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The front page: Amber nuggets and semi-finished amber beads and pendants from pit-house 7/91 in Biskupice, Poland.
Photo: Marcin Woźniak.
The back page: Suspension loop for gold bracteate S12625, from Hå on Jæren, Rogaland. Photo: Annette G. Øvrelid.

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Iron-cased cloisonné brooches from the Early Medieval cemetery of Harmignies, Prov. Hainaut, Belgium: some aspects of production

BRITT CLAES, FEMKE LIPPOK, ELKE OTTEN AND HELENA WOUTERS

Britt Claes, Femke Lippok, Elke Otten and Helena Wouters 2025. **Iron-cased cloisonné brooches from the Early Medieval cemetery of Harmignies, Prov. Hainaut, Belgium: some aspects of production.** *AmS-Skrifter 29,* 61–72, Stavanger, ISSN 0800-0816, ISBN 978-82-7760-205-9.

In this article, *the Mero-Jewel project* (BRAIN-be 2.0) presents its first production-focused research results regarding iron-cased cloisonné brooches from the Merovingian cemetery of Harmignies. The aim is to elucidate technical aspects of production to possibly differentiate artisanal tendencies or shared knowledge, which helps identify the network of production and exchange in which these objects circulated. To this effect, the composition of these brooches is discussed, and key observations are made regarding techniques, material composition and decoration. While specific workshops remain undefined, the article discusses future avenues of research while considering the large amount of data retrieved from this relatively small, yet representative sample.

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Key words: Early Medieval, cloisonné jewellery, production, Mero-Jewel, Harmignies, cross-craft interaction

Introduction

The Early Medieval Period in Northwestern Europe (450–725 CE) can be characterised as an era of transition marked by significant socio-political, economic, and religious changes. At the same time, the rich and varied material culture found in cemeteries presents a strikingly uniform character and testifies to the existence of several extensive networks of cultural, material and technological trade and exchanges. This aspect is particularly evident in Merovingian jewellery, where it is clear by the sheer number of jewels that a large segment of the population could easily acquire these products (Theuws 2024). Indeed, many graves, mostly women's, but not exclusively, contained beautiful sets of fibulae, hairpins, rings, necklaces, earrings and other types of jewellery manufactured with sometimes quite simple techniques such as lost wax casting with a decorated mould. The raw materials and finished products circulated in Northern Gaul via well-functioning and complex long-distance trade networks extending to parts of Asia (Calligaro et al. 2007; Drauschke 2011). Despite the evident skill and creativity displayed in the craftsmanship of these artefacts, comprehensive analyses within Belgium have been notably lacking compared to neighbouring countries (Claes *et al*. 2025).

The *Mero-Jewel project* (https://www.belspo.be/belspo/brain2-be/projects/Mero-Jewel_E.pdf), within which this article's research was conducted, is coordinated by the Royal Museums of Art and History (RMAH) in collaboration with the Royal Institute for Cultural Heritage (KIK-IRPA) and the University of Liège (ULiège). The project comprises an in-depth study of Merovingian jewellery, encompassing their precious materials, production techniques, and exchange networks. Funded by the Belgian Science Policy Office under the Brain.be research program, the project began in 2023 and will run for four years. Mero-Jewel aims to address the gap in research regarding Early Medieval jewellery in Belgium by adding a significant volume of fresh scientific data, enriching existing international evidence, and enabling comparative analysis. Central to the project is the interdisciplinary study of the craftsmanship of Merovingian jewellery.

Additionally, we seek to postulate distinct workshop practices and demonstrate chronological shifts and trends within this specific object category.

This article marks a pivotal initial step in our study, focusing on iron-cased cloisonné brooches, a jewellery category prevalent in the Harmignies cemetery (Prov. Hainaut, Belgium), with a representative sample of 21 items. These artefacts, excavated in the late 19th century, constitute a cornerstone of the Merovingian section at the RMAH but remain largely unpublished. Iron-cased cloisonné brooches were more numerous in Northern France and Belgium than elsewhere (Vielitz 2003, 18), but despite their prevalence, have never been subjected to microscopic and material-technical analyses. Through our investigation, we have scrutinised the different components, material compositions, and the construction of these multi-material brooches. With these initial results, our project, still in its early stages, aims to enrich scholarly discourse on this specific brooch type and propose future research perspectives.

