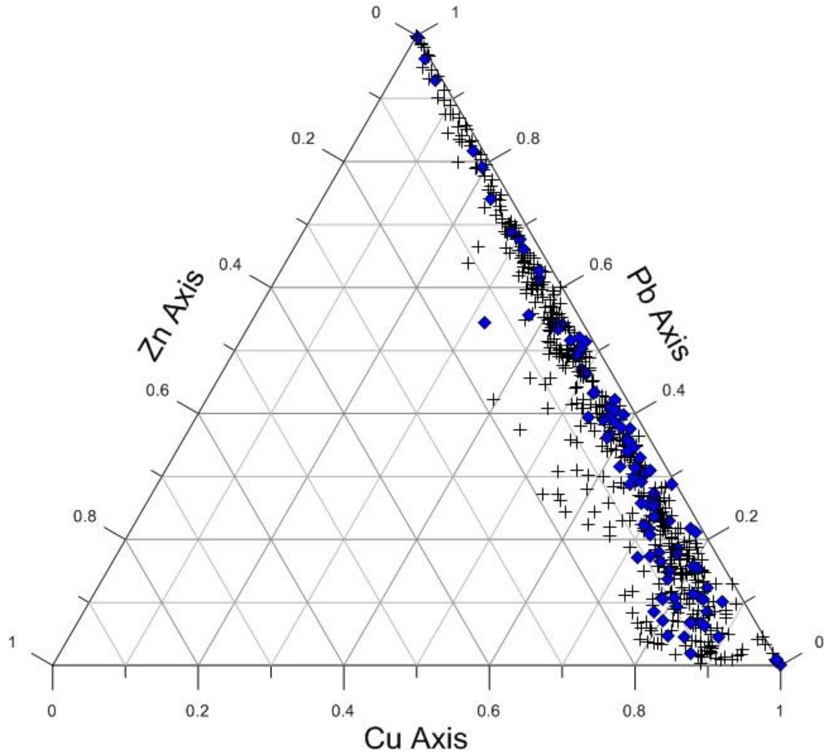

Figure 47: Pseudo Coin brooches (blue) vs. 8^{th} – 12^{th} Century, Cn-Pb-Zn

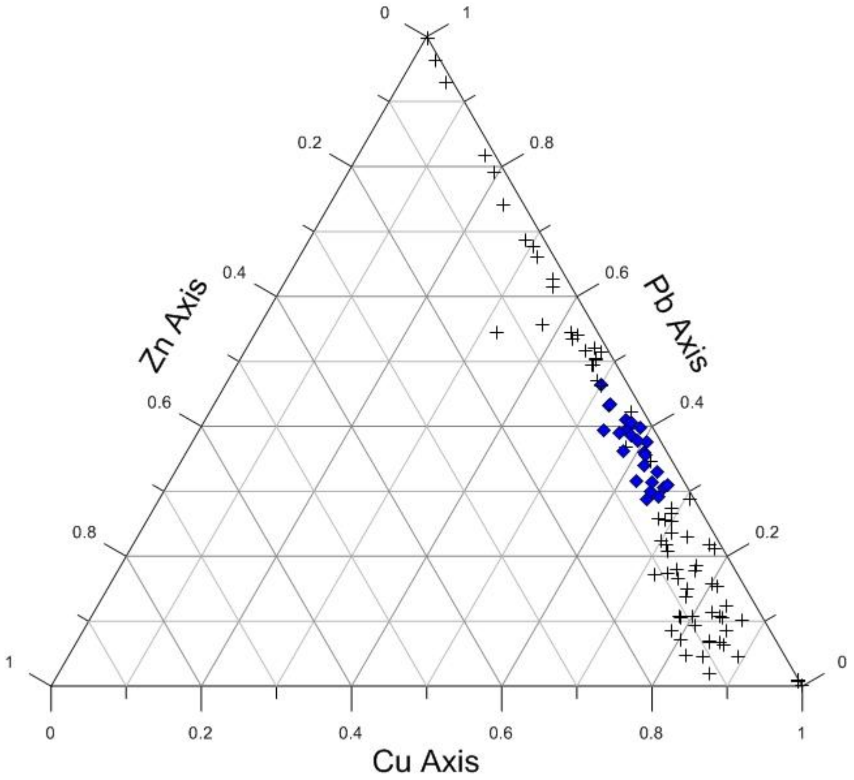

Figure 48: Pseudo Coin brooches: group of rear readings (blue)

4.4.2.4 The 'Button' brooches or Nabenemailscheibenfibeln (Bos 2.1.2.1)

These Disc brooches (of which there are 51) are unusual in that they only measure around 11mm in diameter with a subsequently small pin. The use in terms of garment fasteners remains uncertain, possibly intended for children (Bos 2006, 715). Even though this type of brooch was enamelled, measurements on the rear were not taken. The inner metal ring was the target for the sole reading as it was very frequently free from patina.

The scatter diagram of lead versus zinc for this 'button' group of brooches demonstrates a grouping suggestive of leaded copper, typically over 40% lead but below 6% Zinc (fig. 49). As per the rest of the period, tin levels were negligible.

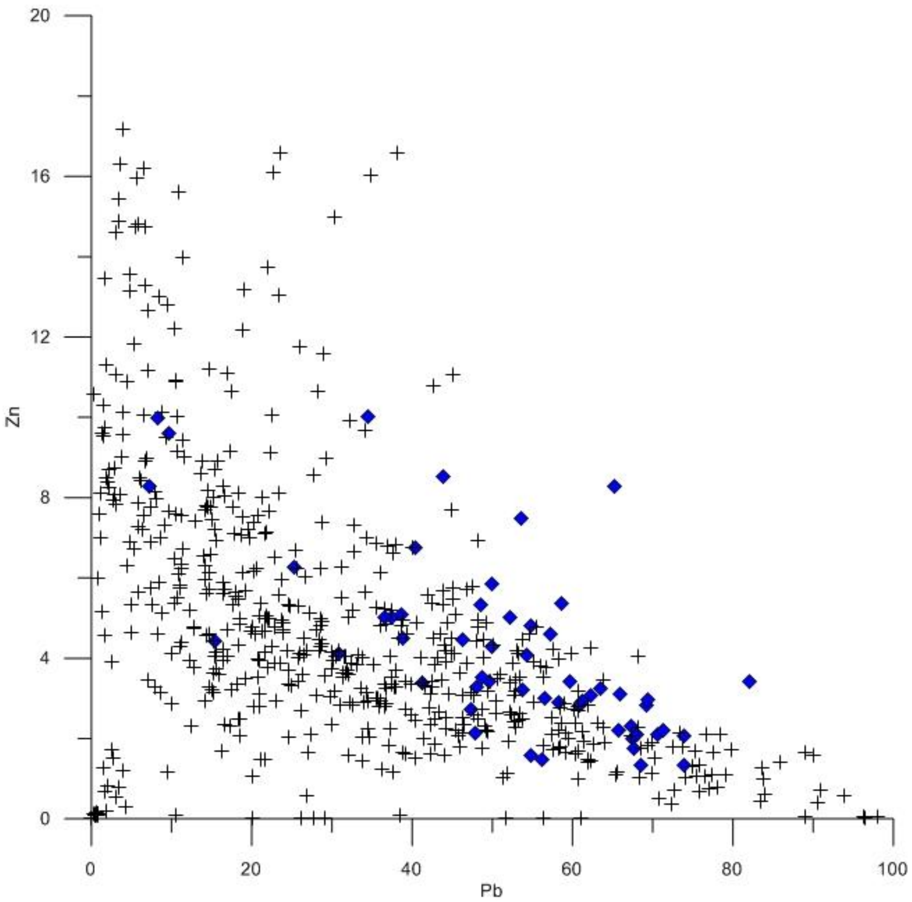

Figure 49: 'Button' brooches (blue) vs. 8th -12th Century, Pb – Zn

4.4.2.5 Maltese Cross brooches (Bos 2.5.1.1)

The Maltese Cross motif is by far the most common image in the dataset. Whilst Bos's category groups this image it also combines three different production techniques. There are 59 measurements from 35 brooches, 18 of which are made in the cloisonné technique. Because these brooches were enamelled, front and rear measurements were taken resulting in the extra measurements. The differences between these measurements will be presented in section 4.5.1.

The first scatter diagram presents this group in relation to the rest of the 8th – 12th century dataset (fig. 50).

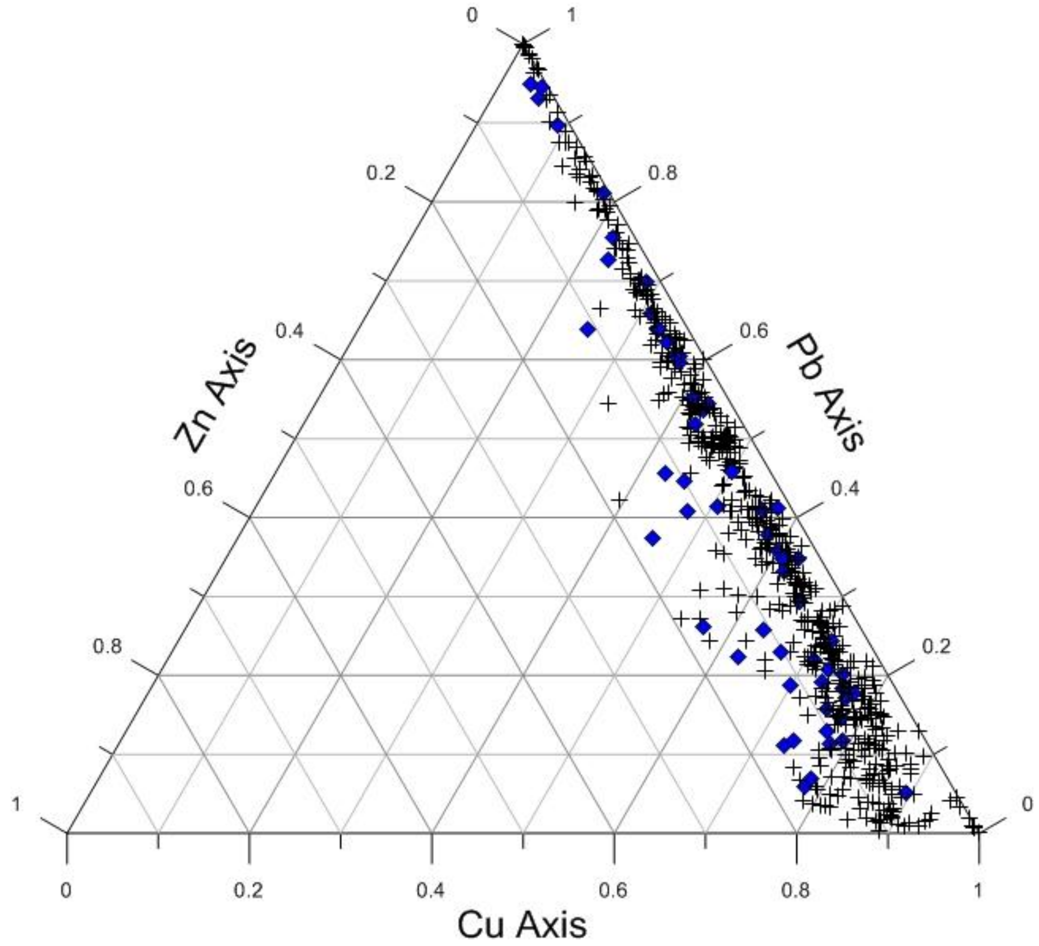

Figure 50: Maltese Cross brooches (blue) vs. 8th -12th Century, Cu-Pb-Zn

There are a noticeable number of measurements that fall between the 0.8 to 0.9 copper limits. Also the group seems very under represented over the 0.8 copper and under the 0.2 lead divisions. The group of plots that fall behind the 0.9 copper division are from a similar mix of manufacturing techniques (cloisonné or champlevé*).* A common factor is that all these measurements are from the front face of the brooches. These brooches are either leaded copper or to a lesser extent leaded brass.

4.4.2.6 Cloisonné compared to Champlevé

There is no reason for the alloys for these two different techniques to be different. In principle both types start by casting a similar 'blank' brooch onto which the different cell making techniques are applied. The exception could be the copper alloy wire used to create the divisions in the cloisonné process. Fig.51 presents the scatter diagram of cloisonné versus champlevé hhXRF readings from which two groups are noticeable.

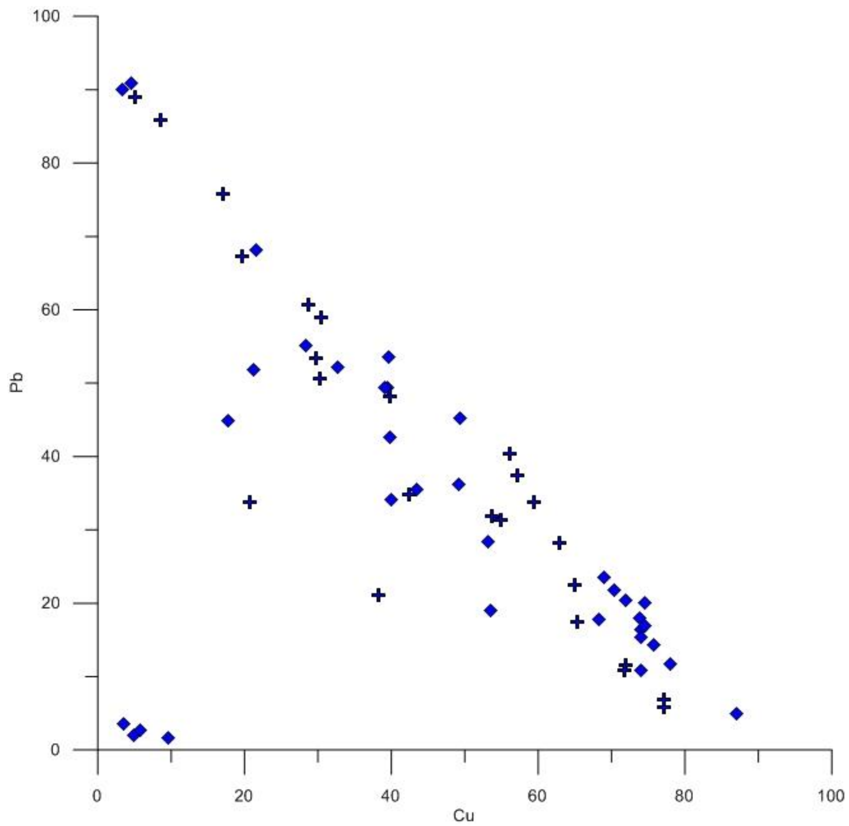

Figure 51: Cloisonné (blue) vs. Champlevé, Cu-Pb

The first are a group of four measurements exhibiting very low copper and lead values. All of them are front face readings from the cloisonné technique. These measurements gave very low readings of bulk metal and that may associate with the hhXRF analysis missing the thin wire amongst the corroded glass and dirt.

The second group gather around the 70% copper – 20% lead intersection. These are twelve measurements all from brooches finished in the cloisonné technique. They are an equal mixture of front and rear readings from different brooches. This does seem to relate to a general grouping theme seen in the combined plot of all Disc brooches (fig.51).

4.4.2.7 Saints or Helligenfibel (Bos 2.7.1)

This section presents the scatter plot results for this very individual group of brooches, enamelled in the *c*hamplevé technique. The initial analysis looked for trends compared to the bulk of the 8th-12th century dataset. The second compared readings against the typological subgroups created by Bos. There are 29 measurements from 22 brooches, which divide into the following typological subgroups (table 9).

Table 9: Saints brooch subgroups

		No.
Saints (Bos 2.7.1.2)	x	11
Saint with symbols? (Bos 2.7.1.3)	x	1
Saint 'Frisian type' (Bos 2.7.1.4)	x	2
'St Peter & St Paul' (Bos 2.7.1.4 or 5)	x	1
Saint with pallum dot (Bos 2.7.1.5)	x	3
Saint no torso 'Frisian Type' (Bos 2.7.1.6)	x	1
Saint unidentifiable (Bos 2.7.1.9)	x	3
		22 Total

This first scatter plot diagram (fig.52) presents the whole group against the 8th – 12th century dataset and the group generally conforms to this period. However there is a notable exception in that the central outlier (leaded gunmetal),

containing four times as much tin as the rest is the 'St Peter & St Paul' brooch from Oud Naarden (ON020) found 150km south of the rest of the group.

Looking at the arrangement of alloy compositions just within the Saints group produced the following observation. The analysis of the ratios of copper, lead and zinc produces a

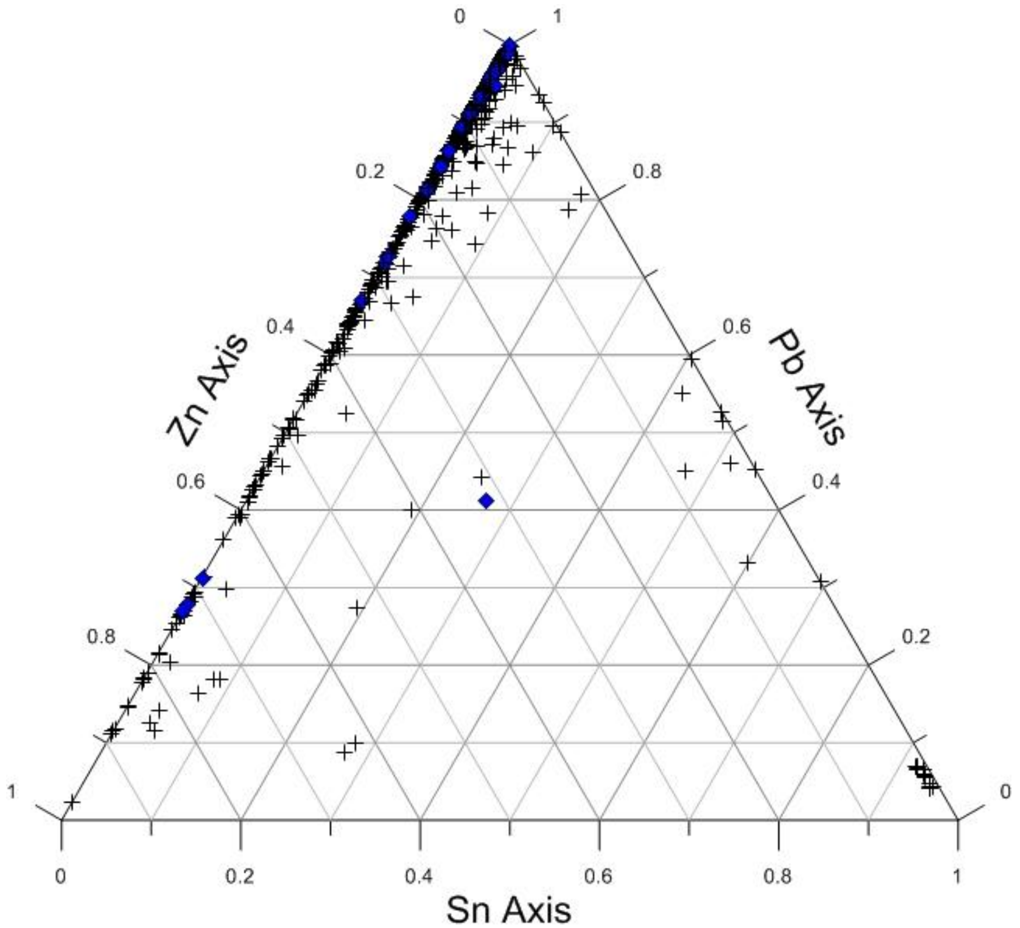

Figure 52: Saints brooches (blue) vs. 8th-12th Century, Sn-Pb-Zn

clear grouping along regional lines (fig.53). The alloys from Friesland, Groningen and Oud Naarden group separately from each other. The two Oud Naarden brooches (blue) sit under the 10% lead division. The five Groningen brooches

(also blue) sit above the 50 % lead division. The rest of the collection from Friesland, sit in between these values.

There is also a regional correlation with the colour of the enamels on these brooches. The remaining enamel on seven of the brooches from Friesland and Groningen are still a bright clean red. This does not conform to Frick's colour typology for this type (1993, 289).

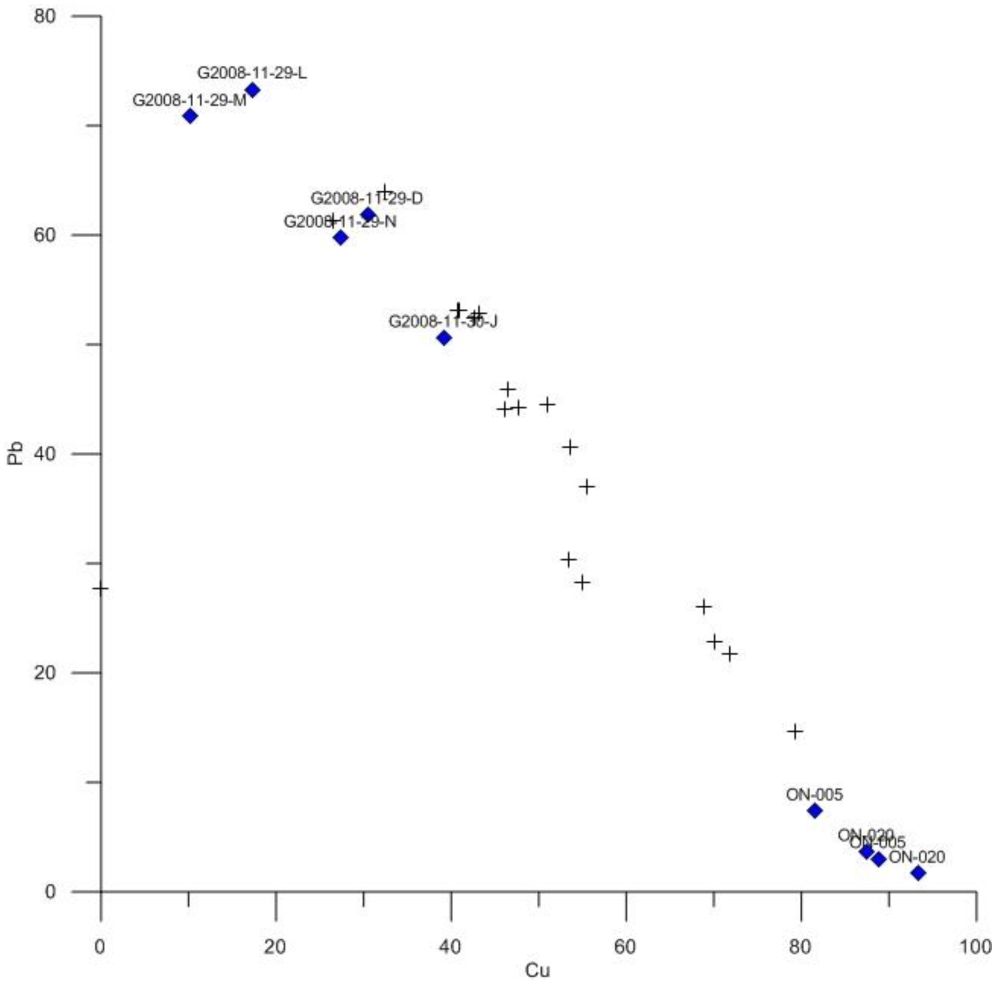

Figure 53: Saints brooches regional distribution (Friesland = crosses), Cu-Pb

4.4.2.8 The Scandinavian types

Lastly in order to engage with Frisian contact with the Viking world the brooches considered to be Scandinavian or Anglo-Scandinavian will now be presented (table 10). Of the 478 brooches analysed from the 8^{th} – 12^{th} century only five have been identified as having Scandinavian links and as such do not conform to the Bos typology.