Earlier research

Since researchers began exploring Early Medieval archaeology in the 19th century, they have shown particular interest in jewellery, specifically those pieces crafted from precious metals and adorned with gems and glass. Traditionally, this object group was examined to discern patterns indicative of social status, hierarchies or group identities (Koch 1998; Martin 1997). Scholars focused on the type and placement of brooches in reconstructing costumes, hoping to uncover regional variations in dress that might reflect distinct (ethnic) ways of wearing such adornments (Koch 1998, 518–19, 521, 535; Müller and Steuer 2011 [1994], 133–34; Siegmund 2000, 218–20). This approach was deeply rooted in nationalistic and ethnic interpretations of archaeological material and faced significant criticism over time, as exemplified by Effros (2004) and others (Hakenbeck 2011; Sorg 2022, 12). Frank Siegmund (2000, 228) contributed to these critiques by suggesting that attempts to identify regional variations in brooch placement encountered a notable uniformity instead. He observed widespread, similar changes in the positioning of brooches, which did not indicate regional (or ethnic) differentiation in deposition practices.

The 20th century search for past ethnicities also led to an interest in chronologically differentiating archaeological finds to assign them to historically attested ethnic groups (Meier 2020, 238). This process culminated by the mid-century with the development of typochronologies, greatly enhancing the precision of dating Merovingian funerary ensembles. Presently, typochronologies such as AG Franken (Müssemeier et al. 2003) and LPV (Legoux, Périn and Vallet 2004) enjoy widespread use, enabling placement of objects within narrow chronological intervals. However, they have encountered criticism for their perceived oversimplification and rigidity, potentially overlooking nuances such as inheritance practices, extended object biographies as well as unique objects that resist straightforward classification (Kars 2011; Martin 2020; Meier 2020). Typochronologies also largely overlooked aspects like materiality and more technological details of the production process, as mostly decorative and morphological characteristics were considered for object classification. Scholars have now mostly moved away from ethnic and purely typochronological interpretation to instead focus on economic aspects, manufacturing techniques, and materials required for the production of jewellery.

Within the category of Merovingian jewellery, cloisonné brooches have frequently been studied. As its name implies, these brooches are characterised by the use of thin metal strips, typically made of gold, silver (often gilded) or copper alloys that form compartments or cloisons, creating intricate designs, usually geometric and occasionally zoomorphic. The cells are filled with backing paste and foils, the latter frequently made of gilded silver featuring fine grid patterns, and are inlayed with garnet stones or, less commonly, coloured glass.

Numerous publications discuss the origin of cloisonné brooches and their typochronological and technical developments. A milestone in this regard was Birgit Arrhenius' (1985) monograph on Merovingian garnet jewellery, in which she identified a series of workshops in the German Rhineland and Southern Germany. Although this publication remains a significant academic work, there are some issues regarding localising production areas based on the material characteristics of the backing paste, which have proved difficult to verify (Horváth 2012, 210). Some decades later, Kathrin Vielitz (2003) researched garnet cloisonné brooches, focusing particularly on typochronological classification. Her work emphasised the importance of morphological characteristics but did not examine the production techniques and materials used.

An exemplary avenue of material and production studies were the analytic methods for determining the origin of garnet stone inlays. Notably, Thomas Calligaro and colleagues conducted non-invasive PIXE analysis, providing conclusive results for identifying the provenance of garnets (Calligaro et al. 2002, 2006–2007). Their research revealed that Merovingian goldsmiths used garnets from six distinct sources: 5th and 6th century types I, II (almandines) and IIIa (almandines/pyropes) from different regions in India; type IIIb (almandines/pyropes) from Sri Lanka; and 7th century types IV and V (pyropes), possibly from Portugal, and Bohemia, respectively. These findings revolutionised the study of garnet jewellery, as the garnets' origin confirms their makers' involvement in long-distance exchange networks.