Table 10: Scandinavian Disc brooches

		No.	
Disc brooch, Convex, decorated. Groningen province	x	2	
Trefoil brooch. Friesland	x	2	
Anglo-Scandinavian brooch (English?). Oud Naarden	x	1	
		5	Total

This first scatter diagram (fig. 54) presents their position in relation to the rest of the 8^{th} – 12^{th} century dataset. All of the group sit away from the bulk of the Carolingian alloys. The furthest away is the tentatively attributed Anglo-Scandinavian (English?) brooch, from Oud Naarden, with the highest tin level. The two trefoil brooches from the Friesland area have the next lowest tin level. Lastly the two decorated concave Disc brooches from Groningen sit closely to the bulk of the 8^{th} – 12^{th} century dataset, but sitting at the upper end in terms of lead content. They are all leaded bronzes.

4.4.3 Summary

This section presented the results of the hhXRF analysis of the 8^{th} – 12^{th} century brooches. The comparison of the previous 5^{th} to 8^{th} century data demonstrated a widespread downward shift in tin content that is very noticeable in the scatter diagrams. The alloy mixtures of the Carolingian period exhibit a shift to leaded

brass and leaded copper from the leaded bronze and leaded gunmetal of the previous centuries.

The Equal-Arm brooches are typical of the 8th to 10th centuries but an early form with a heavy bow does not group with the rest. The typology put forward by Bos claims that this Heavy Bow form (Bos 1.3) dates back as far as the 6th – 7th century (Bos 2006, 459). This is supported by the scatter diagrams where this type associates very closely with the brooches of the earlier centuries. The 'Bow Tie' type however (Bos 1.8.1.2) which is the largest Equal-Arm group conforms entirely to the 8th -12th century

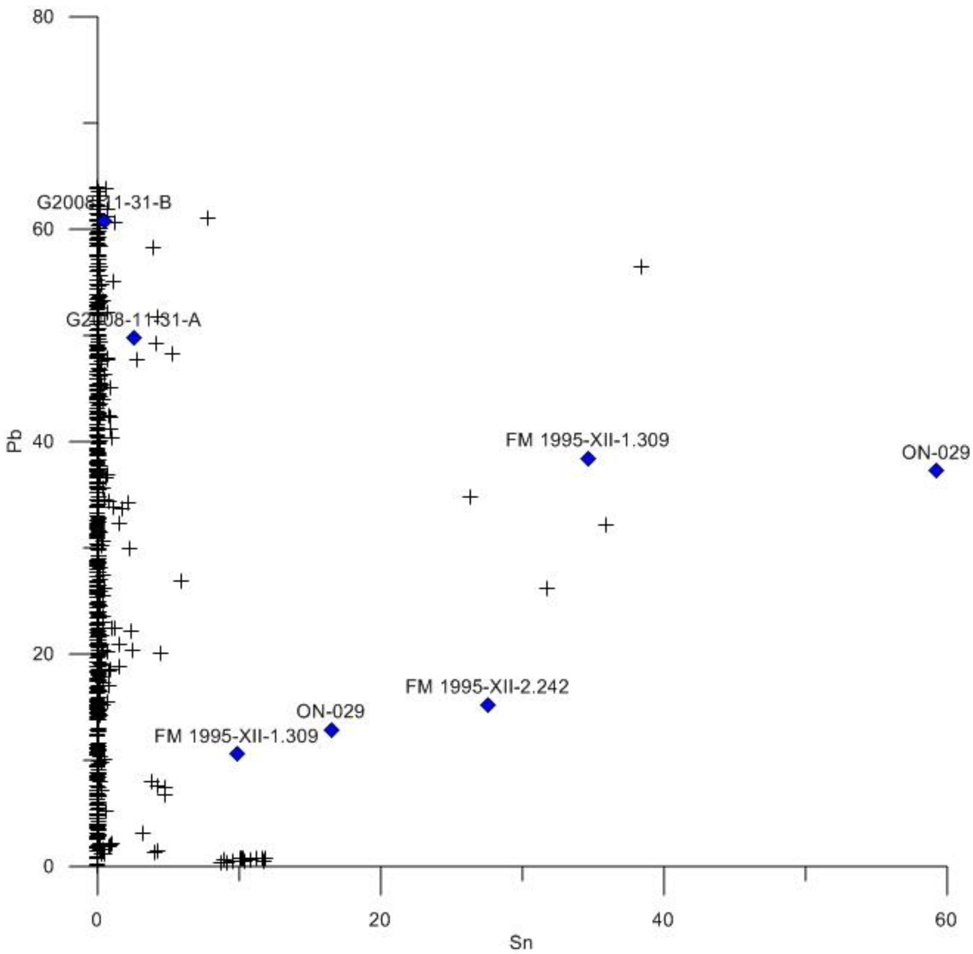

Figure 54: Scandinavian brooches (blue) vs. 8th – 12th Century, Sn-Pb

The Disc brooches represent by far the largest group in the analysis. Within this category the Pseudo Coin brooches (Bos 2.6) contained the largest number of individuals. These 60 brooches (which were organised into further subgroups) demonstrated a strong association with the 8th – 12th century dataset. However a measurement of the front face of the brooch was taken in conjunction with one on the rear. When these paired values were analysed 15 rear values grouped in association with a larger group of non Pseudo Coin brooches (the front values of which did not group). There were no obvious typological reasons for this observation.

The individual typological subgroups were also analysed but again no obvious grouping of alloy readings was noted. These typological subgroups were based on subtle changes in the decoration that may not have been historically significant, hence the grouping of the rear values.

The next group to be analysed was the 'Button' or Nabenemailscheibenfibeln type (Bos 2.1.2.1) of which there were 51 individual brooches. As with the Pseudo Coin type they conformed strongly with the 8th – 12th century alloys. But in addition to that they also form a subgroup in their own right comprising of leaded copper.

The Maltese Cross groups were more problematical because the aesthetic orientated category combined two enamelling techniques (Cloisonné and Champlevé). These techniques where recorded during the research phase of the project and so form the basis for the research into this group. The results of the analysis of the Cloisonné types (fig.51) produced a group of four very low metal content readings probably due to corrosion and the hhXRF analysis missing the very thin wire cell divisions. Another twelve Cloisonné values combined in association with a larger cluster of "non Maltese" readings around the 70% copper, 20% lead ratio. Within the twelve values nothing typologically significant was noticed and the champlevé plots did not cluster.

One final observation was that readings from the front faces of the cloisonné types became outliers in the copper, lead, zinc ternary plot (fig.51), primarily through a reduction in copper levels.

There were 22 Saint brooches in the study which like the Pseudo Coin category Bos divides into further subgroups. This group conforms to the bulk of the 8th - 12th century dataset with the exception of one outlier, the double Saint brooch from Oud Naarden whose alloy comprised of leaded gunmetal.

Subsequent analysis of the alloy ratios revealed that the Saints type grouped by regional distribution (I.E. Friesland, Groningen, Oud Naarden) rather than by typology (fig.53).

Lastly the small number of Scandinavian brooches did not associate with the bulk of the 8th-12th century dataset even though the dating for these Viking age pieces is well substantiated. Essentially they are leaded bronzes more akin to the brooches of the earlier centuries. The furthest removed (and therefore demonstrating the highest tin level) is a brooch from Oud Naarden that has no comparisons in the regional literature but has a comparison in the English Portable Antiquities scheme database as a late Anglo-Saxon (English) or Anglo-Scandinavian brooch. The next closest are the two fragments of trefoil brooches displaying much higher tin levels compared with the main group. The two convex disc brooches sit quite closely but do not quite integrate with the bulk of the 8th-12th century dataset that on the whole exhibits very negligible tin levels.

Overall the results of the hhXRF analysis show evidence of alloy measurements grouping both chronologically and typologically. The alloys of the brooches from the 5th to 8th centuries comprised of leaded bronze and leaded gunmetal, with a shift to leaded brass and leaded copper from the 8th century onwards.

4.5 Techniques of the trade: Enamelling, gilding & compositional choice

This section provides the results of the hhXRF analysis of techniques rather than those aimed at understanding chronological and typological distribution. What is the effect of taking an hhXRF measurement on a treated surface such as the many Carolingian period enamelled Disc brooches, or the earlier Anglo-Saxon Square-Headed brooches, showing evidence of fire gilding? Also did the early medieval artisans use different alloys when producing different groups of objects? The results of these studies are presented here.

4.5.1 Enamelling

This analysis was conducted to see how the hhXRF measurements compared when recorded from enamelled brooches. The following scatter plot diagrams present the difference in readings between the front and rear faces of three groups, selected for this analysis. All are Maltese Cross brooches (Bos 2.5.1.1) but the level of remaining enamel and alloy cell divides is different. The first group, presented on the left are nine brooches enamelled in the Cloisonné technique. The copper alloy wires that create the cells are very thin and the glass although corroded is intact. The second group is of five brooches enamelled in the champlevé technique with much thicker copper alloy cell walls and some corroded enamel in place. The last (on the right) is a group of three Champlevé brooches from Oud Naarden. They have no enamel remaining and therefore are most similar to their rear surfaces.

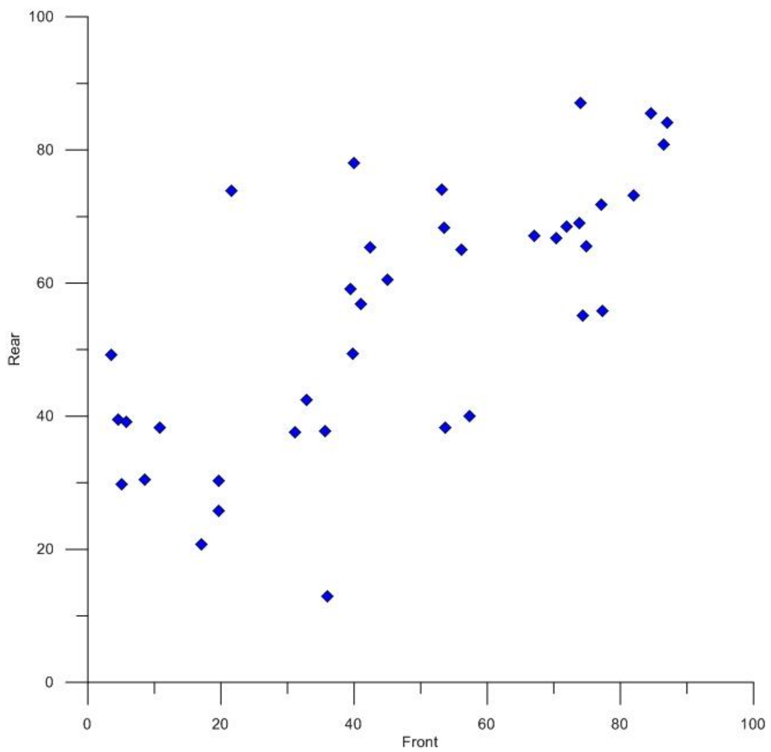

Figure 55: Maltese Cross brooches: Copper - Front vs. Rear

The analysis of the copper levels (fig.55) demonstrated that the Oud Naarden pairs were closest matched with an average 16% difference between front and rear. The next closest were the champlevé brooches at an average of 32% difference. The highest difference was with the cloisonné brooches at 51%. Typically rear faces contained higher copper content than the front.

The difference in lead content (fig. 56) was as follows. The champlevé brooches scored about the same at 40% and 44% (Oud Naarden). As with the copper the cloisonné brooches performed worst with a 54% difference. In this analysis the front faces contained the higher lead values compared to the rear.

The analysis of the zinc levels produced the following results (fig.57). The readings from the group of five champlevé brooches were most alike at an average of 37% difference. The cloisonné and Oud Naarden groups were similar at 43% and 45% respectively. There was no trend in the case of zinc in terms of the front or rear faces containing the higher readings.

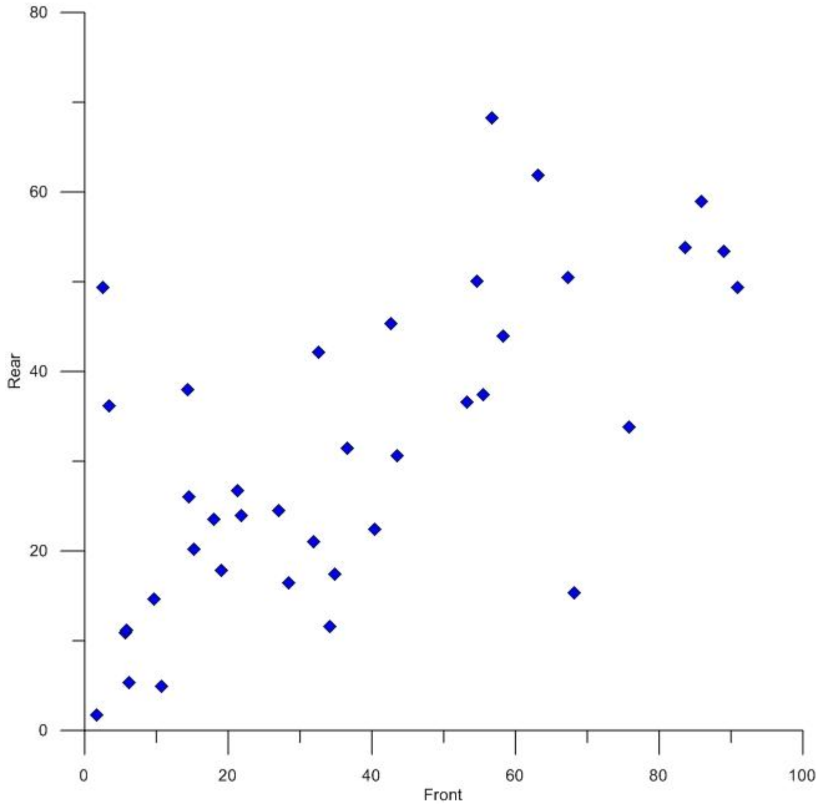

Figure 56: Maltese Cross brooches: Lead - Front vs.Rear

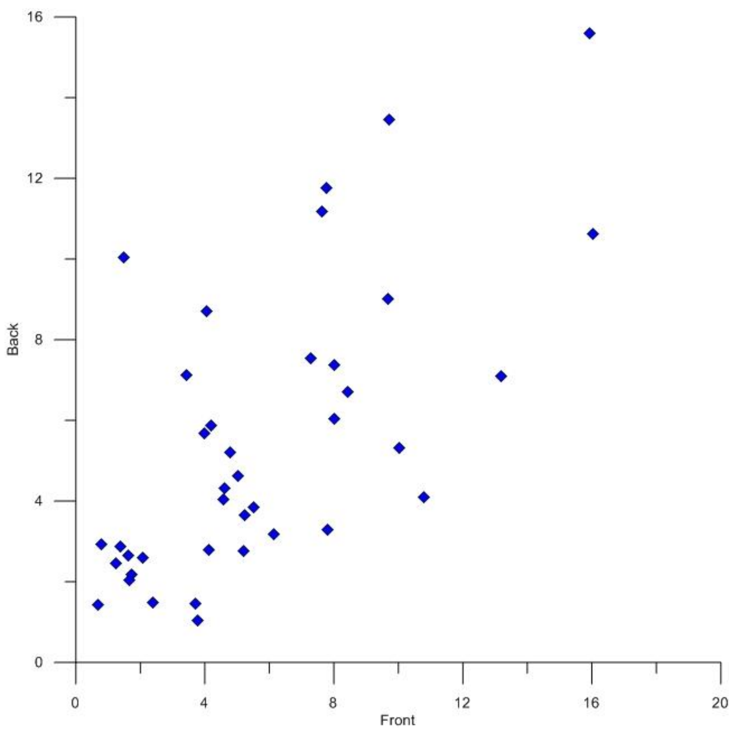

Figure 57: Maltese Cross brooches: Zinc - Front vs. Rear

4.5.2 Fire Gilding

This technique for applying gold to the surface of a non precious metal involved the use of an amalgam made of a gold and mercury paste which was rubbed onto the item. The treated surface was then volatised to create the gold effect which when finished would still retain a degree of mercury. Could the process of fire gilding be seen in the hhXRF measurements?

The full dataset for the early medieval brooches contains 898 measurements. From this only 62 measurements contain gold, mercury or both (fig.58). Subsequently only 15 of the measurements contained a combination of both gold and mercury. These corresponded to the brooches presented in table 11.

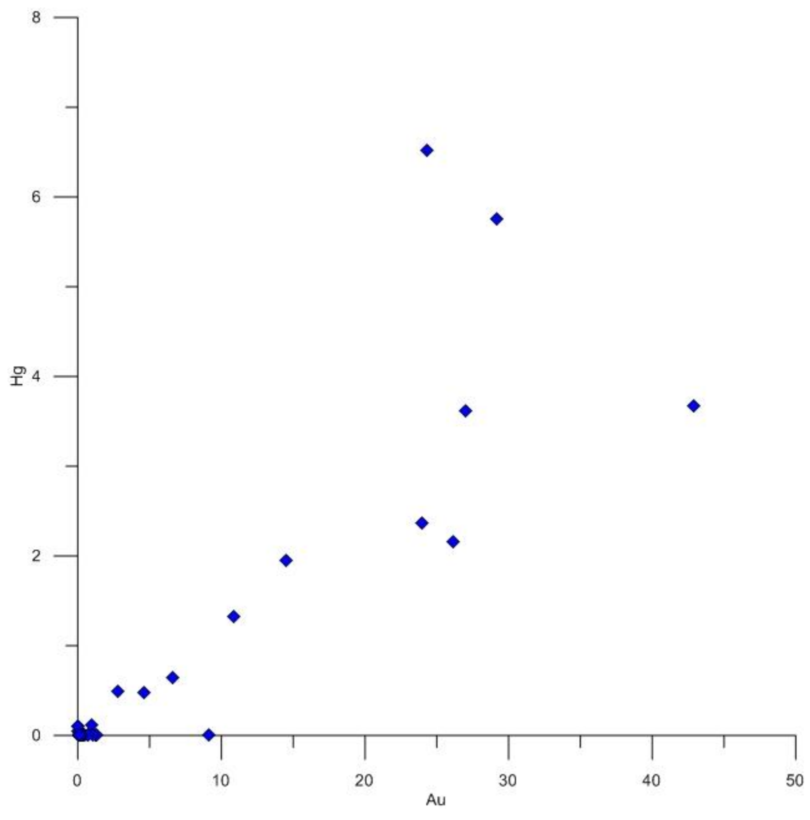

Figure 58: All readings containing gold and mercury

Table 11: Fire gilded brooches

		No.
Square-headed brooches	x	5
Radiate or Square-headed brooches	x	4
Equal-Arm 'bow tie' brooch	x	1
Disc with convex central boss, star motif	x	1
Disc with 6 petals and a central ornamental stone	x	1
Disc with saint motif	x	1
		13 Total

The three Disc brooches and the one Equal-Arm brooch dating from the 8th – 12th century may have been fire gilded, but if so, appear to be unique cases as they are not representative of the rest of their typological groups.

The four brooches tentatively categorised in the Radiate group are fragmentary and as the morphology is very similar to the Square-Headed, Anglo-Saxon type there may be a cross over. Of the five Square-Headed brooches only one is complete but the other fragments are fairly recognisable.

These results match a visual inspection where both of these categories display signs of gilding. Only one other brooch (FM 1995-XII-1.342) from the Square-headed group visually displayed evidence of gold on the surface but did not record any mercury in the hhXRF measurement. Also of note is that these brooches also contain high proportions of silver. This is not evident in other brooch types (fig.59).

4.5.3 A comparison with hairpins

The focus of this research has been to identify differences in early medieval copper alloys using hhXRF techniques. Brooches represent a very common group of finds that have good dating and typological provenance, but are the alloys present in this group representative of other items of the time? Or where alloys

selected for different purposes? Hairpins have a clearly different function to brooches and this difference may be reflected in their alloys.

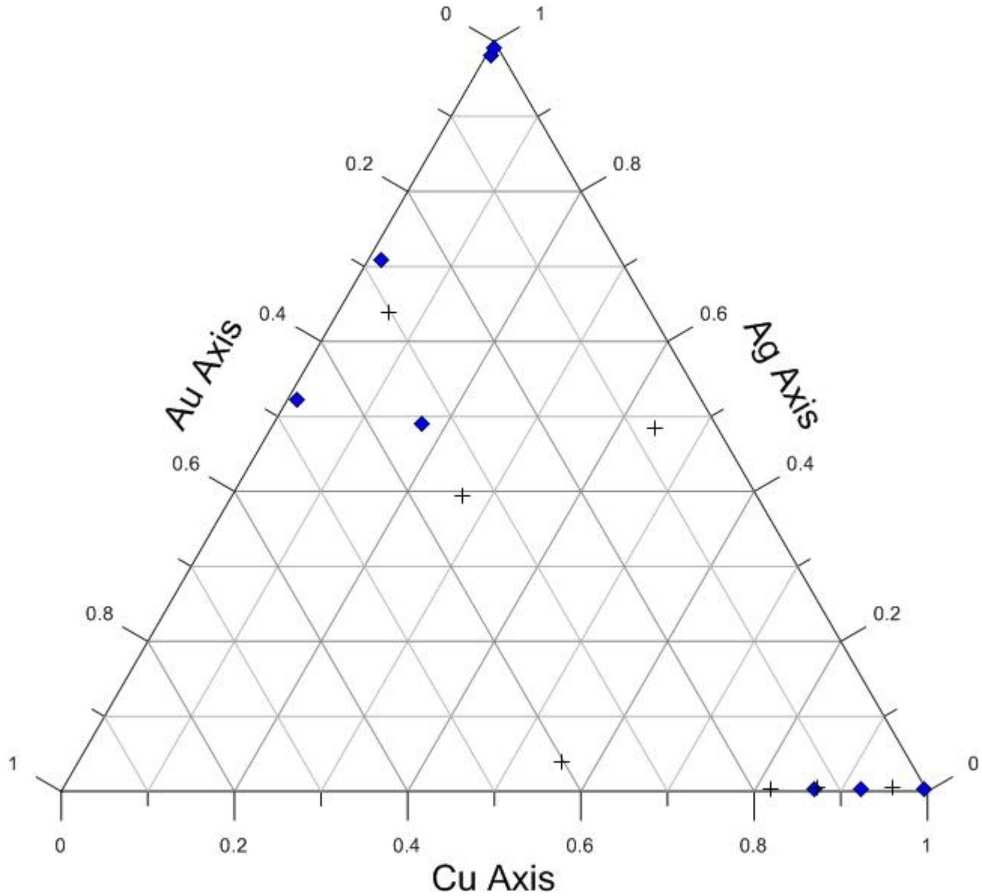

Figure 59: Radiate (blue) vs. Square-headed brooches ternary, Cu-Ag-Au

A total of 21 hhXRF measurements were taken at different locations on eleven hairpins dating from the 8th to 12th century. Their proximity in alloy content to that of brooches is shown in the following ternary graph (fig.60). The alloys that were used to make these hairpins clearly form their own group separate from the brooches. They have a higher proportion of copper and tin in them than the brooches and therefore seem to have a composition that is more towards leaded bronze rather than leaded brass.

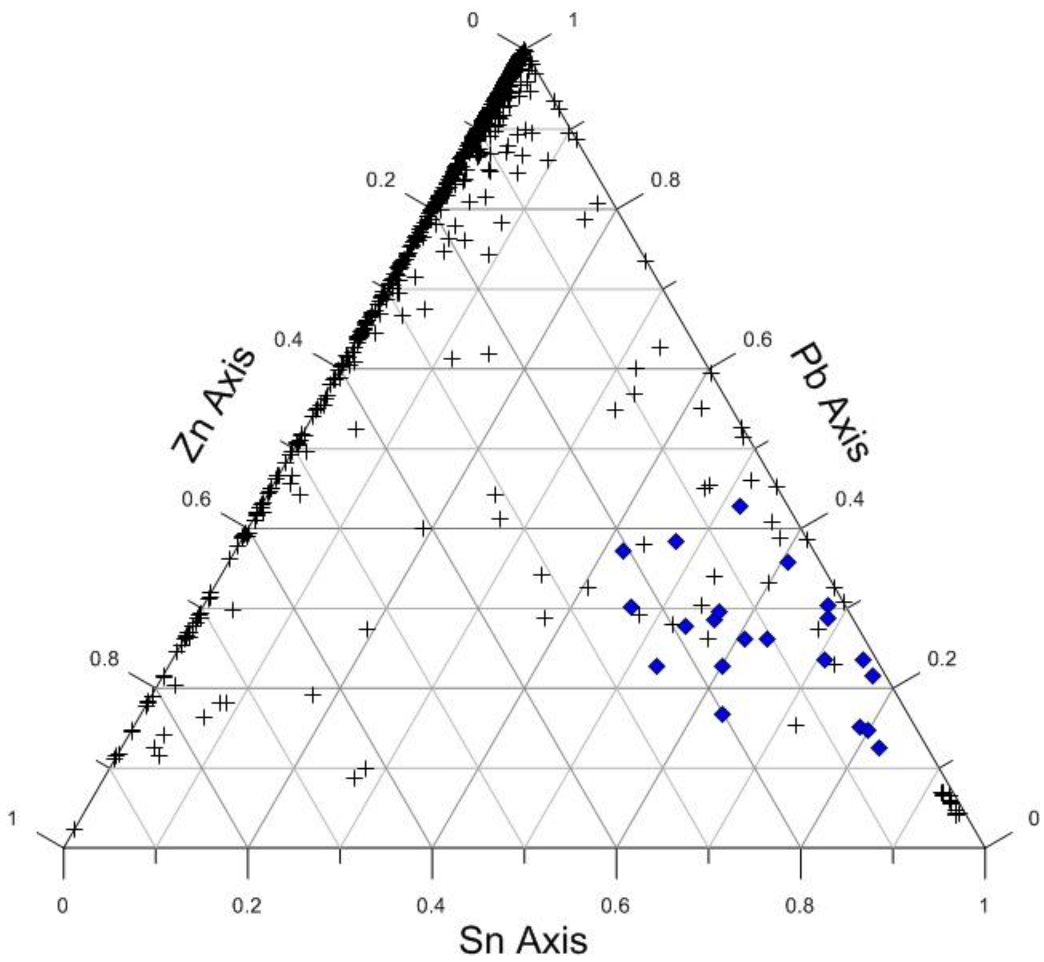

Figure 60: Hairpins (blue) vs. 8th-12th century brooches, Sn-Pb-Zn

4.5.4 Summary

This section presented the results of an analysis of hhXRF performance against some clearly defined techniques that could have been chosen by a metalworker. It presents paired readings from enamelled brooches in order to investigate metal levels in proximity to corroded glass, followed by the results of an investigation into fire gilding to determine if hhXRF can detect surface treatment techniques. Finally, the results of comparing hairpins to brooches are presented to determine if compositional choice can be seen in the bulk alloy measurements.

The comparison of paired readings (front and rear) from enamelled, Maltese Cross brooches demonstrated a 51% difference in copper values (in front vs. rear

measurements) for the cloisonné enamelling technique. The champlevé technique with its thicker copper alloy cell walls produced a 32% difference. Typically copper levels were seen to be higher on the rear faces of the brooches. This was the opposite for lead values, the highest readings being on the front faces (possibly due to solder being used in the enamelling process). The cloisonné technique exhibited a 40% difference between front and rear readings compared to a 54% difference for the champlevé technique. The zinc measurements produced the closest matched pairs, with the cloisonné technique at 43% being slightly worse than the champlevé technique showing an average of 37% difference. For zinc there was no trend in terms of which faces exhibited the higher readings.

The analysis of gold and mercury identified two typological groups where fire gilding was likely to be present, the Anglo-Saxon Square-Headed brooches and the Frankish Radiate brooches. Upon visual inspection these two groups show traces of surface treatment (gilding). The hhXRF measurements appear to match this observation. Also these two groups uniquely demonstrate a high level of silver in conjunction with the gold and mercury.

Finally in an attempt to detect compositional choice by the early medieval artisan an analysis of 8^{th} – 12^{th} century hairpins vs. brooches was undertaken. The results demonstrated a clear composition grouping for the hairpins, which also sat someway apart from the bulk of the broach alloys. The hairpins typically comprised of leaded bronze whereas the brooches were leaded brass or leaded copper.

5. *The hhXRF Interpretation*

The compositional analysis of a thousand Roman brooches by XRF was conducted by Bailey and Butcher in the early 1990's as part of a larger program of analysis mainly within the British Isles but also including brooches from two sites in Belgium (Bailey and Butcher 1992, 113). A strong correlation between alloy composition and typology was noted. The project found that the bulk of alloys were composed of bronze with only 20% of them being brass (with or without some degree of leading). The analysis suggested that making brooches from bronze was a local tradition and that the introduction of zinc came about during the Romanisation of these regions. Subsequently some brooches were seen to have been made in brass and others in bronze. By the 2nd century AD however this changes as zinc seems to be withdrawn from circulation (Bailey and Butcher 1992, 118) leading to a return to compositions containing bronze instead.

5.1 The 5th to 8th Centuries

The alloys from the few measurements of Roman period broaches gathered during this project should therefore exhibit a pattern similar to that described above. This does in fact appear to be the case for brooches found in Frisia, as the larger group of measurements consist of leaded bronze. The compositions for the 5th - 8th centuries follow this trend as well.

Frisia, the Frankish empire and England started using currency well before 800 AD and Hodges proposed that initially there was little control exercised over its use in long distance trade (1983, 116) and that both tin and lead whilst not being struck as coinage were also considered to be precious metals (1983, 115). Therefore if the long distance trade in precious metals (gold, silver, tin, lead) followed similar distribution mechanisms then the debate over early coinage production may be partly of use.

John, R. Collis' theoretical systems model for the introduction of coinage partly discusses the effects of innovation (or change) on the introduction of new coinages into different regional systems (1971, 72). The point to consider is that his model suggests that change was not instigated by the introduction of coins but already existed within the social and economic structure. Importantly this model for change (or resistance to it) does not rely on tribal or political control and that interchange within the economic systems are instead suggested as the main reasons for innovation. Equally he also goes on to propose that change of this nature was not brought about through major displacement of populations (Such as the Anglo-Saxon migrations into Frisia and Britain) as proposed by earlier theories.

The supply of the 'precious' metals needed to make brooches (in this instance copper , tin and lead, possibly already produced as bronze ingots) could therefore be considered in a similar way to the supply of the metals needed for coinage, especially if as Hodges suggests that these metals were also used as primitive money (1982, 116).

Colins' model as summarised by Hodges (1982, 107) promotes two different organisational structures: one that is centralised and controlled with a hierarchical social structure, perhaps with an overall ruler, the other a decentralised society with several individuals of equal status based on family ties and social obligations.

The early medieval society on the terps of Frisia could therefore have fitted the more decentralised model in the migration period slowly becoming more

centralised as the kingdom of Frisia came into being. This decentralised society based on family ties and social obligations would more likely have respected cultural traditions such as those seen in the morphologies of brooches (the Anglo - Saxon Cruciform brooch for example has its origins in the 4th century but with the exception of small decorative changes remains essentially the same for two centuries).

This respect for tradition could also have resisted any change or innovation in terms of alloy composition such as the adoption of brass if made available through the supply system. The alloys from the 5th to 8th century brooches seem to fit this concept. The decentralised model could also go further in explaining the wide variations in leaded bronzes and leaded gunmetals found in the analysis. If workshop organisation was more decentralised in these early centuries then the individual artisans or more isolated workshops could have maintained various alloy making traditions. Therefore if free choice is considered as opposed to reactions to raw material shortages, alloy ratios could group along traditional lines as well as typological ones. To explore this further though, another phase of hhXRF measurements would need to be taken for 5th to 8th century brooches and compared against regional distributions. This could also prove useful in tracing brooches back from their point of discovery to their more likely area of manufacture. Unfortunately there were too few examples from this period in the analysis especially across such a wide typological range that there is little more to say at this point.

5.2 The 8th to 12th Centuries

It can clearly be seen in the scatter plot analysis that there is a major shift in alloy composition from the 8th century onwards. The previous centuries see a preference for leaded bronze and leaded gunmetal alloys which is due to the presence of tin. Tin almost disappears in the alloys of the following centuries, leading to the almost exclusive use of leaded brass and leaded copper. The notable exception to this is from the very small number of late Scandinavian brooches which mirror the

leaded bronze tradition common before the Carolingian period. It must also be remembered that this hhXRF study did not include enough other metal items to ascertain if this was a unique change to brooches or reflective of a greater change in other items. The small group of hairpins analysed are of leaded bronze giving a slight suggestion that this may be just confined to brooches. Taking into consideration these factors, the reasons for a change to leaded brass and leaded copper can be considered against theoretical models.

5.2.1 The trade model scenarios

From the outset these scenarios make an assumption that the reduction in tin is reflective of a wider change in the availability of certain metals. The two main tin producing areas for Europe in medieval times were Cornwall in England and the Erzgebirge mountains on the border between Germany and the Czech Republic (Penhallurick 1986). One source therefore would be through the North Sea trade route, perhaps via Domburg, Quentovic and Dorestad (Verhulst 2002, 112); the other is through the hinterland via the Rhine again perhaps using Dorestad as an entrepôt *(*Hodges 2012, 108).

From the 7th century onwards Frisian merchants are believed to have dominated interregional trade in the North Sea (Costambeys et al. 2011, 343) and Frisias geography and ecology also encouraged trade along the rivers of the hinterland. Frisian traders seem therefore to have been in a very good position to source tin from either route.

The change to leaded brass and leaded copper (i.e. the exclusion of tin in the alloying process) may be an indication of a disruption to supply either through a shortage of tin or a more beneficial availability of zinc. The closest source of zinc in the medieval period would have been la Calamine in Belgium (Boni & Large 2003, 715). The Carolingian age is seen as a period of economic revival either fuelled by trade or agrarian intensification and Frisia, lacking arable land is said to have engaged instead with craft production where raw materials from the hinterland were processed and traded onwards (Costambeys et al. 2011, 345). A

suggestion might therefore be that the increasing demand for tin outstripped supply leading to the decision to produce brooches in leaded brass or leaded copper.

Another scenario could be that the annexation of Frisia into the Carolingian empire had an influence on the regions trading partnerships. The first half of the 8th century is seen as problematic in terms of understanding the Carolingian economy as it is a period of military conquest and general unrest (Verhulst 2012, 133). It is also a period that subsequently sees the reintroduction of Christianity to Frisia. Whilst the growth of trade and in particular the emporia has been seen as relatively free from elite control (Verhulst 2012, 133) being separated from royal and ecclesiastical centres, Verhulst proposes that the success of Frisian maritime trade was through the control of a mainly ecclesiastical elite. A change in trade direction, by elite influence, perhaps in favour of the hinterlands rather than with the traditional coastal communities could have created pressure on tin supplies from the south, making zinc a more favourable choice. Certainly Disc brooches see a proliferation of Christian symbolism from this time suggestive of ecclesiastical influence. It would be interesting to conduct a future survey of brooch composition from other regions to see how local a phenomenon this change to leaded brass and leaded copper actually is.

The last scenario is that the reduction in tin is indicative of an economic downturn. Metcalf suggested in a study of Anglo-Saxon England that a sharp downturn in metal finds from the 10th century was due to a disruption of interregional trade with its European partners causing demand to fall instead onto her own hinterland (2007, 8). Costambeys et al. also suggest that production initially driven by the elite falters in the last half of the 9th century (2011, 347). Perhaps at this difficult time, tin becomes a less economic option.

A final observation is that the brooches from Oud Naarden have a noticeably different alloy composition to those from the North. They contain higher levels of zinc which may be indicative of being that much closer to the Frankish world than Frisland or Groningen.

5.2.2 The Agrarian model scenarios

The presence of tin over a few percent is considered to be a deliberate act. Also these small percentages of 1-3% at most can also be indicative of residual quantities that have come from objects that have been recycled into new brooches (see Miller 2007b, 157; Reiderer 1992, 28). So can this deliberate act of replacing bronze with brass tell us anything about the artisan production and workshop organisation during this period?

In Merovingian times Verhulst suggests that most artisan activities took place in urban centres. As the economy of North West Europe strengthened during the Carolingian period, the location of artisan production (such as tools, weapons, glass and pottery) changes, establishing itself in a more rural and manorial context. This period also sees a concentration of artisans living around large ecclesiastical centres to support the needs of the large communities living there (Verhulst 2002, 72). Verhulst goes onto question whether or not these artisans would have been free or unfree members of these communities, especially in terms of producing goods for their own benefit.

The role of the ecclesiastical elite in its involvement in commercial activities is well acknowledged, especially in its drive to raise capital within a politically orientated economy dominated by power and privileges (2002, 91) and Frisia appears to be no exception to this influence.

Lebecq suggests that the terps of Frisia were noted for their cloth production, with historical sources mentioning deliveries of both high quality and ordinary cloth to local abbeys (Lebecq 1983, 131-4). These ecclesiastical centres were also known for making weaponry, a commodity which was carefully monitored by the royal elite (Verhulst 2002, 79). But whilst Verhulst suggests that artisan activities were mainly centred around industrial sites such as abbeys, royal courts, large estates and urban centres, he also suggests that there was a smaller proportion of wandering artisans that would perhaps have been more free to make their own living than those tied to these centres (Verhulst 2002, 84). Therefore different organisational structures for artisan activities seem to have existed.

A classification of Merovingian and Viking Age workshop organisation was published by K.R. Hedegaard (1992) and subsequently adopted by Anders Söderberg (2004) in his analysis of archaeological ceramics found on early medieval metalworking sites. This classification is as follows and I will attempt to interpret the change in alloy composition through reference to it.

a) Administered urban casting at permanent production sites.

b) Merchants' and raw material casting, a mobile activity producing simple products such as ingots and weights.

c) Professional super-regional casting – at permanent workshops but by mobile professional craftsmen. An intensive seasonal activity with the products intended for sale at periodic markets.

d) Court casting, within royal centres with valued highly skilled artisans working in potentially permanent workshops and possibly engaged as bondsmen.

e) Socially determined casting – characterised by a lack of experimentation, and long periods between activities at primitive workshops. Typically found at peripheral inland sites.

f) Domestic household casting of a non-professional manner including simple types of jewellery and repairs such as riveting and soldering.

A fundamental aspect of the change to brass-based production was just how widespread and permanent the change was. Hedegaard's models a), c) and d) all exhibit a strong element of organisation and hence control. Therefore a change of composition could be relatively easy to initiate, especially if the flow of raw materials through model b) was dependant on the demand of these larger production sites. Rather than supplying tin, merchants could have instead supplied zinc. The origin of this change could have been associated with either a production decision by the artisans whereby their suppliers had to resource zinc instead of tin. Or the other scenario is where these merchants presented a mutually beneficial opportunity for artisans to use brass in their production. This

opportunity would most likely have been accepted by the controlling elite, perhaps by those in a position to govern commercial exchanges.

These two models could go some way in explaining such a widespread change. To explore these models further however more archaeological investigations would be required. Brooches and production waste at large permanent sites found in good stratifiable contexts could elucidate how quickly and how fully this transition was. If there was a period where both bronze and bass were used side by side, or if the switch over was swift, it could tell us something about the relationship between the supply and production and ultimately its control.

Hedegaard's models e) and f) provide scenarios for potential resistance to this change. The artisans within these frameworks could be seen as more detached from the larger production centres and therefore exercise more freedom in compositional choice. It may also be that more variability or opportunistic decision making was employed, especially in the recycling of older metals. Certainly there could have been a delay in the transition to brass, perhaps finally realised due to an increased market preference for brooches made in the new alloy. Also with the overtly Christian motifs on most of these brooches, competition in a ritual economy could have made variation difficult? 'Long term transactions' as Hodges puts it (2012, 103), involving a 'social or cosmic order' (perhaps controlled by the ecclesiastical elite), thus making items bearing Christian motifs inalienable to their owners, could have presented problems for those involved in independent secular production.

Confirmation of these hypotheses could also be looked for in archaeological settings. If workshops from these classifications could be identified in context with brooches and or production waste, the transition to brass if it occurs could be noted. Another area for further research are the few examples of metal detected brooches that have been produced in bronze. By a careful study of the find locations could also determine if they associate with larger production centres, or with rural peripheral or domestic lesser types.

6. Morphological analysis

This chapter presents the results of the visual morphological examination which was conducted alongside the hhXRF analysis and as such was limited to information that could be gathered at the repositories of the different collections. The hhXRF analysis engages with the choices made in alloy composition and subsequent manufacture. The next stages in the biographical analysis are not directly dependant on the results of the hhXRF measurements and for clarity have been given this separate chapter.

The visual inspection took place of 688 brooches broadly dating from the 1^{st} to 12^{th} century. The purpose was to use the hhXRF data gathering exercise to survey the brooches for new biographical evidence and assess the possibility of future micro-wear analysis. Once done any observations or opportunities that could be engaged with within the logistical parameters of this project would be reported. Also the Roman period brooches would not be included in this analysis as their main purpose was only to provide a comparison of alloy composition for the subsequent medieval periods.

The following three sections present those aspects of morphological analysis that could be engaged with. The fourth section presents the opportunities that were identified but could not be investigated within the scope of this thesis.

6.1 Pin design and application

This section presents the results of the analysis of two aspects of brooch design. The first is the design of the housing that holds the pin to the back of a brooch, the second is the orientation of the pin to the motif on the front face.

6.1.1 Pin design

Two designs of pin housing were observed by Frick (1993, 248) in his analysis of Carolingian-Ottonian Disc brooches (fig. 61). His fig.3 shows a pin holder and pin rest mounted parallel to each other. Then fig.4 shows a more complicated pin holder whereby the pin is mounted onto an axel mounted between two parallel plates. In discussions these will be referred to as type 3 and type 4 designs respectively.

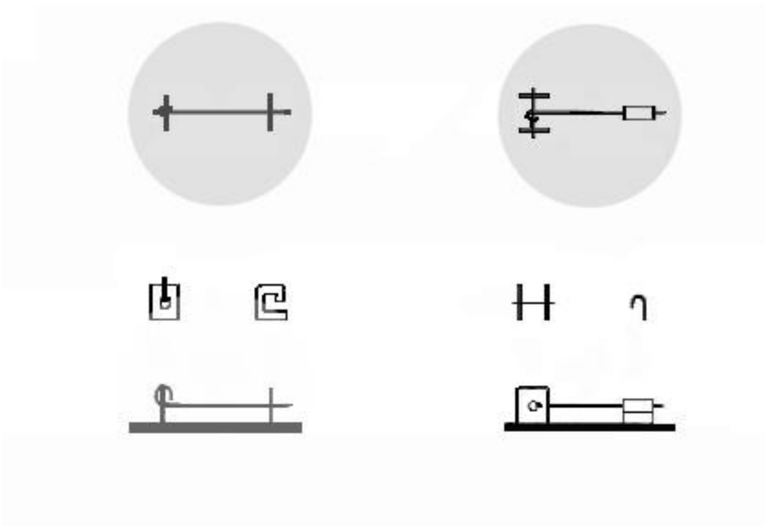

Figure 61: Pin housing design (after Frick 1993, Fig.3 & Fig.4)

There are 536 brooches that were in good enough condition to recognise the design of the pin housing. The early period (5^{th} - 8^{th} century) produced 104 examples and the later period (8^{th} – 12^{th} century) contributed the rest.

6.1.2 The 5th to 8th century

The analysis identified 61 type 4 and 42 type.3 designs. One additional variant of type 3 was present whereby the housing and holder plates were in line with each other rather than in parallel. This was on a unique Frankish Bird brooch (FM 1995-XII-1.354). The typological inspection produced the following results.

Table 12: Type 3 vs. Type 4 pin designs

		Type 3	Type 4	
Domburg	Regional	1	32	
Equal-Arm	Regional	4	9	
Cruciform	Anglo-Saxon	21	3	
Small-Long	Anglo-Saxon	2	9	
Square-Headed	Anglo-Saxon	2	2	
Long	Anglo-Saxon	0	2	
Disc-On-Bow	Anglo-Saxon	0	1	
Radiate	Frankish	2	6	
Bird	Frankish	5	0	
Bow	Germanic	2	0	
		39	64	Total

The two largest groups are the Domburg (Regional) and the Cruciform (Anglo-Saxon) types. They demonstrate the opposite preference in terms of pin design.

6.1.3 The 8th to 12th century

Of the 432 brooches assigned to this period only twelve of them bear the type 4 design. A unique cross shaped brooch (Bos 2.11.8), whose dating is problematic (Bos 2006, 779) and a tentatively assigned Equal-Arm or earlier Small-Long brooch (Bos 1.8.4.3?) is included in this group. There is also a unique rectangular

brooch (Bos 2.9.2.1) from the 9th century. The remainder come from the Pseudo Coin group of Disc brooches as shown below.

Table 13: Pseudo Coin type 3 vs. type 4

	Type 3	Type 4	
Pseudo Coin, 'Louis the pious' (Bos 2.6.5.3)	1	3	
Pseudo Coin, Natural head, beaded (Bos 2.6.5.2?)	0	2	
Pseudo Coin, beaded rim (Bos 2.6.2.1)	1	1	
Pseudo Coin (Bos 2.6.4.1)	3	1	
Pseudo Coin (Bos 2.6.4.3)	9	1	
Pseudo Coin (Bos 2.6.6.2)	1	1	
	15	9	Total

These Pseudo Coin brooches date from the 9th – 11th centuries and are spread equally between Friesland and Groningen provinces. Also a scatter plot analysis of the type 3 versus type 4 alloys did not show any noticeable grouping.