In subsequent years, other aspects of cloisonné production were taken up. In her doctoral study on 5th and 6th century polychrome fine metalwork from the Carpathian Basin, Eszter Horváth considered aspects such as materiality and technological details of the production process (Horváth 2013). She further refined Arrhenius' classification of different types of cloisonné by concentrating on the technology of cell work construction (Horváth 2012, 215–16). Horváth's work demonstrated that a single typochronological group might present major differences in technological details and materials. She warns that ignoring distinct production methods might produce false conclusions regarding workshop origins and distribution patterns. Through her observations, Horváth discerned different workshop practices based on their cell work technologies, thus distinguishing local products of Langobard-period Pannonia from imported objects.

Most recently, projects in Germany, such as the *Weltweites Zellwerk – International Framework* project, delved into the social and symbolic significance of garnet jewellery, as well as questions about its economic role (Quast et al. 2017), but results remain largely unpublished.

Overall, previous studies on production-related factors regarding cloisonné jewellery confirm that detailed examination of the materials and techniques used can reveal aspects of their production and potential workshop tendencies. This encourages us to scrutinise the technological aspects of iron-cased cloisonné brooches.

The case of Harmignies: an introduction

Our subsequent analysis focuses on iron-cased cloisonné brooches from the Harmignies cemetery. This particular category of brooches was selected for study because it has been suggested to be a regional product (Vielitz 2003, 18, 97), yet they have never been examined in detail. The Harmignies cemetery provides a substantial sample of these brooches, which have remained unpublished despite the considerable time elapsed since the site's excavation at the end of the 19th century. These excavations uncovered 351 graves dating from the late 5th century (MA1: 470/80–520/30 CE) to the third quarter of the 7th (MR2: 630/40–660/70 CE) (Claes and Vrielynck 2025). Of the 351 excavated graves in the Merovingian necropolis of Harmignies, 261 contained grave goods. Among these, 104 graves contained jewellery such as beads, rings, pins, earrings, or brooches. Of these, 92 were female, 8 were male, and 4 were of undetermined gender/sex. Because skeletons were not or poorly preserved, determining gender mainly depended on the excavator's notes from the 1890s, which sometimes classified graves as "male" or "female." Additionally, the preserved material culture plays a role in this assessment. Traditionally, jewellery is associated with female graves, while weapons are linked to male graves. Although we recognise the limitations of using material culture for gender determination, the context of the excavation necessitates this gendered interpretation of grave goods. In total, 57 graves contained brooches: 49 were female and 8 were male gendered. The majority (N=33) were cloisonné brooches, discoid (N=28), rosette (N=3), or lobed (N=2) in shape, with measurements ranging from 1.9 to 3.3cm. With the exception of two pairs of brooches, they all have an inlaid central motif, around which the cell walls radiate. The earliest and smaller cloisonné brooches feature glass, garnet, bone or amber inlays (still to be confirmed by analysis), while the later and larger brooches display more elaborate central motifs with pressed sheets, a mix of filigree and/or garnet stones, and in two cases, – two radial zones with inlays. These types succeed each other more or less chronologically as more intricate examples from MA2 (520/30–560/70 CE) replaced the smaller brooches. Cloisonné brooches were mostly placed near the neck or on the deceased's chest. Only some pieces dating to MA2 (520/30–560/70 CE) were found lower on the body.

Iron-cased cloisonné brooches: first Mero-Jewel results

For the study of the iron-cased cloisonné brooches, the Mero-Jewel project combined traditional archaeological contextual research with non-invasive visual and elemental analyses for material-technical studies. We performed microscopic analyses, hand-held and micro-XRF-analyses, radiographies, and SEM-EDX on 21 intact and partially preserved iron-cased cloisonné brooches (Figure 1). The handheld XRF analysis was conducted using the S1 Titan 800, while the μ-XRF analysis utilised the ArtTAX model (both BRUKER, Germany). Both X-ray tubes were equipped with a Rh anode and operated at 50 keV, without any filters, with the analysis conducted in open air. The pXRF had a beam size of 6mm, and measurements were taken over 35 seconds. In contrast, the μ-XRF featured a beam size of 0.07mm and the analysis was carried out for 200 seconds of real time.

Figure 1. Overview of the iron-cased cloisonné brooches in the Harmignies corpus. Of the pairs, the most representative piece is depicted each time.