6.1.4 Discussion

The type 4 design appears to be much more popular before the 8th-12th centuries. If the Domburg type is a regional as suggested by Bos (2006, 455) then it could relate to a regional choice in pin design. The Anglo-Saxon cruciform brooches conversely prefer the type 3 format. After the 8th century the type 4 design almost disappears except within a small group of Pseudo Coin brooches. Frick recognises these two designs but does not offer any further information on typological or regional distribution (1993, 248). Bos makes the distinction between early and late forms (2006b, 714) by suggesting that types who's housing run parallel to the pin (it is unclear whether he is referring to Frick's type 4) are

early forms. If this is entirely the case it would make the dating of the Pseudo Coin brooches problematic as they are quite late.

The differences between these two designs could be explored in the future through experimental reconstruction. The performance of the two types could be investigated under different conditions e.g. wet or dry, heavy or light garments. This could help determine if the choice of the type 4 design on the Domburg brooches had a functional reason rather than just being a different tradition.

6.1.5 Pin Orientation

This section presents the results of an investigation of the pin orientation in relation to the image on the front of the brooch. The assumption here is that an image such as a human face, or crucifix would be worn the "right way up" so that the head for example is uppermost, or a cross motif would be upright not upside down or at an angle. For earlier brooches the pin orientation is governed by the morphology of the overall design. For the Carolingian-Ottonian period Disc brooch this is not the case. The pin will still function regardless of its positioning on the rear face.

For the Carolingian-Ottonian rectangular brooch (in fashion parallel to the disc variety) it may be noted that all of the pins in the dataset present themselves at 90 degrees to an edge. No "off centre" or poorly aligned pins were seen.

This analysis was therefore conducted on 214 out of 401 Disc brooches of which the front motif could be orientated (if desired) in a particular direction. The number of brooches versus the orientation of the pin is as follows in table 14 and table 15. The orientation of the pin is expressed in degrees as shown in fig. 62.

Table 14: Number of Disc brooches versus their pin orientation

Degree (to motif)		No.
90	x	131
45	x	60
22	x	18
12	x	1
0	x	4
		214 Total

Table 15: Typological groups versus pin orientation

Group	Degree	0	12	22	45	90
Cross Maltese (Bos 2.5.1.1)		0	1	6	13	15
Cross Maltese (Bos 2.5.1.30)		0	0	0	2	7
Cross simple (Bos 2.5.2.3)		0	0	1	9	3
Cross with 4 dots (Bos 2.5.3.1)		0	0	0	0	7
Cross complex (Bos 2.5.1.14)		0	0	2	0	4
Cross quintuplet (Bos 2.5.1.15		0	0	0	3	5
Pseudo Coin (Bos 2.6)		3	0	0	1	45
Saint (Bos 2.7.1)		0	0	0	0	19
Human & Animals (Bos 2.7.2)		1	0	0	1	7
	Total	4	1	9	29	112

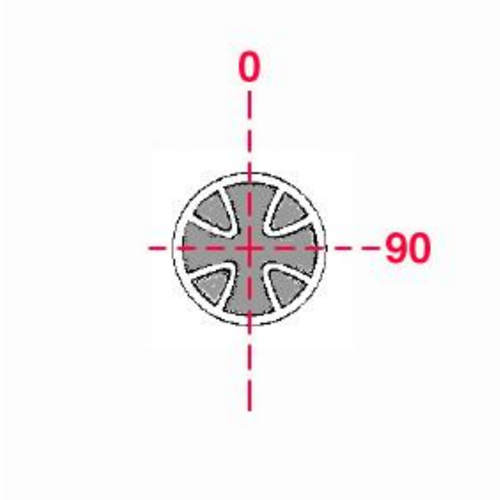

Figure 62: Pin orientation in degrees (from the vertical)

6.1.6 Discussion

It could be suggested from the data that the preferred orientation for pins was 90 degrees to the front motif. The saints, emperors and animals strongly follow this trend with 92% of them orientating to 90 degrees. But this is not the case for the brooches bearing cross motifs where only 52% of them are orientated at 90 degrees. This becomes more evident in two of the typological groups. The Maltese Cross (2.5.1.1) group have 43% at 90 degrees compared to 37% at 45 degrees. The simple cross (2.5.2.3) is the only group that exhibits the opposite trend with 69% at 45 degrees.

Those pins with an orientation of less than 45 degrees could possibly be the result of inaccurate positioning. The 45 degree position seems intentional and it may suggest that the orientation on crosses was not as important as other groups. However an alternative solution could be that some crosses were intended to be worn at a different angle. If these pins are instead turned to the 90 degrees then the cross becomes a saltire, I.E. the cross of St Andrew the martyr and the 90 degree preference is therefore maintained. This is a common symbol from the Roman period onwards and the fault may be with typological organisation where crosses are automatically assigned the more usual upright meaning (i.e. a crucifix). Frick (1992) does not discuss pin orientation, however Bos recognises

the orientation of the pins on the Cross brooches (2006b, 730) but does not offer suggestions. The significance of people wearing the cross of St Andrew as a motif would need further research and would be suitable for continuation outside the scope of this thesis, especially as a larger number of brooches may be needed to confirm the trend in pin orientation. If the theory subsequently proved to be good then, I believe, this observation would be of great interest to both historians and archaeologists.

6.2 Reuse: Veneration and heirlooms

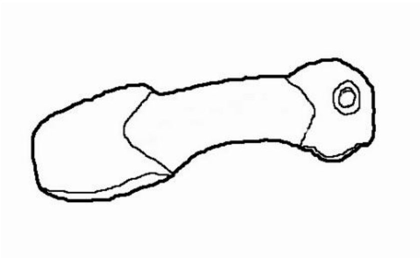

Figure 63: Domburg brooch with hole in headplate

Documents from the early medieval period record the inheriting of jewellery from one generation to the next and there is archaeological evidence for heirlooms being found amongst the grave goods of this period (Caple 2010, 307). Brooches and especially those displaying religious symbols could have obtained a special meaning for those who owned them (Hinton 2005, 62). This special meaning could be identified through evidence of extended retention, repair and care of a brooch (Caple 2010, 307). Repairs to the pin housing, holes suggesting the conversion into pendants or mounts (fig. 63), or worn faces from polishing could all support this concept. If brooches are seen to have the potential to stay in use beyond the generally accepted dates, care needs to be taken when attributing them to archaeological contexts.

This section therefore presents evidence for the modification of brooches beyond the original manufacture. The visual inspections of the brooches during the hhXRF data gathering phase allowed for an examination of each brooch. Subsequently 14 brooches showed signs of modification suggestive of reuse and they are as follows.

FM 1995-XII-2.438 - The earliest brooch displaying signs of reuse is a Roman period Disc brooch that has a hole through the centre. It is unclear if this is an original feature or a later addition. The pin is missing but the pin housing is still in good condition, however the hole is wide enough to allow it to be threaded and used in another way.

This is a good reminder that a significant amount of Roman personal items are found in early medieval contexts (Caple 2007, 306) and therefore could have come from a later context than typologically accepted. Roman items appearing in much younger contexts and in particular at Wijnaldum have been problematic in dating layers (Galestin 2010, 71).

FM 1995-XII-1.170 is an unusual brooch that has tentatively been categorised as a Small-Long type possibly of Germanic origin. Its alloy composition made it an outlier in comparison to the rest of the 5^{th}-8^{th} century brooches (fig.18). It has a drill hole that is possibly a repair to the pin housing made to extend its useful life.

G2008-11-181J-E is a 'Louis the pious' type Pseudo Coin brooch that has had its pin housing re-drilled, possibly as a repair, but a thread could have also been passed through it. Bos (2006b, 755) associates the development of this type with coins found in early medieval gold hoards, especially those used as pendants. There is a second Pseudo Coin brooch, G2008-11-29-V that is badly worn with a hole through the face. This could have been threaded and used as a pendant, in which case the image of the emperor would be upside down. A pin driven through the hole attaching it to another surface could be another option. This would infer reuse as a mount.

There are a further eight brooches that have drill holes in them that could be interpreted as reuse (FM 1995-XII-1.376, FM 1995-XII-2.431, G2008-11-30-O,

ON-017, FM 1995-XII-2.117, FM 1995-XII-2.230, FM 1995-XII-2.240, F 2007-IV-112). These all have holes in the front face where a thread could be passed through. However if the intent was to use it as a pendant then this is problematic for the saint and quadruped brooches as this would mean that they were hung upside down. They could have been reused however by mounting them to another object but visually "the right way up".

There is a very unusual brooch from the Oud Naarden collection, ON 039. It has four drill holes through it and would easily be categorised as a belt mount from the Middle Ages (see Willemsen and Ernst 2012). It has a direct parallel however in Bos's Disc typology (2.11.9), a unique example found in Westergo (2006b, 781). This could be an example of an heirloom being kept in use as a belt ornament.

Finally one of the few Scandinavian objects in the collection is a convex Disc brooch (G2008-11-31-A) that has an extra plate on the rear in addition to the pin housing. This plate has a hole in it which could allow it to be conveniently interchanged between a brooch and a pendant. A very recent reappraisal of the large quantity of Carolingian metalwork found in England (Thomas 2012, 510) suggests that there was a widespread cultural practice in the Scandinavian homelands of converting Carolingian items into brooches and pendants, demonstrating the complexity of cultural influence in the North Sea world during this period. There may therefore be other reasons for turning brooches into pendants. Fashion, perhaps in the wearing of talismans suggested by Thomas (2012, 502) could be another governing factor.

6.3 Recycling: Evidence in the breaks?

This section presents the results of the analysis of broken to unbroken brooches as observed during the data gathering phase of the project. Bos considers the Domburg brooches to be a forerunning group of the later Equal-Arm brooches (2006c, 459). Date wise they are considered to be from the 6th century whilst he

suggests that the first of the equal-arm brooches appear around the same time. But there is a clear difference on whole versus fragmented items.

There are 47 complete or fragmented Domburg brooches and upon inspection of the type of breaks present it was found that damage could be categorised into 5 groups (table16).

Table 16: Domburg broken vs. unbroken

Damage group		No.	
Complete	x	8	
Headplate only	x	5	
Headplate & Bow	x	22	
Bow & Footplate	x	6	
Footplate only	x	6	
		47	Total (= 17% unbroken)

The opportunity also presented itself to study 53 complete or fragmented Equal-Arm brooches. These brooches appear to be quite similar morphologically however in categorising the damage only three groups were necessary (table 17).

Table 17: Equal-Arm broken vs. unbroken

Damage group		No.	
Complete	x	49	
Endplate only	x	1	
Endplate & Bow	x	3	
		53	Total (= 92% unbroken)

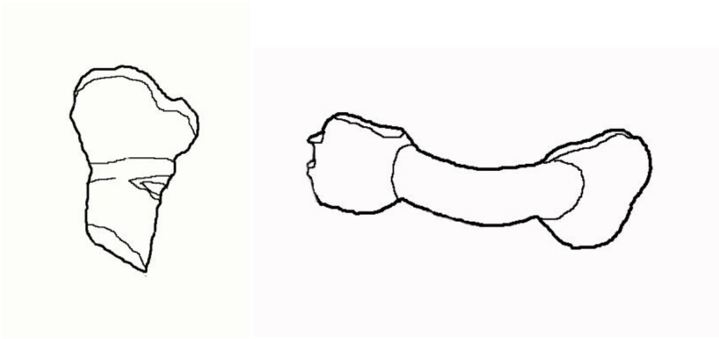

Figure 64: Domburg fragments

6.3.1 Discussion

The analysis suggests that the Domburg brooches have been deliberately broken (see fig. 64 for examples), as closer inspection revealed relatively sharp (and historical) breaks rather rounded ones. One brooch in particular (FM 1995-XII-1.88) has been split into two by a sharp clean stroke at 45 degrees across the centre of the bow. Also some footplates appear chipped (e.g.FM 1995-XII-1.42) in a way that is reminiscent of coin pecking, a process employed in testing the purity of Viking age silver (Archibald 2007, 49).

The find locations suggest that at least twelve of the 39 fragments came from Wijnaldum. Three came from Dongjum, two from Boer, one from Zweins and one from S1 Terp. A scatter plot analysis of the alloys versus this distribution had nothing to add as no meaningful grouping of plots was observed. An inspection of the weights of each piece (which varied between one to six grams) also showed no correlation to the breakage pattern. If a correlation had been found it may have been suggestive of the brooches being broken up by weight in order to be conveniently included in a new mixture at a later date.

Bayley (1991, 120) suggested in an analysis of finds in Anglo-Saxon England that there was some evidence of base metal sorting before recycling. This was suggested through the range of alloy compositions that had been identified, but she also admitted that archaeological evidence had been elusive. Even though this group of Domburg fragments does not represent a singular metalworking hoard as

the find locations are quite dispersed. It may represent evidence of a wider practice of scrap metal sorting across many terps. However I do not believe the presence of metal sorting could be considered evidence for the presence of workshops as these small fragments are very portable and could equally have found their way (perhaps through exchange) to a workshop some distance away.

Other suggestions that could be put forward for the fragmentation of the Domburg brooches were as follows. The fragmentation could have occurred through modern plough strikes just prior to recovery by metal detectorists. This idea becomes problematic though when you compare the differences in damage between the Domburg and Equal-Arm groups. It would not be unreasonable to suggest that both types (being morphologically very similar) were exposed to the same risks in the plough soil before being recovered and therefore should exhibit similar levels of fragmentation, which they do not. Also a visual inspection of the patina on the broken edges suggested that it had formed at the same time as that on the rest of the undamaged surface areas i.e. that the breaks appear to be historical rather than new. I believe therefore that this suggestion for the fragmentation is less likely.

Suggestions that fragmentation could have occurred as part of a ritual practice, perhaps in a funerary context, or that they could have been broken up in the Christian period because they displayed pagan motifs, were also considered. However, I could find no evidence of these practices in the literature on the early medieval period (e.g. Costambeys et al. 20011; Loveluck and Tys 2006; Lucy 2000), therefore they seem less likely scenarios to the previous ones.

More research into this very interesting situation could produce a better understanding of why these breakages occurred. But unfortunately this is beyond the current scope of the thesis.

6.4 Further opportunities

As explained earlier the scope for biographical analysis was limited to hhXRF measurements and visual observations that could be made at the repositories of the different collections. The exercise did however serve to identify the following avenues of investigation. These opportunities are discussed in this last section.

6.4.1 Polish Analysis

Caple (2010, 308) suggested that veneration in the care of personal items (considered valuable beyond a monetary sense by an owner) could be identified by the presence of excessive wear, perhaps caused by frequent polishing over a certain length of time. A pertinent example of this was subsequently given in the high levels of wear present on the beaded decoration of the early medieval, copper alloy 'Anglian Helmet ' found in York (see also Tweddle 1992, 980-2). Repeated acts of polishing an item to the extent that features become worn away, was considered as almost a ritual activity on a valued possession (Caple 2010, 308). The Pseudo Coin brooches bearing visibly worn beaded edges and at their centres unrecognisably worn busts of Emperors heads, become interesting because of this. Bos interprets this "wear" as a deliberate act of manufacture (2006b, 757) including it within a wider practice of replicating degenerative images of earlier gold Pseudo Coin brooches. This is interesting in two ways. Firstly, if Bos is correct that the intention was to manufacture "pseudo venerated" items i.e. items that could be perceived as heirlooms (Caple 2010, 308), or as talismans (Thomas 2012, 510), infers a certain demand for such objects. This demand would be regardless of the recipient's knowledge of the genuineness or otherwise of the heirloom and is one of the most frequently found brooch typologies demonstrating its popularity.

Secondly if these brooches can be shown instead to have been modified through excessive cleaning or polishing, then that too would infer a more personal degree of veneration. But this also engages with concepts of fashion, whereby a growing demand for personal dress accessories in copper alloy, perhaps influenced by a

lack of availability (or affordability) of precious metals as suggested by Owen-Crocker (2004, 207), could have resulted in brooches staying in use even when they looked less than new.

A microscopic study of wear traces on the beaded surfaces of these brooches in collaboration with an experimental reconstruction would be useful in exploring these arguments. A microwear analysis of socketed axes demonstrated the usefulness of this approach (Roberts & Ottaway 2003) on objects that are bronze age in date and therefore much older than these brooches. If polish marks survive under the patina and could be identified and subsequently recreated on replicas, made in similar alloys, then the question of whether the wear was natural or manufactured could be answered. Estimations of the length of time the item was in use could also be made, perhaps suggesting if the wear to the motifs was slow enough for the brooch (and its meaning) to be passed through more than one generation of owners.

6.4.2 Pin strength and garment identification

During the data gathering phase measurements of the distance between the pin holder and the shoe were taken. When available the diameter of the hole in the pin holder was also documented. Many brooches display signs of wear possibly due to the movement or pressure of the pin against the housing during use. Some pin housings also seem to have been worn completely through, perhaps in contact with a harder pin, thus rendering the brooch unusable.

This data was taken in response to the noticeable difference in the size of Disc brooches and by inference to their functional limits in terms of the amount of material that could be gathered behind the pin. Also the effects of heavy versus light material perhaps influenced by use in wet or dry environments could be a contributing factor to the performance of different pin assemblies. These factors could be explored by experimental recreation and subsequent testing of newly made brooches in suitable alloys

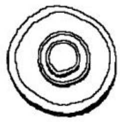

Figure 65: Button or Nabenemailscheibenfibeln, (FM 1995-XII-2.150)

By far the smallest brooch in the assemblage is a Carolingian period Disc brooch that Bos labels as the Nabenemailscheibenfibeln type (Bos 2006b, 715) or "button" brooch. These have been found in some quantities and with 51 individuals (typically only having a diameter of around 1.1cm) they constitute a substantial group in this study.

Bergmann suggests that they might be for children's clothes (1999, 441). Boss instead suggests that they may be used as a form of button (2006b, 715), but the common assumption is that these brooches were used on female's tunics and men's cloaks (e.g. Frick 1993, 356; Owen-Crocker 2004, 212), which seems rather impractical for this size of brooch.

This very small brooch could therefore provide an ideal opportunity to determine the performance characteristics of its pin assembly, perhaps in terms of how much weight it could hold or how much cloth could be gathered behind it. Also micro-wear analysis may be of use, as a large proportion of the brooches still retain a heavy protective patina, which as suggested by Roberts and Ottaway (2003, 120) could preserve any original marks, perhaps made by the garments rubbing against the rear surface of the brooch. With the careful removal of the patina these marks could be differentiated from those made by post depositional processes and therefore be of use in suggesting the type of cloth the brooches were in contact with.

6.5 Summary

The morphological study of these early medieval brooches, on site at their repositories, identified characteristics that could be analysed during the course of the project. Furthermore several opportunities were also identified for future research.

The analysis of the design of the pin assembly identified different preferences between the Domburg and Anglo-Saxon groups, and although chronologically the type 4 design all but dies out by the 8^{th} century, an isolated group of Pseudo Coin brooches curiously adopt this design once more but at a much later date. This choice of design could perhaps be linked to tradition or possibly there is a functional benefit between choosing one over the other, possibly relating to garment use.

The angle at which the pin assembly was placed in relation to the motif generally seems to be 90 degrees. This could possibly be linked to ergonomic factors such as placing a brooch on a garment the correct way up by feel rather than by sight, e.g. somewhere around the neckline. The exception to this observation is apparent in the cross motif groups. The Maltese Cross brooches show an equal preference for 90 and 45 degrees. Furthermore a group of "simple" cross types show a greater preference for 45 degrees. This could be because there was no need to orientate the motif on these brooches when dressing or perhaps the interpretation of the motif is slightly wrong. A possibility is that the crosses were meant to be displayed as the cross of St Andrew, i.e. as a saltire, which would then allow the pin assembly to conform to the 90 degree rule seen on other brooches.

The analysis also found evidence of repair and reuse, possibly as pendants or mounts, engaging with concepts of veneration and ancestry. Some holes could be interpreted as being created to convert brooches into pendants but were subsequently seen to be problematic in that the orientation of the hole to the motif meant that they would hang upside down. A suggestion that these brooches were reused as mounts seems more plausible as they could then be orientated the correct way up.

Also a significant difference was noticed between the Domburg brooches and their close cousins in the Equal-Arm group. After a visual inspection the Domburg group seem to display damage that may associate with metal sorting before recycling as opposed to post depositional plough damage or suggestions of ritual breaking.

Future opportunities were also identified that would require microwear and experimental analysis. The identification of polishing or otherwise of the Pseudo Coin group would again engage with concepts such as veneration, fashion and the keeping of talismans. Microwear analysis in conjunction with experimental pin assembly testing may also improve our knowledge of the type of garments that these brooches were regularly in contact with. These opportunities unfortunately are beyond the scope of this current project.

7. Conclusions

One purpose of this biographical research was to find new ways to study the large quantity of brooches that have been collected by metal detector enthusiasts since the 1970's. To achieve this, the methodology chosen had to be non destructive and take place at the repositories that housed the collections. The techniques employed therefore were hhXRF combined with a detailed morphological visual analysis, both of which are relatively new in the study of copper alloy artefacts from this period.

The main research questions were subsequently dependant on whether hhXRF had the potential to see qualitative differences between individual brooches, especially as hhXRF use was considered inferior to laboratory based techniques and suitable only for surface analysis. Detailed morphological analysis which has had limited application to brooches would collect observable data as the items were examined and assess the potential for further studies that could involve microwear analysis and experimental recreation.

Once the data was collected and integrated into a database which included the most up to date typological descriptions, the following questions were asked of it.

a) Is there evidence for chronological changes in alloy use from the end of the Roman period to the beginning of the Middle Ages?

The answer is yes, as the compositional change around the 8th century from bronze to brass based alloys is quite striking. The analysis demonstrated a tradition of brooch production using bronze based alloys until around the time the region was absorbed into the Carolingian empire. After this time a widespread change to the production of brooches in brass (also with some leaded copper) is observed. This change also coincides with the integration of the region into the Christian sphere of influence. As a great many of the brooches from this time onwards bear overtly Christian motifs, a theory is proposed that a more centralised elite facilitated this change through increased control of artisan production, or instigated a reorientation of trading partners from traditional coastal communities to the Frankish hinterland. Interestingly a small group of Scandinavian brooches from the 11th century suggested a continuation of brooch production in bronze in that neighbouring region. A small group of hairpins from around the 10th century were also seen to contain bronze which may suggest a different workshop organisation than for the brooches. Unfortunately further analysis of these observations was beyond the scope of the current project but the potential it has to bring additional dating evidence for brooches found in archaeological contexts. The wider implications of why brass is reintroduced at this point could also be very important in understanding the decisions made in craft production at this time.

b) Is there evidence for the deliberate control of metal composition, perhaps between different types of brooches?