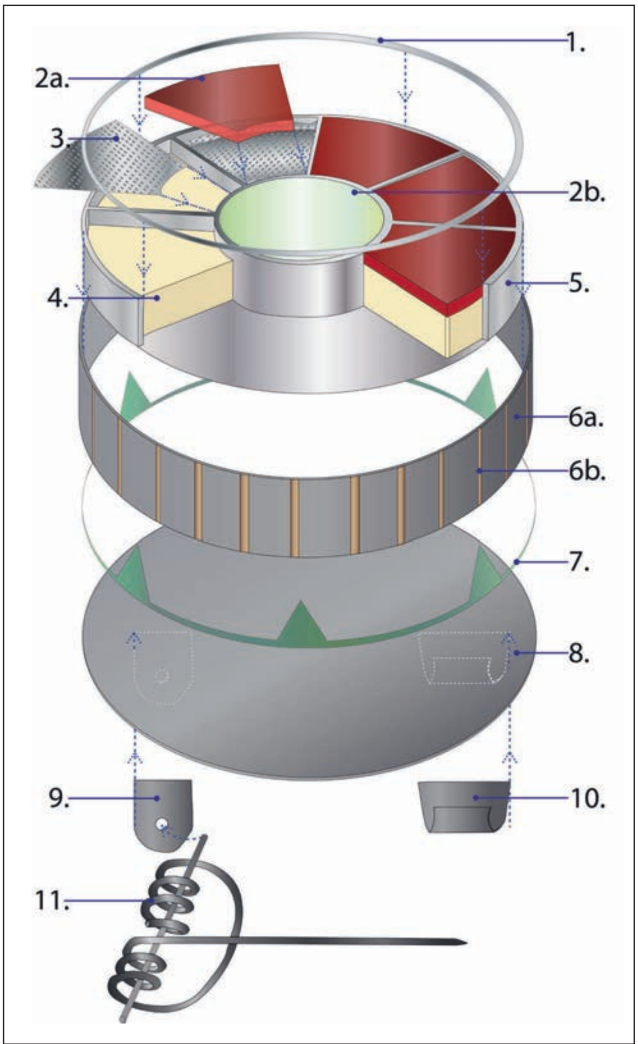

Figure 2. Schematic representation of the different constituting components of an iron-cased cloisonné brooch (Lippok after Gilg et al. 2010). The numbers represent: 1. Topping, 2. Inlays (a) and central motif (b) 3. Backing foil, 4. Backing paste, 5. Mount frame, 6. Side plate (a) with wire inlay (b)*, 7. Jointing wire*, 8. Base plate, 9. Spiral holder, 10. Pin holder, 11. Rod, spiral and pin. *These elements were not observed in all iron-cased cloisonné brooches.*

All brooch components were described and recorded in our flexible and open-source database, designed to facilitate comparison between objects. This approach allowed exploration of material, technical, and decorative similarities among components, aiding in understanding possible workshop-related practices or shared ideas in brooch production. These ideas must have circulated among artisans, as workshops were likely transient or composed of several itinerant artisans. Artisans would also have depended on one another for materials, tools, technical expertise, and ideas (van Wersch 2022, 280). Therefore, our primary focus is on shared knowledge, highlighting the dynamic nature of craftsmanship and the dissemination of techniques and styles.

Regarding the Harmignies corpus, caution is warranted due to modern conservational treatments that have not been recorded and are not always immediately visible. Previous conservation-restoration interventions such as cleaning, consolidation and reconstruction, and the application of resins, varnishes, or other substances may have significantly altered the materials, their current appearance and the original assembly of the different components. These interventions sometimes caused the replacement or erroneous relocation of garnet stones, foils, and pressed sheet motifs. In what follows, we accounted for such changes relative to the original condition when assessing the technical characteristics.

The components of a typical iron-cased cloisonné brooch

Figure 2 shows a schematic representation of the components of the studied brooches. We will elaborate on each component below, discussing their material compositions and technical characteristics if applicable. Table 1 contains all details regarding the material composition of each analysed brooch, providing an additional level of detail that will not be discussed further in the text.