The answer to this is again yes. The hhXRF analysis also showed that alloys grouped with certain typologies. The curious 'button' brooches, the smallest of the Carolingian disc brooches were only made from leaded copper. Pseudo Coin brooches also showed overall signs of grouping but not by any of Bos' individual Pseudo Coin subgroups. These relationships give us new insights into the workshop organisation of the time. Pseudo Coin brooch production may only have been made at certain workshops for example, with different styles being produced in the same alloy. This subtle difference in the Emperors busts and the various differences in edge decoration could be reflective of the choices of individual

artisans perhaps eluding to the level of freedom they had in their skill. Another option is that the changes occur over time, either as a fashion choice or perhaps a change in the artisan(s) at the workshop. This grouping of alloy composition is therefore really important in understanding for the first time the level of control these artisans had over their craft production.

c) A further question that naturally follows is can regional differences in composition be seen (perhaps eluding to the availability or otherwise of raw materials)?

Again the answer was yes. A regional difference in distribution was observed between the northerly collections and the Oud Naarden collection (containing noticeably more zinc and recovered approximately 150km further south). The analysis of the Carolingian period Saints brooches also showed clear regional grouping where the copper to lead ratios were observed. This is another really important discovery because it has implications on the find locations of brooches bearing certain alloys within archaeological contexts. In a similar way fabric analysis is used in provenance of traded pottery, if alloy compositions can shown to come from a certain region, the movement of brooches can be tracked more successfully rather than relying on typology alone, as is the case at the moment.

d) Furthermore can hhXRF identify other techniques employed in brooch manufacture such as fire gilding or soldering?

Surface treatments could also be detected as hhXRF also produced measurements containing gold silver and mercury, so again the answer is yes. Anglo-Saxon, Square-Headed brooches in particular were probably fire gilded, suggested by the presence of gold and mercury readings in conjunction with a visual examination. This is again important in providing a new technique for identifying surface treatments that are no longer visible to the naked eye.

The morphological examination of such a large group of brooches also produced very positive results. The question asked of this analysis was as follows.

e) Can a detailed morphological study of data gathered in parallel to the hhXRF analysis contribute to our understanding of the cultural biographies of these artefacts?

Yes is the answer. Firstly the study of the Domburg brooches revealed a very high level of fragmentation suggestive of being broken up in a sorting process prior to recycling. Secondly a closer inspection of the orientation of the pin assembly to the motif on the front face of many Disc brooches produced some interesting correlations. As it is today, the preference for pin orientation seems to be one of 90 degrees to the motif, a choice that may be related to the act of pinning a brooch to a garment without having a good visual line of sight (around the neck for example). Subsequently this theory suggests that some of the many cross bearing motifs could actually have been intended to be worn as a saltire, I.E the cross of St Andrew. A future examination of additional brooches could build up more evidence for this symbol which is easily lost by the misleading assumption that all crosses orientate in an upright fashion. The rediscovery of this motif and the subsequent meaning for the people who carried it would not be insignificant for archaeologists and historians alike.

Overall therefore this biographical examination has been extremely effective, especially in the hhXRF analysis that has successfully demonstrated its ability to see meaningful differences in alloy compositions. The research was not only highly relevant in establishing new techniques but has also contributed meaningfully to the current debate surrounding the archaeology of the early medieval period in Western Europe.

The opportunity for future studies is also considerable and will provide an important contribution to the advancement of our biographical knowledge of early medieval copper alloy artefacts.

A wider data gathering program beyond my original research region will be able to contextualise differences in alloy composition. Tracking the change from bronze to brass use, which if present outside of Frisia, would contribute to our knowledge of technological change as well as elucidate trade in raw materials (e.g

tin versus zinc sources), perhaps also compared to what are believed to be the main trade routes of the time.

The find locations for copper alloy artefacts with better understood compositions in archaeological situations may be able to act as a provenancing tool (eg. a brooch whose alloy composition matches a group from a significant distance from the find location may contribute to our knowledge of the movement of people or items). Also alloy compositions may be able to be linked to archaeologically significant sites such as emporia, monasteries and royal estates, through a subsequent analysis of copper alloy items found in close proximity to them.

The compositions identified by the hhXRF analysis could also form the starting point for experimental work in recreating and subsequently testing the strength and functionality of different brooch types. This could initiate a multi-chaîne opératoire project that looks at the operational sequences that support the artisan rather than just those directly linked to the production of the item. It could then deploy highly relevant biographical research criteria such as technical choice (e.g. brass versus bronze) in relation to early medieval socio-cultural systems. 'Cross-craft' interactions such as the separateness or otherwise of garment manufacture and personal decorative objects could also be employed and concepts such as 'toolkits' could also be explored in terms of investigating the "behind the scenes" craft activities required to produce brooches. Research into memory and learning could also be of value (e.g. by comparing apprentice versus family orientated craft learning, and cultural memories in terms of what it may mean to turn from a bronze making tradition to a brass making one). This fuller biographical approach would contribute significantly in comparison to current theories on early medieval workshop organisation. Biographical models for brooches made by itinerant artisans versus unfree ones (perhaps in a royal estate or monastery) would be very interesting to compare, possibly identifying benefits or problems of artisan activities within very different social structures.

Two other hhXRF projects are currently underway by researchers from other universities. One researcher has gathered data on the early medieval copper alloy finds (including brooches) recovered from the beach at Domburg, the other is

working in Belgium on similar data. Although their research questions are very different to my own, the sharing of databases would be a first step in widening the area of research to include the southern area of Greater Frisia and the Frankish hinterlands. This would immediately allow more analysis of zinc levels in brooches to be undertaken and they would be much nearer Belgian zinc sources than brooches made in the north of Holland. This could tell us fairly quickly if there is a correlation in distance from the nearest source versus the quantity found in Carolingian period brooches. It is a question that I would like to see answered.

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Abstract

Many hundreds of brooches from the early medieval period have been recovered by metal detector enthusiasts since the hobby became popular in the 1970's. Much typological work has been completed and some compositional research has already been undertaken for those found in Greater Frisia but not on a large scale. This research undertook the bulk analysis of over 600 copper alloy brooches by handheld XRF and onsite use-wear analysis at repositories in the north of Holland.

The compositional analysis subsequently showed regional and chronological differences in the bulk elements as well as clear correlations to typological groups. The analysis produced evidence that Greater Frisia abandoned its tradition of producing brooches in bronze, in favour of production in brass shortly after being annexed into the Carolingian empire in the 8th Century. The morphological analysis also produced evidence of recycling practices and a new interpretation for some cross motifs. These castaways, while lacking the most basic stratigraphical contexts and frequently marginalised in archaeological research, have much more to offer than previously thought.

Appendix 1: Ternary diagrams (Sn-Pb-Zn) for 5^{th} – 8^{th} Century

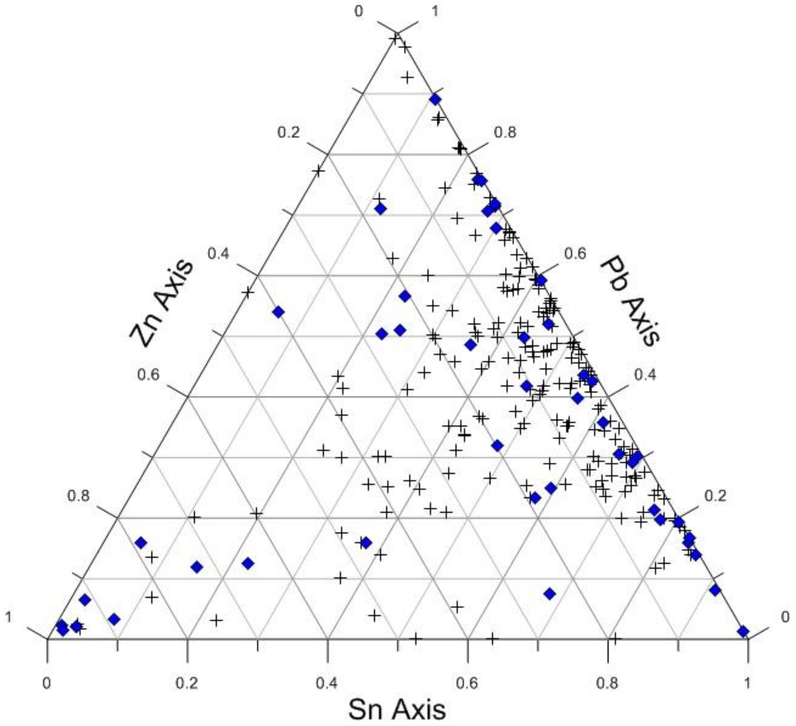

Fig. 1: Roman 1^{st} – 5^{th} Century (Blue) vs. 5^{th} – 8^{th} Century

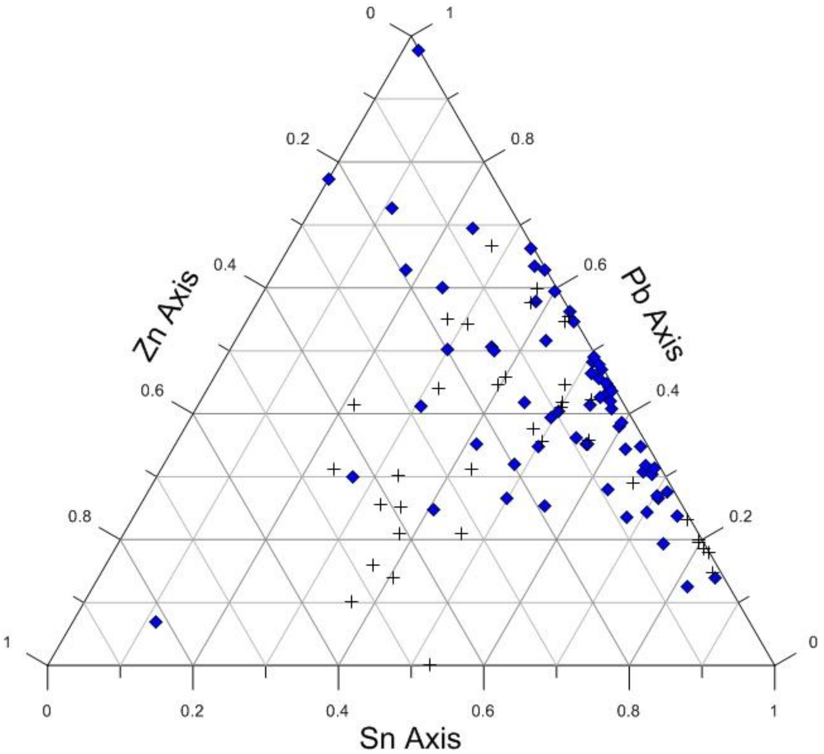

Fig. 2: Anglo-Saxon Cruciform brooches (Blue) vs. 5^{th} – 8^{th} Century

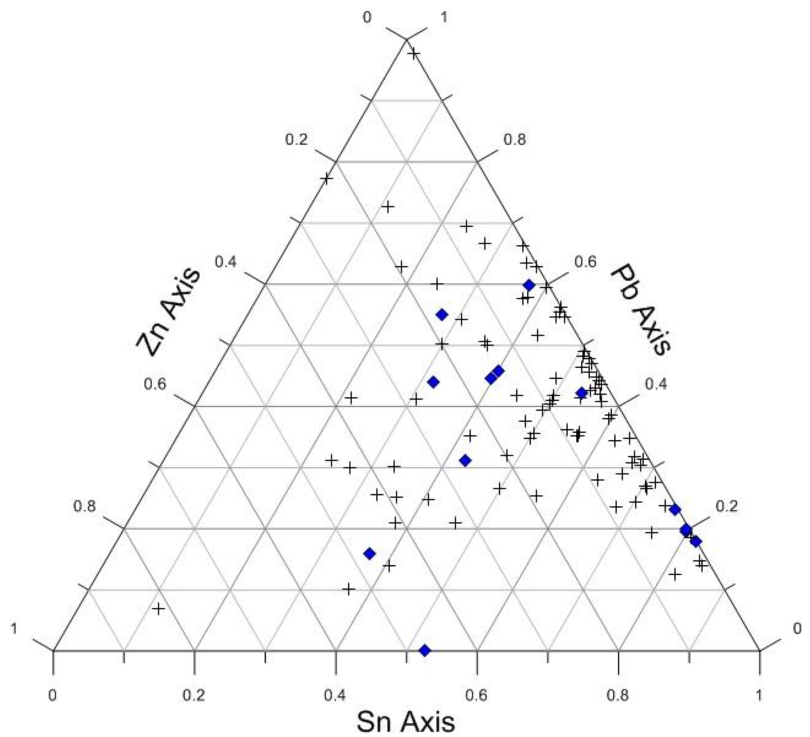

Fig. 3: Square-Headed brooches (Blue) vs. 5th – 8th Century

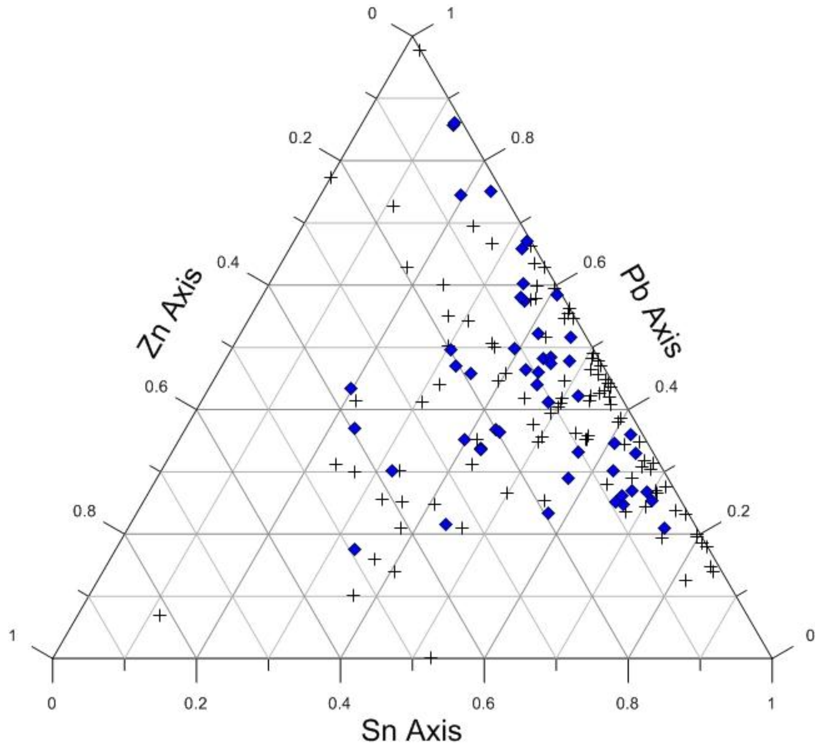

Fig. 4: Domburg brooches (Blue) vs. 5th – 8th Century

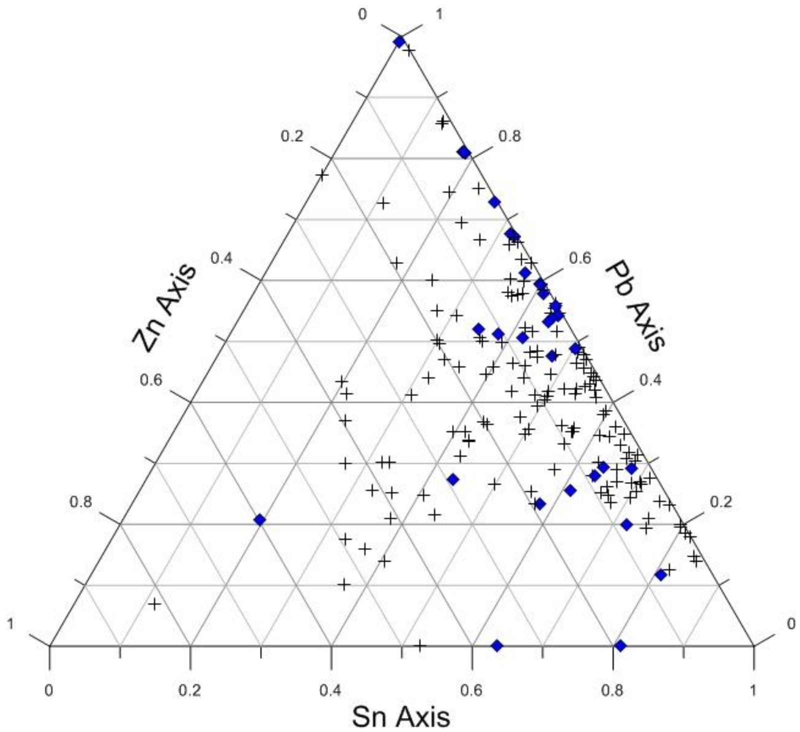

Fig. 5: Frankish brooches (Blue) vs. $5^{th} – 8^{th}$ Century

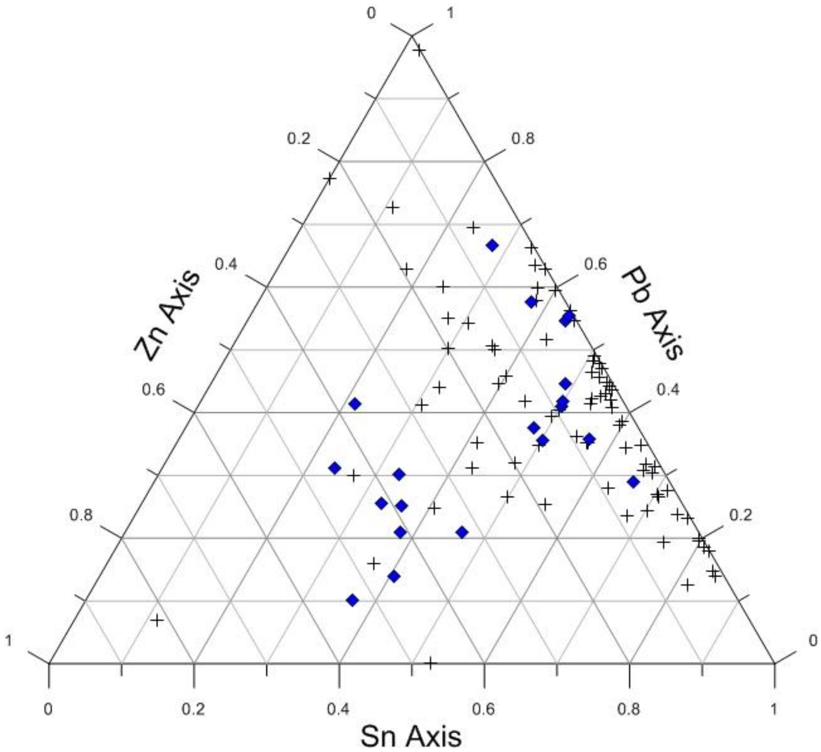

Fig. 6: Small-Long brooches (Blue) vs. $5^{th} – 8^{th}$ Century

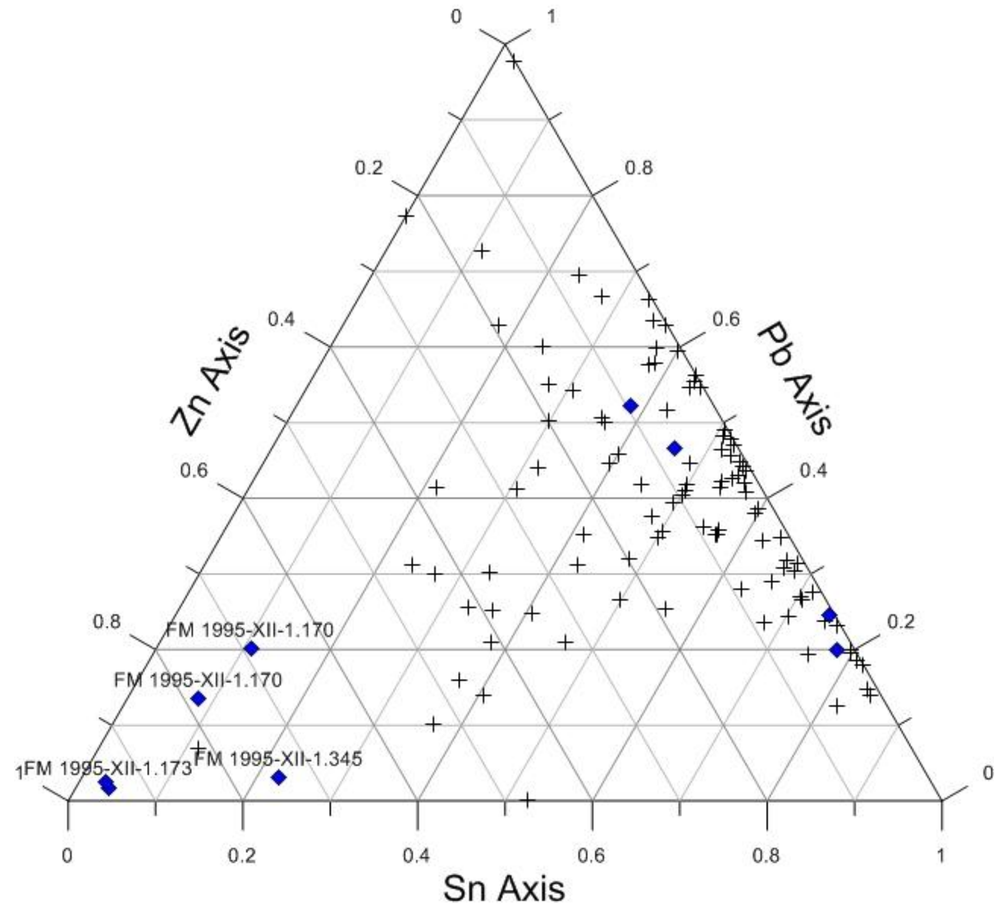

Fig. 7: Germanic Small-Long brooches (Blue) vs. 5th – 8th Century

Appendix 2: Ternary diagrams (Sn-Pb-Zn) for 8th – 12th Century

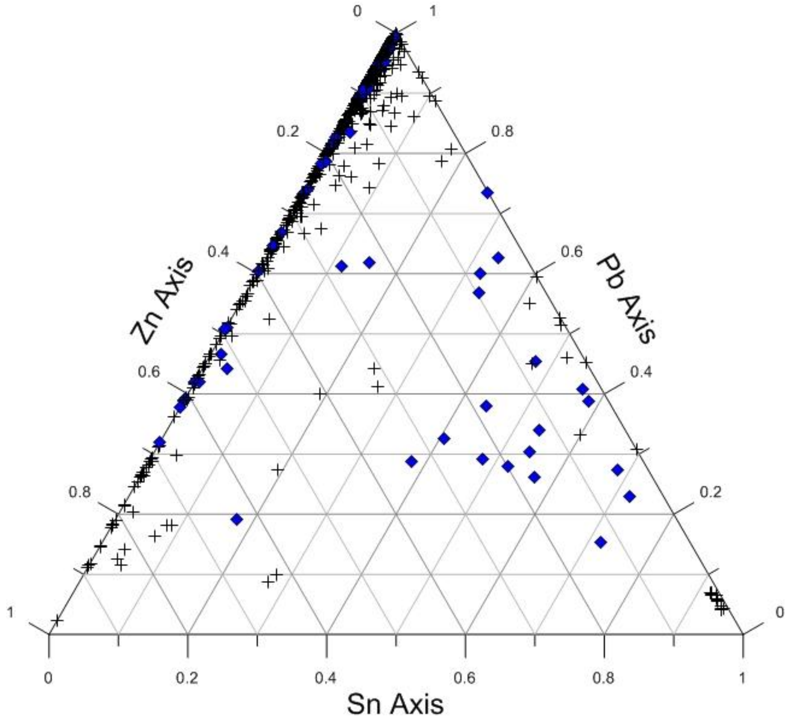

Fig. 1: Equal-Arm brooches (Blue) vs. 5th – 8th Century

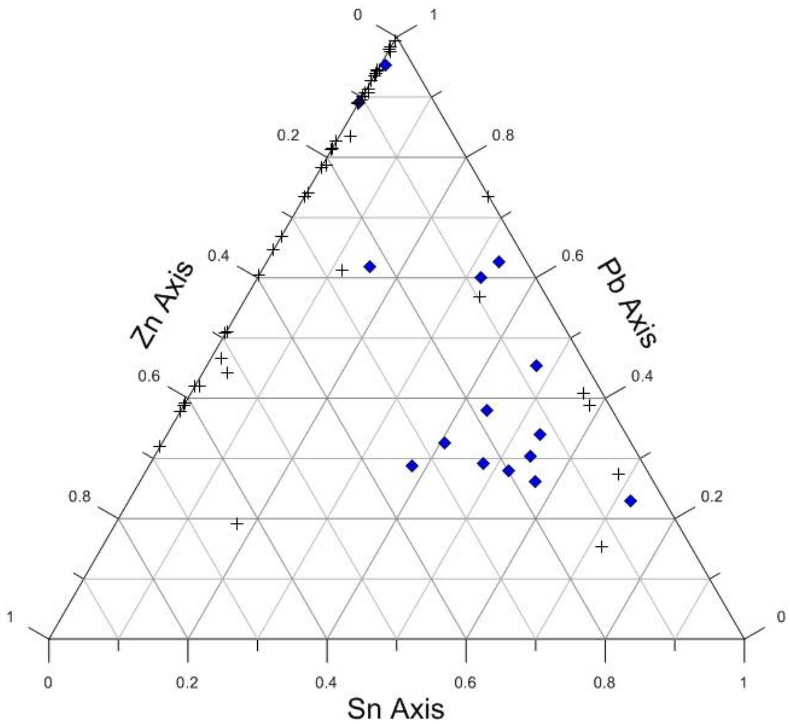

Fig. 2: Heavy Bow type (Blue) vs. Equal-Arm brooches

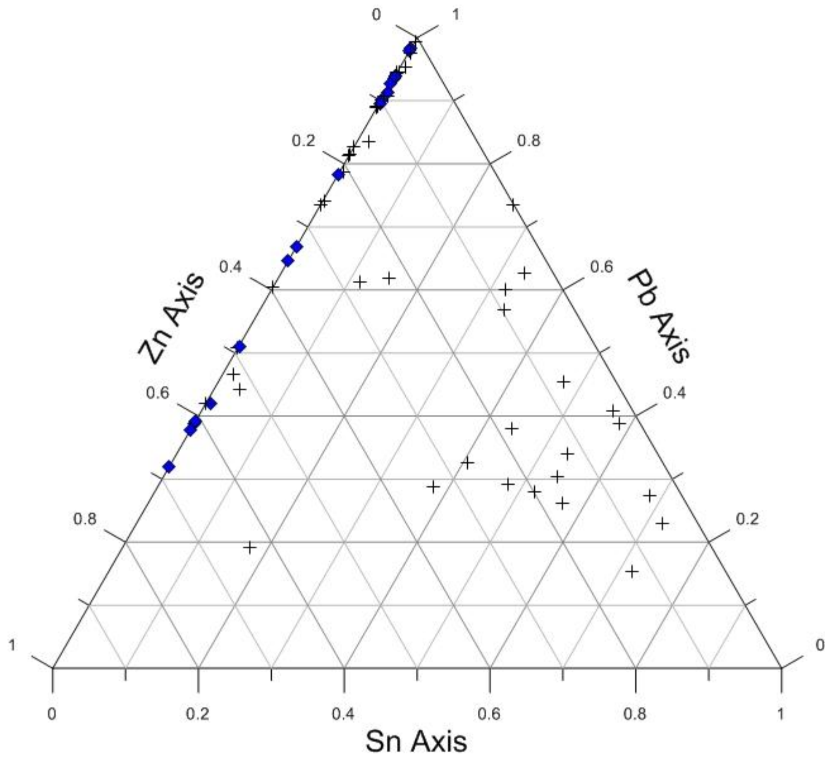

Fig 3: 'Bow Tie' Type (Blue) vs Equal-Arm brooches

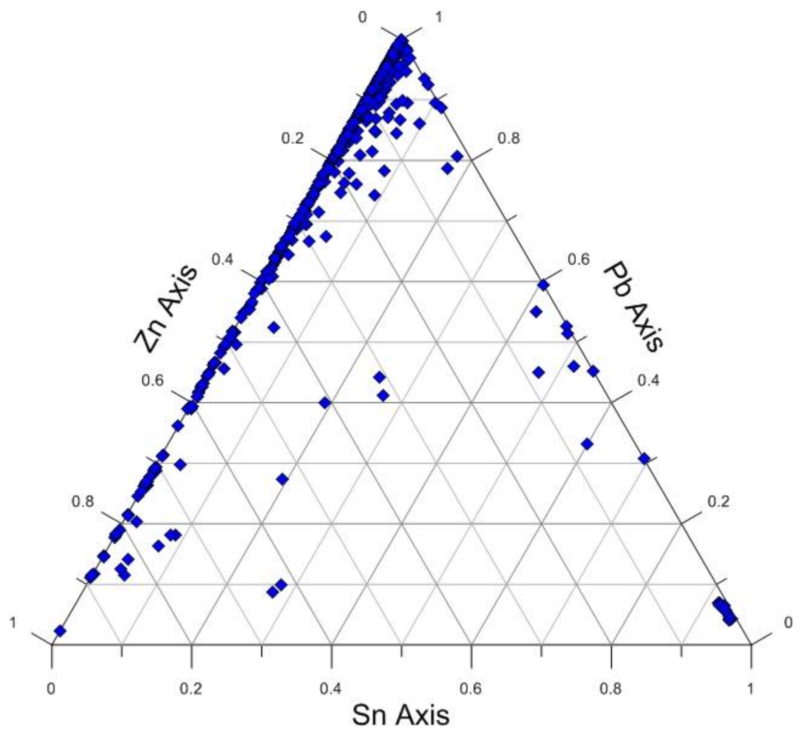

Fig 4: Disc brooches

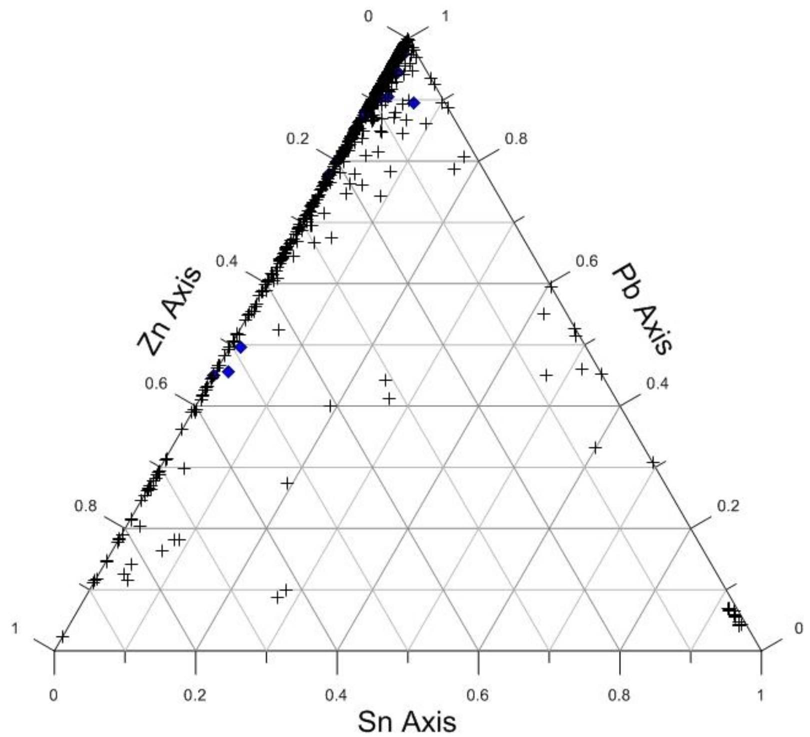

Fig 5: Button brooches (Blue)

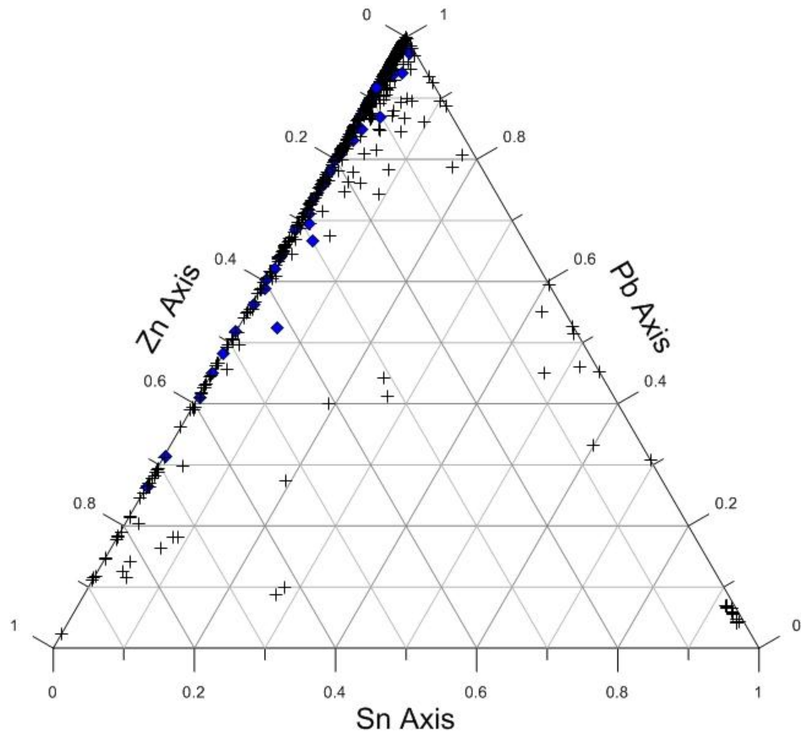

Fig 6: Maltese Cross brooches (Blue)

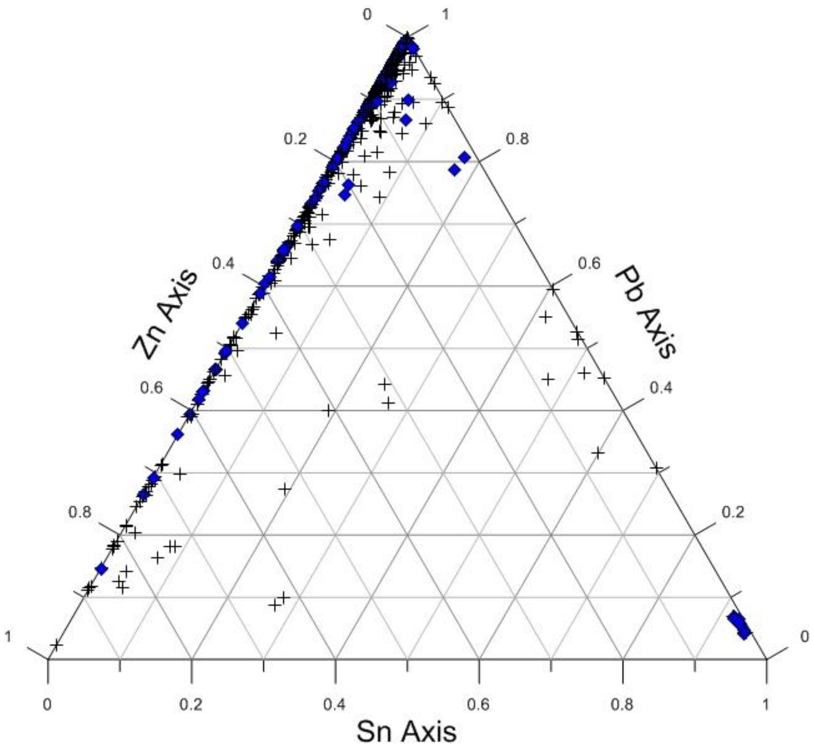

Fig 7: Pseudo Coin brooches (Blue)

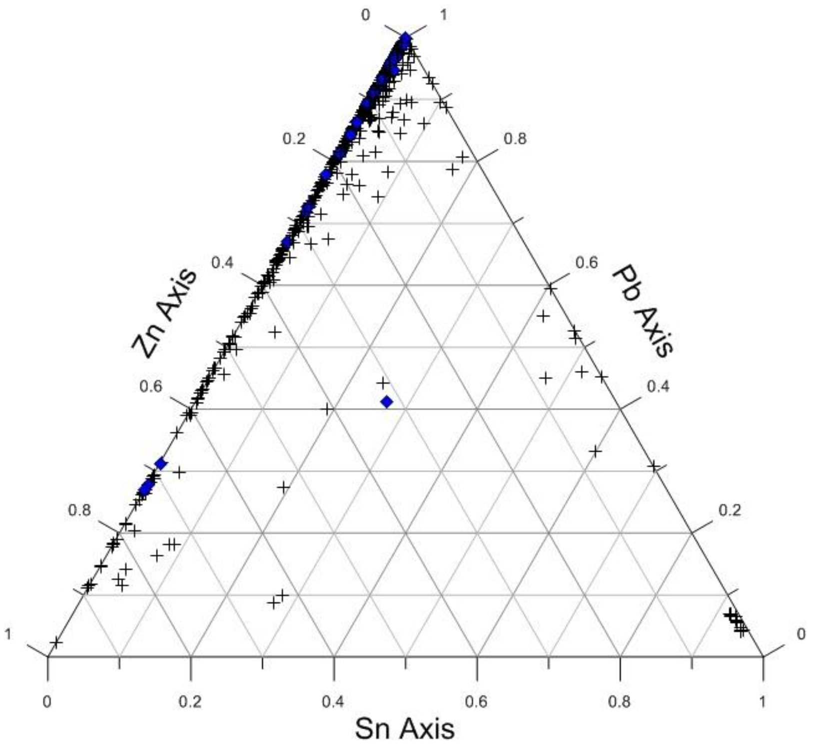

Fig 8: Saints brooches (Blue)

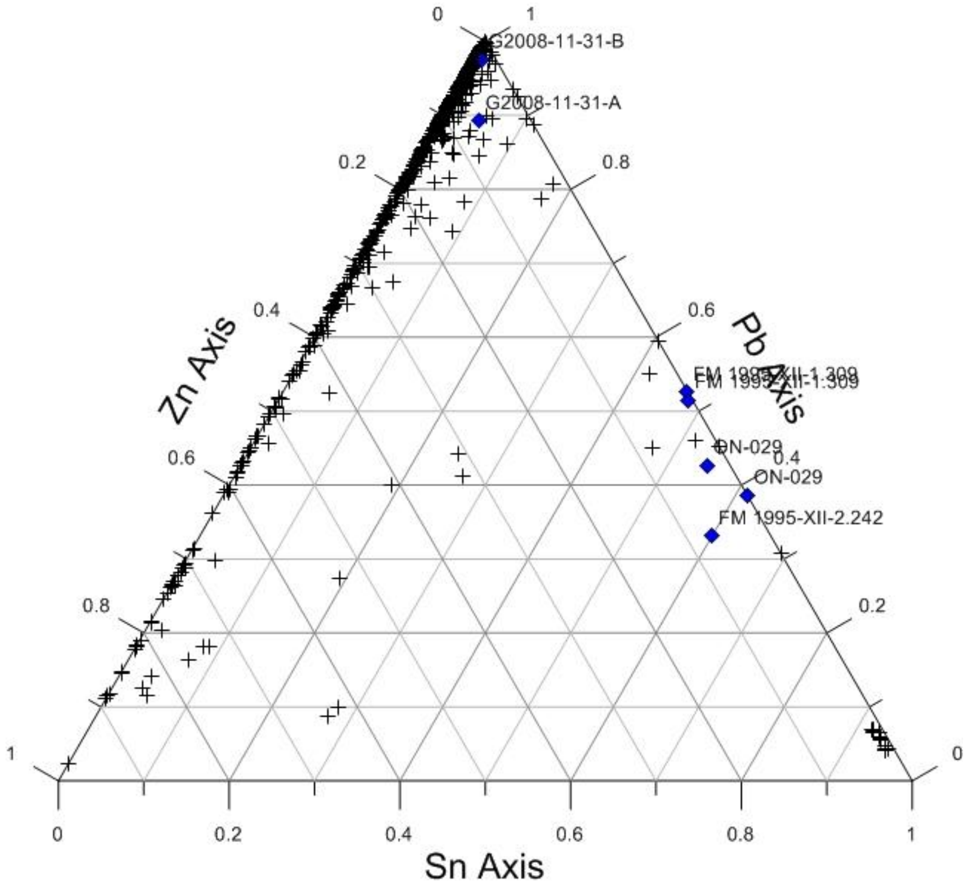

Fig 9: Scandinavian brooches (Blue)

Appendix 3: The catalogue (5th – 8th Century)

Finds ID	Description
F 2007-IV-139	Bird
FM 1995-XII-1.354	Bird
F 2007-IV-138	Bird,
FM 1995-XII-1.371	Bird, headplate half
FM 1995-XII-1.350	Bird, ring & dot decoration.
FM 1995-XII-1.99	Bow, 3 knobbed triangular headplate, bow, elongated beaked footplate
FM 1995-XII-1.345	Bow, 3 knobbed triangular headplate, bow, no footplate
FM 1995-XII-1.123	Bow, 3 knobbed triangular headplate, no bow, no footplate
FM 1995-XII-1.329	Bow, 3 knobbed triangular headplate, no bow, no footplate
74b-8	Cruciform, 1 knob, headplate, bow, animal head, Aberg Type 2
07HALV000386	Cruciform, 1 knob, headplate, bow, animal head, Aberg type 1
07HALV000460	Cruciform, 1 knob, headplate, bow, animal head, Aberg type 1
FM 1995-XII-1.159	Cruciform, 1 knob, headplate, bow, footplate, animal head, Aberg Type1
FM 1995-XII-1.129	Cruciform, 1 knob, headplate, bow, no footplate, Aberg type 1
FM 1995-XII-1.128	Cruciform, 1 knob, headplate, fragment of, no bow, no footplate, Aberg Type1
FM 1995-XII-1.127	Cruciform, 1 knob, headplate, saltire dec., half bow, no footplate, Aberg Type1
FM 1995-XII-1.130	Cruciform, 1 knob, headplate, square dec., bow, no footplate, Aberg Type 1
FM 1995-XII-1.102	Cruciform, 3 knob headplate (1 knob missing), no bow, no footplate, Aberg Type 1 or 2
FM 1995-XII-1.101	Cruciform, 3 knob headplate (2 knobs missing), bow. Aberg type 1
FM 1995-XII-1.104	Cruciform, 3 knob headplate (2 knobs missing), no bow, no footplate, Aberg Type 1,2, or 3
FM 1995-XII-1.106	Cruciform, 3 knob headplate (2 outer smaller than central), no bow, no footplate, Aberg 2 fig 59 ?
FM 1995-XII-1.122	Cruciform, 3 knob headplate, (2 missing), no bow, no footplate, Aberg Type 1
07HALV000064	Cruciform, 3 knob headplate, bow, animal head, Aberg type 2 or 3
FM 1995-XII-1.119	Cruciform, 3 knob headplate, bow, no footplate, Aberg type 1, 2 or 3
FM 1995-XII-1.116	Cruciform, 3 knob headplate, bow, no footplate, Aberg type 2 or 3
FM 1995-XII-1.103	Cruciform, 3 knob headplate, bow, no footplate, Aberg type 2,3 or 4 ?
FM 1995-XII-1.120	Cruciform, 3 knob headplate, no bow, no footplate, Aberg type 1, 2 or 3
FM 1995-XII-1.108	Cruciform, 3 knob headplate, no bow, no footplate, Aberg type 2 or 3
FM 1995-XII-1.117	Cruciform, 3 knob headplate, no bow, no footplate, Aberg type 4, fig 5?
FM 1995-XII-1.105	Cruciform, 3 knob headplate, no bow. no footplate, Aberg type 1, 2 or 3?
FM 1995-XII-1.100	Cruciform, 3 knob headplate, no bow. no footplate, Aberg type 2 or 3
FM 1995-XII-1.118	Cruciform, 3 knob headplate, thin knobs and banded, no bow, no footplate, Aberg type 4
FM 1995-XII-1.12	Cruciform, bow with dotted line decoration, no headplate, no footplate, Aberg Type 2 fig 60 ?