Figure 2, element 1 indicates the topping, an addition that seems typical for the iron-cased cloisonné brooch variant with garnet inlays (element 2a), although sometimes absent, as shown on brooch no. 2 (Figure 1). When present, this metal top layer is located on the brooch's outer rim and consists of the same material as the cell walls of the mount frame (element 5), which is mostly silver, often gilded. This topping may have functioned by unifying and maintaining the integrity of the different components, notably the mount frame and the iron outer case (element 6), and covering the possible gap between them. Ultimately, it enhances the visual aspect of the finished product by giving it a silver rather than iron appearance.

Figure 2, element 2a represents the inlays set into the mount frame. These inlays, almost exclusively garnet stones, radiate in a concentric field around a central motif (element 2b). The garnets all share more or less the same arch-segment shape, designed to conform to the form of the cloison, with average dimensions of 0.6 by 0.7cm in height and width and 0.1cm in thickness. Brooch pair no. 13 shows a different arrangement of the cloisons with a more geometric pattern and a combination of garnet and glass inlays. The garnet stones exhibit more or less smooth edges, although several small traces of breakage are visible on almost every stone. Garnet inlays always

Table 1. Handheld XRF results and µXRF results of a selection of iron-cased brooches

Object	Location	Au (gold)	Ag (silver)	Cu (copper)	Fe (iron)	Sn (tin)	Zn (zinc)	Pb (lead)	Type of alloy
B004481 - 003	topping		xxx	xx	xx				silver alloy
	side			xxx	xxx				inlay = copper
	back		x	x	xxx				iron
B004537 - 004B	central motif	x	xxx	xx	xx			x	silver alloy, iron from the case
	cloisonné	x	xxx	x	xx				silver alloy, iron from the case
	side		xx	xxx	xxx				inlay = silver alloy
	back			xx	xxx				iron case and some parts of copper
µXRF results	side – inlay			xxx					pure copper
	cloisonné	xx	xxx	xx	x				silver alloy
	central motif	xx	xxx	xxx	x		x	xx	Silver alloy with addition of leaded copper alloy
B004585 - 006	cloisonné			xxx	xx	xxx			bronze
	topping			xx	xxx	x	x	x	heavily corroded
	side			xxx	xxx		x		
	white inner layer			xxx	xxx	xxx		x	
	back			xx	xxx				iron with copper corrosion
B004618 - 002A	central motif	xx	xx	xxx	x	xx	x	x	gilded copper-silver alloy
	cloisonné	xx	xxx	xxx	xxx	x			gilded copper-silver alloy
	side		x	xx	xxx	x			case= iron
	back		xx	xx	xxx	xx			
µXRF results	cloisonné	xx	xxx	xxx	xx		x	x	gilded silver alloy
	central motif	x		xxx		xx		x	gilded copper alloy
	side	xx	xxx	xxx			x	x	gilded silver alloy
	side	xxx	xx	xx	xx				gilded silver alloy
B004629 - 002B	central motif	xxx	xxx	x			x		gilded silver alloy
	topping	xxx	xxx	x	x		x		gilded silver alloy
	side	x	xxx	x	x		x		silver alloy
B004691-003B	central motif			xxx	x	xx	xx	xx	quaternary brass
	side			xxx	x	x	xx	x	quaternary brass
	pin construction				xxx				iron
	back				xxx				iron
B004691-003A	central motif			xxx	x	x	xx	x	copper alloy (brass)
µXRF results	cloisonné			xxx	x	x	xx	x	copper alloy (brass)
B004526-011	central motif	xxx	xx	xx					gold alloy
µXRF results	cloisonné	xx	xxx	xx					silver alloy
	side				xxx				iron

Table 1 continued. Handheld XRF results and μXRF results of a selection of iron-cased brooches