FM 1995-XII-1.95	Cruciform, bow with square design, footplate chipped, no headplate, Aberg Type 1 ?
FM 1995-XII-1.131	Cruciform, bow, part of footplate, no headplate
FM 1995-XII-1.96	Cruciform, footplate beaked, bow, Aberg , Dorchester type Fig 12, p 13
FM 1995-XII-1.139	Cruciform, footplate, animal head with round, enlarged nose, no headplate, no bow. Aberg Type 1
FM 1995-XII-1.125	Cruciform, footplate, animal head, bow, no headplate, Aberg Type 2 or 3?
FM 1995-XII-1.144	Cruciform, footplate, animal head, chipped, bow, no headplate, Aberg type 2 or 3 ?
FM 1995-XII-1.113	Cruciform, footplate, animal head, chipped, bulging eyes, bow chipped, no headplate
FM 1995-XII-1.142	Cruciform, footplate, animal head, chipped, no headplate, no bow, Aberg Type 1 fig 52?
FM 1995-XII-1.141	Cruciform, footplate, animal head, chipped, no headplate, no bow, Aberg Type 1 fig 55?
FM 1995-XII-1.109	Cruciform, footplate, animal head, chipped,bow with square design, no headplate
FM 1995-XII-1.135	Cruciform, footplate, animal head, half bow, no headplate, Aberg Type IV fig 49 ?
FM 1995-XII-1.136	Cruciform, footplate, animal head, no headplate, no bow, Aberg Type 1
FM 1995-XII-1.137	Cruciform, footplate, animal head, no headplate, no bow, Aberg Type 1
G2008-11-24-A	Cruciform, footplate, animal head, no headplate, no bow, Aberg Type 1
FM 1995-XII-1.132	Cruciform, footplate, animal head, no headplate, no bow, Aberg Type 1 Fig 52
FM 1995-XII-1.133	Cruciform, footplate, animal head, no headplate, no bow, Aberg Type 1 Fig 52
FM 1995-XII-1.134	Cruciform, footplate, animal head, no headplate, no bow, Aberg Type 1, 2 or 3
FM 1995-XII-1.140	Cruciform, footplate, animal head, no headplate, no bow, Aberg Type 1, fig 52
FM 1995-XII-1.158	Cruciform, footplate, animal head, scroll nostrils, no bow, no headplate, Aberg Type 3
FM 1995-XII-1.143	Cruciform, footplate, animal head,enlarged nostrils, no headplate, no bow, Aberg Type 1 or 2 ?
FM 1995-XII-1.138	Cruciform, footplate, thin animal head with enlarged nostrils, no headplate, no bow, Aberg type 1
FM 1995-XII-1.115	Cruciform, knob, drilled hole, 2mm dia, Aberg Type 1
FM 1995-XII-1.147	Cruciform, knob, drilled hole, 2mm dia, saw mark. Aberg Type 1
FM 1995-XII-1.148	Cruciform, knob, drilled hole, 2mm dia, saw mark. Aberg Type 1
FM 1995-XII-1.145	Cruciform, knob, drilled hole, 5mm dia. Aberg Type 1
FM 1995-XII-1.151	Cruciform, knob, drilled hole, iron wire, Aberg Type 1
FM 1995-XII-1.146	Cruciform, knob, flat back, drilled hole 2.5mm dia, saw mark. Aberg Type 3 fig 66, 2
FM 1995-XII-1.149	Cruciform, knob, flat back, drilled hole 2mm dia, Aberg Type 3 fig 6, 2
FM 1995-XII-1.150	Cruciform, knob, flat back, drilled hole 2mm dia, saw mark, Aberg Type 2 or 3
FM 1995-XII-1.114	Cruciform, knob, flat back, drilled hole 3mm dia, right through, saw mark. Aberg Type 2 or 3

FM 1995-XII-1.124	Cruciform, knob, flat back, drilled hole, right through, 2mmdia, saw mark. Aberg Type 2 or 3
FM 1995-XII-1.153	Cruciform, knob, flat back, hollowed out? drilled hole, 2.5mm dia, saw mark, Aberg 2 or 3
FM 1995-XII-1.152	Cruciform, knob, saw mark (sampling?) Aberg Type 1
FM 1995-XII-1.321	Cruciform? Early type ? rectangular headplate?no bow, no footplate
FM 1995-XII-1.306	Cruciform? Early type
FM 1995-XII-1.317	Disc, central ring & dot ? Some outside ring & dots or a volute ?
FM 1995-XII-1.323	Disc, ring of circles and dots
FM 1995-XII-1.347	Disc-on-bow (Ruckenknopffibula ?)
FM 1995-XII-2.477	Disc-on-bow, 4 opposed dots
FM 1995-XII-1.126	Disc-on-bow, headplate & bow (hole through bow 2.5mm dia), no footplate.
FM 1995-XII-1.88	Domburg weak kidney shaped headplate, half bow cut at 45 degrees, no footplate
FM 1995-XII-1.70	Domburg ? Footplate chipped. Ring & dot decoration
FM 1995-XII-1.64	Domburg ? Footplate, incised oval motif (vulva?)
FM 1995-XII-1.68	Domburg ? Footplate, incised oval motif (vulva?)
FM 1995-XII-1.69	Domburg ? Half bow, footplate, ring and dot decoration
FM 1995-XII-1.41	Domburg ? Small-Long ? Headplate chipped and pierced, end of foot plate chipped. hole in headplate
FM 1995-XII-1.97	Domburg, footplate with extended kidney shaped end, 5 ring & dots, bow fragment, no headplate.
FM 1995-XII-1.40	Domburg, kidney shaped headplate with ring & dots, bow, footplate chipped
FM 1995-XII-1.70a?	Domburg, bow, footplate with nostril shaped end, ring & dot decoration
FM 1995-XII-1.325	Domburg, footplate with incised oval motif, bow, no headplate
FM 1995-XII-1.74	Domburg, footplate, chipped, ring & dot decoration.
FM 1995-XII-1.67	Domburg, half bow, footplate with nostril shaped end, ring & dot decoration
07HALV000266	Domburg, kidney headplate, beak footplate, with nostril shaped end, ring sand dot decoration
FM 1995-XII-1.47	Domburg, Kidney shaped headplate decorated with volutes, bow chipped, no footplate
FM 1995-XII-1.53	Domburg, Kidney shaped headplate with 2 ring & dots simulating volutes? bow chipped, no footplate
FM 1995-XII-1.59	Domburg, Kidney shaped headplate with 2 ring & dots simulating volutes? bow chipped, no footplate
FM 1995-XII-1.51	Domburg, Kidney shaped headplate with 3 ring & dots. No bow, no footplate
FM 1995-XII-1.52	Domburg, Kidney shaped headplate with crude volutes, bow with punched triangles, no footplate
FM 1995-XII-1.62	Domburg, Kidney shaped headplate with ring & dot decoration, bow with line decoration, no footplate
FM 1995-XII-1.54	Domburg, Kidney shaped headplate with ring & dot decoration, bow, no footplate
FM 1995-XII-1.57	Domburg, Kidney shaped headplate with ring & dot decoration, bow, no footplate
FM 1995-XII-1.55	Domburg, Kidney shaped headplate with volutes, bow chipped, no footplate

FM 1995-XII-1.48	Domburg, Kidney shaped headplate with volutes, bow, no footplate
FM 1995-XII-1.56	Domburg, Kidney shaped headplate with volutes, bow, no footplate
FM 1995-XII-1.49	Domburg, Kidney shaped headplate, bow, no footplate
FM 1995-XII-1.50	Domburg, Kidney shaped headplate, bow, no footplate
FM 1995-XII-1.66	Domburg, Kidney shaped headplate, bow, no footplate
FM 1995-XII-1.75	Domburg, kidney shaped headplate, bow, ring & dot decoration, no footplate
FM 1995-XII-1.65	Domburg, kidney shaped headplate, chipped bow, small fragment of footplate
FM 1995-XII-1.39	Domburg, kidney shaped headplate, elongated footplate, chipped
FM 1995-XII-1.76	Domburg, kidney shaped headplate, no bow, no footplate
FM 1995-XII-1.71	Domburg, kidney shaped headplate, pierced 2mm dia. bow with high ridge. No footplate
FM 1995-XII-1.77	Domburg, kidney shaped headplate, ring & dot decoration, no bow, no footplate
FM 1995-XII-1.80	Domburg, kidney shaped headplate, ring & dot decoration, no bow, no footplate
FM 1995-XII-2.259	Domburg, Kidney shaped headplate, ring & dot pattern, chipped, Bow, no footplate
FM 1995-XII-1.58	Domburg, kidney shaped headplate, squarish with volutes, bow, no footplate
FM 1995-XII-1.43	Domburg, Kidney shaped headplate, volutes, bow, footplate chipped, incised oval motif (vulva?)
FM 1998-IV-6.8	Domburg, kidney shaped headplate, volutes, bow, footplate elongated, nostril shaped end.
FM 1995-XII-1.79	Domburg, kidney shaped headplate, volutes, half bow, no footplate
FM 1995-XII-1.78	Domburg, kidney shaped headplate, volutes, no bow, no footplate
FM 1995-XII-1.61	Domburg, Kidney shaped headplate, with ring & dot decoration, bow with ring & dot, no footplate
FM 1995-XII-1.42	Domburg, kidney-shaped headplate has three punched points, end of footplate chipped
G2008-11-21	Domburg, volutes on kidney headplate, bow, elongated footplate
FM 1995-XII-1.46	Domburg? footplate with engraved oval, chipped, bow, no headplate
FM 1995-XII-1.63	Domburg? Footplate with nostril shaped end, no bow, no headplate
FM 1995-XII-1.98	Domburg? footplate with single nostril shaped end , ring & dot decoration. No headplate, no bow
FM 1995-XII-1.60	Domburg? Sub kidney shaped headplate, with volutes Bow chipped, no footplate
FM 1995-XII-1.89	Long-Brooch, Traces of gilding.
FM 1995-XII-1.346	Long-brooch? headplate fragmented and bow half, no footplate
FM 1995-XII-1.337	Radiate ? animal head footplate fragment, silver, gilt. No bow no headplate, see FM 1995-XII-1.163
FM 1995-XII-1.163	Radiate ? footplate, fragment, silver, gilt, see Aberg Fig 147 for similar Friesland decoration
FM 1995-XII-1.341	Radiate or equal-arm?, gilded, notch cut decoration. Bow half, & footplate, no headplate
FM 1995-XII-1.328	Radiate, headplate with 2 or more knobs, bow half, no footplate, gilded 1 side
FM 1995-XII-1.121	Radiate, headplate with 3 knobs (1 missing), half bow, no footplate
FM 1995-XII-1.334	Radiate, headplate with 3 knobs, bow, no footplate

FM 1995-XII-1.336	Radiate, headplate with 3 knobs, no bow, no footplate
FM 1995-XII-1.330	Radiate, headplate with 3 or more knobs, bow half, no footplate.
FM 1995-XII-1.335	Radiate, headplate with 5 knobs (2 missing), no bow no footplate
FM 1995-XII-1.333	Radiate, headplate with 5 knobs (3 missing), bow half, no footplate
FM 1995-XII-1.331	Radiate, headplate with 5 knobs, bow half, no footplate
FM 1995-XII-1.90	Radiate? 3 knob radiate/triangular headplate, chipped, thin bow, elongated footplate.
FM 1995-XII-1.339	Radiate? fragment of foot plate, gilded. see FM 1995-XII-1.163 and 337,
101-355	Ring, Egan & Pritchard, 1991, p.249,
F 2007-IV-172	Ring, ends bent into stylized animal heads.
FM 1995-XII-1.94	Small-Long, unusual, footplate with three circles each containing ring & dot decoration
G2008-11-20	Small-Long, 3 knob headplate, bow, no footplate
FM 1995-XII-1.87	Small-Long, elongated footplate, bow, no headplate
FM 1995-XII-1.327	Small-Long, footplate
FM 1995-XII-1.320	Small-Long, Square headplate with 5 dots, Bar, inner is concave, no footplate
FM 1995-XII-1.84	Small-Long, Square headplate, border decoration,
FM 1998-IV-6.7	Small-Long, square headplate, bow, elongated footplate, round exaggerated snout
FM 1995-XII-1.45	Small-Long, Square headplate, end of footplate chipped
07HALV000440	Small-Long, Square headplate, pointed footplate, a new footplate welded on?
FM 1995-XII-1.92	Small-Long, Square headplate, ribbed bow, concave in rear, small button footplate.
FM 1995-XII-1.81	Small-Long, Square headplate, ring & dot decoration
FM 1995-XII-1.82	Small-Long, Square headplate, ring & dot decoration
FM 1995-XII-1.83	Small-Long, Square headplate, ring & dot decoration, bow, no footplate
07HALV000141	Small-Long, Square headplate, thin bow, beak footplate, elongated with nostrils
FM 1995-XII-1.91	Small-Long, Square headplate, triangular footplate ending in circle. Ring & dot decoration
FM 1995-XII-1.93	Small-Long? Paddle shaped headplate, thin bow, 1 terminal missing
FM 1995-XII-1.73	Small-Long? Footplate with circle dot trim and rounded end.
FM 1995-XII-1.170	Small-Long? Unusual , 3 knob ? Headplate, notch cut decoration as FM 1995-XII-1.173
FM 1995-XII-1.173	Small-Long? Unusual , 3 knob headplate, notch cut decoration as FM 1995-XII-1.170
FM 1995-XII-1.340	Square-headed ? headplate? Fragment, Gilded
FM 1995-XII-1.342a	Square-headed, bow fragment, gilded
07HALV000339	Square-headed, complete, notch cut
FM 1998-IV-6.5	Square-headed, Fragment of head plate? notch cut decoration.
FM 1995-XII-1.338	Square-headed, fragment, gilded
FM 1995-XII-1.342	Square-headed, headplate fragment, gilded
FM 1995-XII-1.344	Square-headed, headplate part of, bow part of. no footplate
FM 1995-XII-1.343	Square-headed, headplate, no bow, no footplate, decoration similar to Aberg fig 160
F 2007-IV-149	Square-headed? Footplate, fragment

Appendix 4: The catalogue (8th – 12th Century)

Finds ID	Description
FM 1995-XII-1.166	Crescent-shaped, Bird ? Lunula ? Enamel
FM 1995-XII-2.238	Cross-shaped, fragment, footplate
FM 1995-XII-2.417	Cross-shaped, Maltese
ON-020	Saint, St Peter & St Paul?
ON-039	Cross-shaped, reused as a mount?
FM 1995-XII-2.256	Cross-shaped, with notch cut decoration.
ON-032	Disc
ON-005	Disc Saint
FM 1995-XII-2.21	Disc, 5 dimples around edge, central setting for a green ornamental stone
FM 1995-XII-2.23	Disc, 5 dimples around edge, central setting for an ornamental stone, enamelled, used as pendant?
FM 1995-XII-2.56	Disc, 3 cell, cloisonné
FM 1995-XII-2.59	Disc, 3 cell, cloisonné
F 2007-IV-107	Disc, 3 cell, red enamel, cloisonné.
FM 1995-XII-2.49	Disc, 3 cell, thick rim, cloisonné
FM 1995-XII-2.58	Disc, 3 cell, thick rim, cloisonné
FM 1995-XII-2.39	Disc, 3 cell, thick rim, green enamel cloisonné
FM 1995-XII-2.38	Disc, 3 cell, thick rim, white enamel cloisonné
FM 1995-XII-2.46	Disc, 3 cell, turnedback edges, cloisonné
FM 1995-XII-2.63	Disc, 3 cell, turnedback edges, cloisonné
FM 1995-XII-2.62	Disc, 3 cell, unusually deep, cloisonné
FM 1995-XII-2.231	Disc, 3-armed cross, grubenschmelz, green enamel
FM 1995-XII-2.429	Disc, Agnus Dei, surmounted by a cross
FM 1995-XII-2.115	Disc, Agnus Dei? surmounted by a cross, green enamel.
FM 1995-XII-2.116	Disc, Agnus Dei? surmounted by a cross, green enamel.
G2008-11-30-L	Disc, animal? Fragment
F 2007-IV-180	Disc, bird ? Raised middle section, enamel.
G2008-11-31-B	Disc, Borre style?
F 2007-IV-195	Disc, cavities in rosette motif inlaid with enamel.
FM 1995-XII-2.236	Disc, central circle-and-dot, cabled rim
FM 1995-XII-2.433	Disc, central circle-and-dot, cabled rim, enamelled
FM 1995-XII-2.432	Disc, centre missing,
FM 1995-XII-2.54	Disc, centre missing,
FM 1995-XII-2.278	Disc, centre missing, half fragment
F 2007-IV-110	Disc, centre missing, red enamel
G2008-11-29-S	Disc, centre missing, red enamel, cloisonné
FM 1995-XII-2.47	Disc, centre missing, unusually deep
FM 1995-XII-2.403	Disc, complex double cross, green enamel.
FM 1995-XII-2.407	Disc, complex double cross, green enamel.
FM 1995-XII-2.408	Disc, complex double cross, green enamel.
FM 1995-XII-2.397	Disc, complex double cross, green enamel. Cast
FM 1995-XII-1.376	Disc, complex double cross, light green enamel, reused, pendant or mount?
G2008-11-29-Y	Disc, complex double cross, pearled edge

FM 1995-XII-2.73	Disc, complex double cross, red enamel.
G2008-11-29-I	Disc, complex double cross.
G2008-11-29-X	Disc, complex double cross.
ON-029	Disc, concentric rings, an example in PAS suggests Anglo-Saxon
FM 1995-XII-2.290	Disc, convex central boss, smooth
FM 1995-XII-2.431	Disc, convex central boss, star motif similar to 2.4.1.4. edge reused, pendant?
G2008-11-29-J	Disc, Cross ? Half fragment,
FM 1995-XII-2.410	Disc, cross and dot motif, within beaded outer rim
FM 1995-XII-2.288	Disc, cross formed by raised blocks
ON-037	Disc, cross formed by raised blocks
G2008-11-30-F	Disc, cross made of four kidney shaped cells.. Dot pattern around edge. Dot in centre of cross
FM 1995-XII-2.423	Disc, cross motif, circle in centre, dots between cross.
FM 1995-XII-2.420	Disc, cross with four dots
G2008-11-29-U	Disc, cross with four dots
FM 1995-XII-2.27	Disc, cross with four dots, green enamel.
FM 1995-XII-2.28	Disc, cross with four dots, green enamel.
FM 1995-XII-2.416	Disc, cross,
FM 1995-XII-2.411	Disc, cross,
G2008-11-29-T	Disc, cross, central circle
ON-048	Disc, cross, central circle
FM 1995-XII-1.377	Disc, cross, central circle, green enamel.
G2008-11-29-P	Disc, cross, central circle, half fragment, Champlevé
FM 1995-XII-1.378	Disc, cross, central circle, red enamel.
FM 1995-XII-1.380	Disc, cross, central circle, red enamel.
ON-001	Disc, cross, four dimples
FM 1995-XII-2.94	Disc, cross, four dimples in heptagon, red enamel
FM 1995-XII-2.97	Disc, cross, four dimples in heptagon, red enamel
FM 1995-XII-2.106	Disc, cross, four dimples, enamel
FM 1995-XII-2.107	Disc, cross, four dimples, engraved rim, red enamel
FM 1995-XII-2.89	Disc, cross, four dimples, green enamel.
FM 1995-XII-2.91	Disc, cross, four dimples, green enamel.
FM 1995-XII-2.92	Disc, cross, four dimples, green enamel.
FM 1995-XII-2.93	Disc, cross, four dimples, green enamel.
FM 1995-XII-2.95	Disc, cross, four dimples, green enamel.
FM 1995-XII-2.96	Disc, cross, four dimples, green enamel.
FM 1995-XII-2.90	Disc, cross, four dimples, green enamel. Misplaced cavities?
FM 1995-XII-2.88	Disc, cross, four dimples, red enamel.
G2008-11-29-K	Disc, cross, inside concentric rings, resembles Nabenemailscheibenfibeln
FM 1995-XII-2.30	Disc, cross, light green enamel.
G2008-11-30-B	Disc, cross, plain rim
FM 1995-XII-2.274	Disc, cross, plain rim, enamel.
FM 1995-XII-1.388	Disc, cross, red enamel, central circle
FM 1995-XII-2.412	Disc, cross, red enamel.
FM 1995-XII-2.414	Disc, cross, red enamel. Pin housing redrilled, repair or pendant? 2mm dia
F 2007-IV-103	Disc, cross, with four dots.
FM 1995-XII-2.24	Disc, cross, with four dots.

FM 1995-XII-2.25	Disc, cross, with four dots.
FM 1995-XII-2.26	Disc, cross, with four dots.
G2008-11-30-O	Disc, eight dimples, star not cross in circle, hole in dimple, reused as pendant?
G2008-11-29-B	Disc, eight spoked notch cut
ON-024	Disc, empty centre
FM 1995-XII-2.409	Disc, engraved Maltese cross, green enamel
G2008-11-31-A	Disc, Extra loop on rear to make pendant?
FM 1995-XII-2.232	Disc, 'figure in cloak? green enamel?
ON-017	Disc, five holes around edge, central setting for an ornamental stone, reused, pendant?
FM 1995-XII-2.20	Disc, four holes around edge, central setting for an ornamental stone, enamelled.
28-90	Disc, Frick, 1992, 462,
FM 1998-IV-6.9	Disc, human figure ?
FM 1995-XII-2.239	Disc, human figure, Christ ? Head and bust, in front of cross
G2008-11-29-G	Disc, human figure, Christ ? Head and bust, in front of cross
ON-040	Disc, human figure, Christ ? Head and bust, in front of cross
G2008-11-181D	Disc, human figure, Christ ? Head and bust, in front of cross, with beaded cloak? and rim
ON-031	Disc, human figure, Christ ? Standing in attitude of benediction?
FM 1995-XII-2.118	Disc, human figure, Christ? Head and body, attitude of benediction? Green enamel.
FM 1995-XII-2.119	Disc, human figure, running, red enamel.
FM 1995-XII-2.235	Disc, kidney shaped, 3 surface cavities.
F 2007-IV-190	Disc, Maltese cross, enamel, grubenschmelz
F 2007-IV-198	Disc, Maltese cross, light coloured red & white? enamel. Cast
FM 1995-XII-2.405	Disc, Maltese cross, white enamel, cast
G2008-11-29-E	Disc, Maltese cross
G2008-11-30-M	Disc, Maltese cross
ON-002	Disc, Maltese cross
ON-004	Disc, Maltese cross
ON-012	Disc, Maltese cross
ON-019	Disc, Maltese Cross
ON-021	Disc, Maltese Cross
ON-034	Disc, Maltese Cross
FM 1995-XII-2.108	Disc, Maltese cross from four dimples, normal cross within it
ON-018	Disc, Maltese Cross on raised circle
G2008-11-30-E	Disc, Maltese cross on raised circle, dark red ? Enamel
FM 1995-XII-2.110	Disc, Maltese cross on raised circle, enamel
FM 1995-XII-2.74	Disc, Maltese cross on raised circle, enamel
FM 1995-XII-2.75	Disc, Maltese cross on raised circle, enamel
FM 1995-XII-2.77	Disc, Maltese cross on raised circle, enamel
G2008-11-29-A	Disc, Maltese cross on raised circle, orange/brown enamel
FM 1995-XII-2.109	Disc, Maltese cross on raised circle, red enamel
FM 1995-XII-2.111	Disc, Maltese cross on raised circle, red enamel
FM 1995-XII-2.76	Disc, Maltese cross on raised circle, red enamel
FM 1995-XII-2.29	Disc, Maltese cross,
FM 1995-XII-2.16	Disc, Maltese cross, enamel, grubenschmelz
F 2007-IV-105	Disc, Maltese cross, red enamel, cloisonné.

F 2007-IV-102	Disc, Maltese cross, red enamel, cloisonné. Hole drilled in edge by pin house.
F 2007-IV-122	Disc, Maltese cross, cast
ON-035	Disc, Maltese cross, cast
FM 1995-XII-2.48	Disc, Maltese cross, cloisonné
FM 1995-XII-2.50	Disc, Maltese cross, cloisonné
FM 1995-XII-2.51	Disc, Maltese cross, cloisonné
FM 1995-XII-2.52	Disc, Maltese cross, cloisonné
F 2007-IV-101	Disc, Maltese cross, enamel.
FM 1995-XII-2.401	Disc, Maltese cross, green enamel
FM 1995-XII-2.396	Disc, Maltese cross, green enamel, cast
FM 1995-XII-2.399	Disc, Maltese cross, green enamel, cast
FM 1995-XII-2.400	Disc, Maltese cross, green enamel, cast
FM 1995-XII-2.404	Disc, Maltese cross, green enamel, crosses in each quadrant
FM 1995-XII-2.32	Disc, Maltese cross, green enamel, grubenschmelz
FM 1995-XII-2.31	Disc, Maltese cross, green enamel.
FM 1995-XII-2.33	Disc, Maltese cross, green enamel.
FM 1995-XII-2.34	Disc, Maltese cross, green enamel.
FM 1995-XII-2.35	Disc, Maltese cross, green enamel.
FM 1995-XII-2.36	Disc, Maltese cross, green enamel.
F 2007-IV-2	Disc, Maltese cross, light coloured enamel, cloisonné
F 2007-IV-193	Disc, Maltese cross, light coloured enamel. cast
FM 1995-XII-2.41	Disc, Maltese cross, light green enamel, cloisonné
FM 1995-XII-2.40	Disc, Maltese cross, light green enamel, cloisonné, hint of central circle
FM 1995-XII-2.61	Disc, Maltese cross, pearled edge, cloisonné
FM 1995-XII-2.60	Disc, Maltese cross, pearled edge, cloisonné
F 2007-IV-127	Disc, Maltese cross, red enamel, cast
F 2007-IV-126	Disc, Maltese cross, red enamel, cloisonné
F 2007-IV-109	Disc, Maltese cross, red enamel, cloisonné.
F 2007-IV-129	Disc, Maltese cross, red enamel, cloisonné.
FM 1995-XII-2.37	Disc, Maltese cross, red enamel, grubenschmelz
FM 1995-XII-2.421	Disc, Maltese cross, red enamel.
FM 1995-XII-2.45	Disc, Maltese cross, thick rim, cloisonné
FM 1995-XII-2.64	Disc, Maltese cross, thick rim, black ? Enamel, cloisonné
FM 1995-XII-2.65	Disc, Maltese cross, thick rim, black ? Enamel, cloisonné
FM 1995-XII-2.53	Disc, Maltese cross, thick rim, cloisonné
FM 1995-XII-2.55	Disc, Maltese cross, thick rim, cloisonné
FM 1995-XII-2.57	Disc, Maltese cross, thick rim, pearled edge, cloisonné
G2008-11-30-N	Disc, Maltese cross, two holes reused as pendant?
FM 1995-XII-2.44	Disc, Maltese cross, white enamel, cloisonné
F 2007-IV-128	Disc, Maltese cross, white enamel, cloisonné.
F 2007-IV-108	Disc, Maltese cross, white? enamel,
ON-008	Disc, Maltese cross? Cast or Champlevé
G2008-11-30-C	Disc, Maltese cross
G2008-11-30-K	Disc, Maltese cross, white? Enamel
FM 1995-XII-2.422	Disc, openwork cross in pearl rim
FM 1995-XII-2.234	Disc, openwork, zoomorphic? - see PAS LIN-4A3A98, and SWYOR-114BB0
F 2007-IV-104	Disc, pseudo cloisonné, rosette with six petals, enamelled.
FM 1995-XII-2.418	Disc, pseudo cloisonné, six rays, enamel?

G2008-11-29-Q	Disc, pseudo cloisonné, Star motif
FM 1995-XII-2.406	Disc, pseudo cloisonné, star motif, enamel
F 2007-IV-178	Disc, pseudo cloisonné, with seven dimples around a central one, pearled edge, enamelled.
FM 1995-XII-2.18	Disc, pseudo cloisonné, with six dimples around a central button.
ON-036	Disc, pseudo coin ? large pearl rim, many pearls broken off. Scratched animal decoration?
F 2007-IV-196	Disc, quadruped with forked tail, half missing, probably a backward looking beast
FM 1995-XII-2.117	Disc, quadruped, green enamel. Drill hole at base? Pendant? Then upside down
FM 1995-XII-1.349	Disc, quadruped with tail
ON-013	Disc, Quintuplet cross
ON-014	Disc, Quintuplet cross
ON-033	Disc, Quintuplet cross
G2008-11-29-C	Disc, Quintuplet cross, black enamel. Central circle
F 2007-III-100	Disc, Quintuplet cross, green and red enamel. Central circle, cast
FM 1995-XII-2.42	Disc, Quintuplet cross, light green enamel, cloisonné, central circle 3.5mm dia
FM 1995-XII-2.43	Disc, Quintuplet cross, thick rim, light green enamel, cloisonné central circle 2.5mm dia
G2008-11-29-O	Disc, Quintuplet cross. Central circle
FM 1995-XII-2.430	Disc, ragged concentric circles
ON-043	Disc, ragged concentric circles
F 2007-IV-117	Disc, red enamel
FM 1995-XII-2.100	Disc, rosette with eight petals, cross in centre, green enamel
FM 1995-XII-2.99	Disc, rosette with eight petals, cross in centre, red enamel
FM 1995-XII-2.102	Disc, rosette with eight petals, cross with four dimples, enamel
FM 1995-XII-2.104	Disc, rosette with eight petals, cross with four dimples, enamel
FM 1995-XII-2.70	Disc, rosette with eight petals, cross with four dimples, square border, enamelled.,
G2008-11-29-H	Disc, rosette with eight petals, heavy patina
G2008-11-30-H	Disc, rosette with eight petals, heavy patina, possibly not a cross in centre
FM 1995-XII-2.101	Disc, rosette with eight petals, Maltese cross in centre, black enamel
FM 1995-XII-2.66	Disc, rosette with eight petals, Maltese cross in centre, enamel
FM 1995-XII-2.275	Disc, rosette with nine petals, central setting for a blue ornamental stone
FM 1995-XII-2.67	Disc, rosette with seven petals, cross with four dimples
FM 1995-XII-2.103	Disc, rosette with seven petals, cross with four dimples, enamel
FM 1995-XII-2.68	Disc, rosette with seven petals, cross with four dimples, enamel
FM 1995-XII-2.71	Disc, rosette with seven petals, cross with four dimples, enamel
FM 1995-XII-2.72	Disc, rosette with seven petals, cross with four dimples, enamel
FM 1995-XII-2.105	Disc, rosette with seven petals, cross with four dimples, green enamel
FM 1995-XII-2.98	Disc, rosette with seven petals, cross with four dimples, green enamel
FM 1995-XII-2.85	Disc, rosette with six flattened petals, central setting for an ornamental stone, petals inlaid with red enamel.
ON-041	Disc, rosette with six petals
FM 1995-XII-2.112	Disc, rosette with six petals with point circle decoration around hexagonal middle section.

FM 1995-XII-2.113	Disc, rosette with six petals with point circle decoration around hexagonal middle section.
FM 1995-XII-1.324	Disc, rosette with six petals with point circle decoration around middle section.
F 2007-IV-125	Disc, rosette with six petals, enamel
FM 1995-XII-2.15	Disc, rosette with six petals, with point circle decoration, green enamel
FM 1995-XII-2.122	Disc, rosette with six pointed petals, central setting for a blue ornamental stone.
FM 1995-XII-2.123	Disc, rosette with six pointed petals, central setting for a blue ornamental stone.
FM 1995-XII-2.121	Disc, rosette with six pointed petals, central setting for a blue/green ornamental stone.
FM 1995-XII-2.86	Disc, rosette with six pointed petals, central setting for an ornamental stone, petals inlaid with red enamel.
G2008-11-29-D	Disc, Saint
F 2007-IV-194	Disc, saint,
FM 1995-XII-2.228	Disc, saint,
G2008-11-30-J	Disc, Saint, red enamel
F 2007-IV-118	Disc, saint, 'Frisian type'
F 2007-IV-121	Disc, saint, 'Frisian type'
F 2007-IV-119	Disc, saint, 'Frisian type' but without a torso
FM 1995-XII-2.233	Disc, saint, green enamel?
F 2007-IV-191	Disc, saint, half fragment.
F 2007-IV-197	Disc, saint, half missing.
F 2007-IV-124	Disc, saint, hole, reuse ? Cross and alpha or omega symbols ?
F 2007-IV-192	Disc, saint, pallium dot
G2008-11-29-N	Disc, saint, pallium dot, red enamel, holding cross and sceptre?
FM 1995-XII-2.229	Disc, saint, pallium dot, red enamel.
FM 1995-XII-2.240	Disc, Saint, red enamel, hole, reuse?
FM 1995-XII-2.230	Disc, saint, red enamel, reused as a pendant? if so upside down.?
FM 1998-IV-6.10	Disc, saint, red enamel.
F 2007-IV-123	Disc, saint?
G2008-11-29-L	Disc, Saint? red enamel
G2008-11-29-M	Disc, Saint? red enamel, 3/4 fragment
G2008-11-29-b	Disc, saltire within cross
ON-026	Disc, saltire within cross
FM 1995-XII-2.237	Disc, seven dimples around edge, central setting for a blue ornamental stone, groove with green enamel
G2008-11-29-R	Disc, seven dimples around edge, central setting for a green ornamental stone.
ON-028	Disc, seven dimples around edge, central setting for an ornamental stone
FM 1995-XII-2.22	Disc, seven dimples around edge, central setting for an ornamental stone, enamelled.
FM 1995-XII-2.124	Disc, six holes around edge, central setting for a blue ornamental stone.
FM 1995-XII-2.258	Disc, six holes around edge, central setting for a blue ornamental stone.
G2008-11-23	Disc, six holes around edge, central setting for a blue ornamental stone.
FM 1995-XII-2.131	Disc, six holes around edge, central setting for a blue ornamental stone. Cabled edge

FM 1995-XII-2.134	Disc, six holes around edge, central setting for a blue ornamental stone. Cabled edge
FM 1995-XII-2.276	Disc, six holes around edge, central setting for a blue ornamental stone. Cabled edge
FM 1995-XII-2.136	Disc, six holes around edge, central setting for a blue/green ornamental stone
FM 1995-XII-2.132	Disc, six holes around edge, central setting for a blue/green ornamental stone. Cabled edge
FM 1995-XII-2.133	Disc, six holes around edge, central setting for a blue/green ornamental stone. Cabled edge
FM 1995-XII-2.139	Disc, six holes around edge, central setting for a blue/green ornamental stone. Cabled edge
F 2007-IV-199	Disc, six holes around edge, central setting for a green ornamental stone.
FM 1995-XII-2.17	Disc, six holes around edge, central setting for a green ornamental stone.
FM 1995-XII-2.19	Disc, six holes around edge, central setting for a green ornamental stone.
G2008-11-30-A	Disc, six holes around edge, central setting for a green ornamental stone.
FM 1995-XII-2.128	Disc, six holes around edge, central setting for an ornamental stone, cabled edge
FM 1995-XII-2.137	Disc, six holes around edge, central setting for an ornamental stone, cabled edge
FM 1995-XII-2.126	Disc, six holes around edge, central setting for an ornamental stone, half present.
FM 1995-XII-2.125	Disc, six holes around edge, central setting for an ornamental stone.
FM 1995-XII-2.127	Disc, six holes around edge, central setting for an ornamental stone.
FM 1995-XII-2.129	Disc, six holes around edge, central setting for an ornamental stone.
FM 1995-XII-2.135	Disc, six holes around edge, central setting for an ornamental stone. Cabled edge
FM 1995-XII-2.138	Disc, six holes around edge, central setting for an ornamental stone. Cabled edge
FM 1995-XII-2.82	Disc, star with eight rays, central setting for a blue ornamental stone. Drill hole in centre of back 1.5mmdia
FM 1995-XII-2.120	Disc, star with eight rays, central setting for an ornamental stone.
FM 1995-XII-2.78	Disc, star with eight rays, central setting for an ornamental stone.
FM 1995-XII-2.79	Disc, star with eight rays, central setting for an ornamental stone.
FM 1995-XII-2.80	Disc, star with eight rays, central setting for an ornamental stone.
FM 1995-XII-2.83	Disc, star with eight rays, central setting for an ornamental stone.
G2008-11-29-a	Disc, star with eight rays, central setting for an ornamental stone.
G2008-11-29-c	Disc, star with eight rays, central setting for an ornamental stone.
ON-025	Disc, star with eight rays, central setting for an ornamental stone.
G2008-11-30-G	Disc, star with nine rays, central setting for an ornamental stone.
FM 1995-XII-2.81	Disc, star with seven rays, central setting for an ornamental stone.
FM 1995-XII-2.87	Disc, star with seven rays, central setting for an ornamental stone. Rays originally red enamelled
FM 1995-XII-2.84	Disc, star with six rays, central setting for an ornamental stone
FM 1995-XII-2.140	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln

FM 1995-XII-2.141	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.142	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.143	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.144	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.145	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.146	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.147	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.148	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.149	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.150	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.151	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.152	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.153	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.154	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.155	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.156	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.157	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.158	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.159	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.160	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.161	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.162	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.163	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.164	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.165	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln

FM 1995-XII-2.166	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.167	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.168	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.169	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.170	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.171	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.172	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.173	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.174	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.175	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.176	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.177	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.178	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.179	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.180	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.181	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.182	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.183	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.184	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.185	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.186 (1)	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.187 (1)	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
FM 1995-XII-2.188 (1)	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
G2008-11-29-Z	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln
ON-049	Disc, two concentric circles in between enamel. Nabenemailscheibenfibeln

G2008-11-30-I	Disc, unidentifiable
F 2007-IV-100	Disc, ypsilon cross made by three kidney shaped motifs
FM 1995-XII-1.8	Equal-Arm
FM 1995-XII-1.38	Equal-Arm, 1 terminal thinner than other, one pointed not splayed,
FM 1995-XII-1.33	Equal-Arm, 4 lobed terminals, each with 4 dimples
FM 1995-XII-1.11	Equal-Arm, 'bow tie' type
FM 1995-XII-1.13	Equal-Arm, 'bow tie' type
FM 1995-XII-1.14	Equal-Arm, 'bow tie' type
FM 1995-XII-1.15	Equal-Arm, 'bow tie' type
FM 1995-XII-1.16	Equal-Arm, 'bow tie' type
FM 1995-XII-1.17	Equal-Arm, 'bow tie' type
FM 1995-XII-1.18	Equal-Arm, 'bow tie' type
FM 1995-XII-1.19	Equal-Arm, 'bow tie' type
FM 1995-XII-1.20	Equal-Arm, 'bow tie' type
FM 1995-XII-1.21	Equal-Arm, 'bow tie' type
FM 1995-XII-1.22	Equal-Arm, 'bow tie' type
FM 1995-XII-1.23	Equal-Arm, 'bow tie' type
FM 1995-XII-1.256	Equal-Arm, 'bow tie' type
FM 1995-XII-1.257	Equal-Arm, 'bow tie' type
FM 1995-XII-1.262	Equal-Arm, 'bow tie' type
FM 1995-XII-1.34	Equal-Arm, 'bow tie' type
FM 1995-XII-1.35	Equal-Arm, 'bow tie' type
FM 1995-XII-1.2	Equal-Arm, 'Cats paws', ribbed bow
FM 1995-XII-1.263	Equal-Arm, 'Cats paws', ribbed bow
FM 1995-XII-1.29	Equal-Arm, 'Cats paws', ribbed bow
FM 1995-XII-1.165	Equal-Arm, diamond cross terminal, enamelled, 1 terminal missing
FM 1995-XII-1.28	Equal-Arm, flat topped bow
FM 1995-XII-1.261	Equal-Arm, 'fleurs-de-lis'
FM 1995-XII-1.258	Equal-Arm, forked terminals, 3 grooves, manacles
FM 1998-IV-6.11	Equal-Arm, forked terminals, decorated with 2 grooves, saltire on bow. No Bos category?
FM 1995-XII-1.26	Equal-Arm, forked terminals, undecorated
FM 1995-XII-1.265	Equal-Arm, forked terminals, undecorated
FM 1995-XII-1.260	Equal-Arm, 'four leaf clover'
FM 1995-XII-1.267	Equal-Arm, fragment, silver
FM 1995-XII-1.37	Equal-Arm, heavy bow with ribbed terminal
FM 1995-XII-1.10	Equal-Arm, humped bow and two grooves on terminals
FM 1995-XII-1.9	Equal-Arm, humped bow and two grooves on terminals
FM 1995-XII-1.27	Equal-Arm, inverted triangles with 4 raised dots
FM 1995-XII-1.86	Equal-Arm, markedly broadened bow, 1 terminal missing
FM 1995-XII-1.25	Equal-Arm, paddle shaped, undecorated terminals
FM 1995-XII-1.32	Equal-Arm, ribbed ? Broad bow, 1 terminal chipped
G2008-11-30-Q	Equal-Arm, saltires on each terminal
F 2007-III-11	Equal-Arm, straight type with grooves
FM 1995-XII-1.3	Equal-Arm, straight type with grooves
FM 1995-XII-1.5	Equal-Arm, straight type with grooves
FM 1995-XII-1.6	Equal-Arm, straight type with grooves
FM 1995-XII-1.275	Equal-Arm, straight type with grooves, Angular grooves on bow and terminals, unusual
07HALV000273	Equal-Arm, straight type, undecorated

FM 1995-XII-1.1	Equal-Arm, straight type, undecorated
FM 1995-XII-1.30	Equal-Arm, straight type, undecorated
FM 1995-XII-1.4	Equal-Arm, straight type, undecorated or grooved ?
07HALV000275	Equal-Arm, straight type, undecorated, 1 terminal pointed
FM 1995-XII-1.24	Equal-Arm, three 'fingers'
FM 1995-XII-1.7	Equal-Arm, two ribs centrally across bow
FM 1995-XII-2.415	Equal-Arm? Footplate with cross motif. No bow, no headplate
G2008-11-181J-A	Pseudo Coin, 'Louis the pious', beaded rim, heavy patina
FM 1995-XII-2.425	Pseudo Coin, Agnus Dei with cross above?
FM 1995-XII-2.222	Pseudo Coin, bead rim between two concentric circles
G2008-11-181 i	Pseudo Coin, beaded rim
G2008-11-181G	Pseudo Coin, beaded rim, heavy patina
FM 1995-XII-2.210	Pseudo Coin, beaded rim.
FM 1995-XII-2.217	Pseudo Coin, beaded rim.
FM 1995-XII-2.195	Pseudo Coin, double bead rim.
FM 1995-XII-2.196	Pseudo Coin, double bead rim.
FM 1995-XII-2.212	Pseudo Coin, double bead rim.
FM 1995-XII-2.207	Pseudo Coin, double beaded rim
FM 1995-XII-2.205	Pseudo Coin, 'hair & bust', beaded rim
FM 1995-XII-2.211	Pseudo Coin, 'hair & bust', beaded rim
FM 1995-XII-2.213	Pseudo Coin, 'hair & bust', beaded rim
FM 1995-XII-2.214	Pseudo Coin, 'hair & bust', beaded rim
FM 1995-XII-2.219	Pseudo Coin, 'hair & bust', beaded rim
FM 1995-XII-2.424	Pseudo Coin, 'hair & bust', beaded rim
FM 1995-XII-2.426	Pseudo Coin, 'hair & bust', beaded rim
FM 1995-XII-2.427	Pseudo Coin, 'hair & bust', beaded rim
FM 1995-XII-2.428	Pseudo Coin, 'hair & bust', plain rim
FM 1995-XII-2.204	Pseudo Coin, legend, multiple beaded rim
FM 1995-XII-2.203	Pseudo Coin, legend, multiple beaded rim including rear
FM 1995-XII-2.186	Pseudo Coin, 'Louis the pious'
FM 1995-XII-2.187	Pseudo Coin, 'Louis the pious'
FM 1995-XII-2.188	Pseudo Coin, 'Louis the pious'
FM 1995-XII-2.189	Pseudo Coin, 'Louis the pious'
FM 1995-XII-2.190	Pseudo Coin, 'Louis the pious'
FM 1995-XII-2.191	Pseudo Coin, 'Louis the pious'
FM 1995-XII-2.192	Pseudo Coin, 'Louis the pious'
FM 1995-XII-2.193	Pseudo Coin, 'Louis the pious'
FM 1995-XII-2.194	Pseudo Coin, 'Louis the pious'
G2008-11-181-F	Pseudo Coin, 'Louis the pious' beaded rim
G2008-11-181J-B	Pseudo Coin, 'Louis the pious' beading on rear rim, heavy patina
G2008-11-181E	Pseudo Coin, 'Louis the pious' slightly abstract, beaded rim
FM 1995-XII-2.218	Pseudo Coin, 'Louis the pious', beaded rim
G2008-11-181J-D	Pseudo Coin, 'Louis the pious', beaded rim
G2008-11-24-B	Pseudo Coin, 'Louis the pious', beaded rim
G2008-11-181J-E	Pseudo Coin, 'Louis the pious', beaded rim, pin hole redrilled? Repair?
FM 1995-XII-2.197	Pseudo Coin, 'Louis the pious', beaded rim.
FM 1995-XII-2.198	Pseudo Coin, 'Louis the pious', beaded rim.
FM 1995-XII-2.199	Pseudo Coin, 'Louis the pious', beaded rim.
FM 1995-XII-2.215	Pseudo Coin, 'Louis the pious', beaded rim.
FM 1995-XII-2.216	Pseudo Coin, 'Louis the pious', beaded rim.

FM 1995-XII-2.220	Pseudo Coin, 'Louis the pious', beaded rim.
FM 1995-XII-2.221	Pseudo Coin, 'Louis the pious', beaded rim.
FM 1995-XII-2.226	Pseudo Coin, 'Louis the pious', beaded rim.
FM 1995-XII-2.227	Pseudo Coin, 'Louis the pious', beaded rim.
FM 1995-XII-2.200	Pseudo Coin, 'Louis the pious', double beaded rim
FM 1995-XII-2.201	Pseudo Coin, 'Louis the pious', double beaded rim
G2008-11-30-D	Pseudo Coin, 'Louis the pious', double beaded rim
FM 1995-XII-2.225	Pseudo Coin, 'Louis the pious', double beaded rim, half of.
FM 1995-XII-2.206	Pseudo Coin, natural head &bust, beaded rim
FM 1995-XII-2.208	Pseudo Coin, natural head &bust, beaded rim
G2008-11-181J-C	Pseudo Coin, single beaded rim
ON-015	Pseudo Coin, single beaded rim
FM 1995-XII-2.223	Pseudo Coin, with double beaded, between two smooth circles, empty centre
ON-030	Pseudo Coin, with double beaded, between two smooth circles, empty centre
ON-038	Pseudo Coin, with double beaded, between two smooth circles, empty centre
FM 1995-XII-2.224	Pseudo Coin, with some pearl rim, pseudo letters?
G2008-11-29-V	Pseudo Coin? Badly worn, hole in bottom, reused?
G2008-11-181H	Pseudo Coin? Heavy patina
G2008-11-29-F	Rectangular
G2008-11-30-P	Rectangular
ON-007	Rectangular
F 2007-IV-112	Rectangular, or attachment, inlaid with enamel. Reused pendant? Mount?
G2008-11-29-W	Rectangular, cross motif
FM 1995-XII-2.247	Rectangular, cross motif, enamel.
FM 1995-XII-2.246	Rectangular, cross motif, green enamel.
FM 1995-XII-2.251	Rectangular, cross motif, green enamel.
FM 1995-XII-2.244	Rectangular, gold coloured. Inlaid with red enamel.
FM 1995-XII-2.250	Rectangular, green enamel.
FM 1995-XII-2.245	Rectangular, half frag, red, blue, green enamel.
FM 1995-XII-2.252	Rectangular, image of bird.
FM 1995-XII-2.254	Rectangular, image of bird. Half frag
FM 1995-XII-2.253	Rectangular, increased midfield with diamond decoration
FM 1995-XII-2.248	Rectangular, plus midfield with diamond decoration.
FM 1995-XII-2.249	Rectangular, plus midfield with diamond decoration.
ON-006	Rectangular, similar to bos but no dot or edge embelishments
FM 1995-XII-2.255	Rectangular, with enamel picture cross.
FM 1995-XII-2.243	Rectangular, with point circle notch cut decoration and ornamentation. inlaid with enamel?
FM 1995-XII-1.309	Trefoil
FM 1995-XII-2.242	Trefoil ? footplate, with notch cut decoration