Object	Location	Au (gold)	Ag (silver)	Cu (copper)	Fe (iron)	Sn (tin)	Zn (zinc)	Pb (lead)	Type of alloy
B004492-001B	central motif			xxx	xx	x	x	x	copper alloy
µXRF results	cloisonné	xx	xxx	xx	x				silver alloy (gilded?)
	side	x	xxx	xx	x				silver alloy (gilded)
	side			x	xxx				iron
B004545-003	central motif			xx	xxx				
µXRF results	topping	xx	xxx	xxx	x			x	silver alloy
	side - inlay			xxx					pure copper
	side			xx	xxx				
B004581-002	cloisonné	xx	xxx	xxx	x			x	silver alloy
µXRF results	topping	xx	xxx	xxx	x			x	silver alloy
	side - inlay			xxx			xxx		copper alloy (brass)
	side	xx	xxx	xxx	xx			x	silver alloy
	side - triangle			xxx	x				pure copper, remaining Fe of the case
	side				xxx				pure iron
B004536-001A	cloisonné	xx	xxx	xx					silver alloy
µXRF results	side			xx	xxx				
	side - edge	x	xx	xx	xxx				
	back				xxx				pure iron

coincide with mount frames in silver (gilded) alloys. In instances where the brooches feature glass inlays without garnet, such as numbers 11 and 12, they occur in bronze or brass mount frames. In these cases, the geometrical design of the inlay work also differs from the typical radial field present on the brooches with garnet stones.

The inlays of the central motif (element 2b) each display various round designs and different materials ranging from small glass, bone, and amber inlays to small circular metal sheets with pressed motifs. These metallic central motifs comprise copper and silver alloys, often gilded and sometimes consisting of similar material components as the mount frame (Table 1), suggesting that one workshop was potentially responsible for producing both components. In two instances, brooches nos. 8 and 14, the central motifs are composed of gold, while the mount frames are crafted from gilded silver alloys. Conversely, brooch no. 12, which features a purely geometrical design, lacks a central motif.

Analyses of the garnet stones have not been conducted yet. Scheduled chemical analyses with PIXE-PIGE at the CEA of the University of Liège will help us determine the origin of the gems. Previous analysis (Mathis et al. 2008) indicated that type I garnets, originally from India, were most dominantly present in our regions.

Figure 2, element 3 represents the backing foils, which are extremely thin (<0.02cm) silver-gilded foils located underneath the garnet inlays. Adams' experiments (Adams 2006, 18, 20) hypothesise that these foils were produced by pressing a thin metal sheet between a positive and a negative die. Other authors have attested six types of patterns on the foils (Avent and Leigh 1977; Vielitz 2003, 21), but in the present corpus, only the waffle pattern and box grid pattern were attested. The waffle pattern, the predominant type, features a fine pattern of approximately 3 ridges per mm. Brooch no. 7 clearly deviates from this pattern, with one ridge per mm. Regarding the box grid pattern, the second most common type in our sample, we observed that the grids are not always consistent, as seen in brooch pair no. 6, where the grid is divided into three lines vs four lines in one box. Also, the backing foils are not all oriented in the same direction, some are even placed up-side-down. Occasionally, the backing foil can be seen as folded around the sides of the

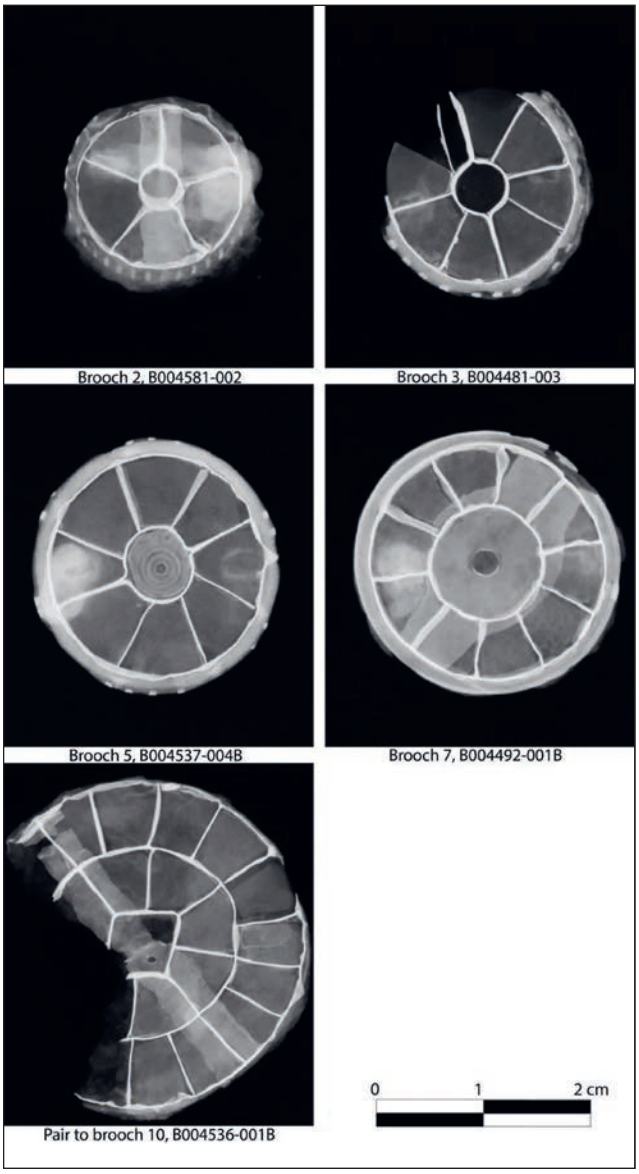

Figure 3. Radiography images reveal partial base plates on brooches nos. 2, 7 and 10; demonstrate double cell walls forming the central motif on brooches nos. 3 and 5; and show the wire inlay in the iron case on brooches nos. 2, 3, and 5. The jointing wire with triangles can also be perceived along the upper and right side of the side plate of brooch no. 2 and on the lower right side of brooch no. 10.

garnet stones. In the case of brooch no. 9, two separate sheets of foil were added as one, possibly indicating the scarcity and/or reuse of the material.

Vielitz (2003, 23) has shown that although the waffle pattern was generally present in Northern France, Belgium and the German Rhineland, the box-grid pattern was much rarer in Northern France and Belgium than in the German Rhineland. She even stated that iron-cased brooches nearly exclusively contain the waffle pattern (Vielitz 2003, 24). The differences Vielitz observed in the distribution of backing foil types may be a proxy for certain workshop practices or shared ideas around the stylistic decisions in the production of backing foils in certain areas. The fact that these types occur over large distances could suggest standardised production or, at least, the circulation of a shared idea of what these foils should look like. Additional analysis should be aimed at meticulously recording the distances between the lines of the patterns to establish comparability between patterns and potential common origin of different samples. Archaeological evidence of a bronze stamp with boxed grid pattern has been previously found in the site of Wijnaldum in the Netherlands (Nicolay and Aalbersberg 2018, 67) and at Bornholm, Denmark (Adams 2006, 18), providing clear evidence of foil production in Frisia and Denmark.

In Figure 2, element 4 represents the backing paste underneath the foil and inlay. Where observable, the backing paste displays an optically rough consistency and a brown, yellow or orange hue. It is sometimes unclear if the backing paste was originally orange and brown or if the iron case's metal corrosion (rust) affected its colour. Other samples appear light beige to white. This likely categorises the backing pastes from Harmignies as sand paste, as described by Arrhenius (1985, 86) and Vielitz (2003, 24–25). However, since our sample's backing pastes could not be analysed, further information remains unavailable.

Figure 2, element 5 represents the mount frame, designed to secure the inlays, the foils and the backing paste. When the iron case (element 6) is either missing or only partially preserved, as in the instances of brooches nos. 1, 4, 11 and 12, the mount frame is visible in its full height. They all exhibit consistent technology and are constructed from several thin sheets of metal, forming a base and cell walls that define the cloisonné compartments. Additionally, bent sheets create the central motif and the side plate, which encloses the construction and is inserted into the iron case. The cell walls often exhibit slight irregularities as their fragile profile is easily deformed. In certain instances, the cell walls are folded over, resulting in a double-walled structure, possibly to strengthen their construction. This is observed on brooches nos. 3 and 5, where the double wall also constitutes the central motif (Figure 3).

In the Harmignies case, the metal sheets of the mount frame comprise predominantly silver alloys, mostly gilded, with three exceptions (brooch pair 11 and brooch 12) in copper alloy and brass. Radiography revealed that in most cases, the base of the mount frame supported only parts of the cell walls and was not fully circular. Instead, thin strips – sometimes perforated – were observed

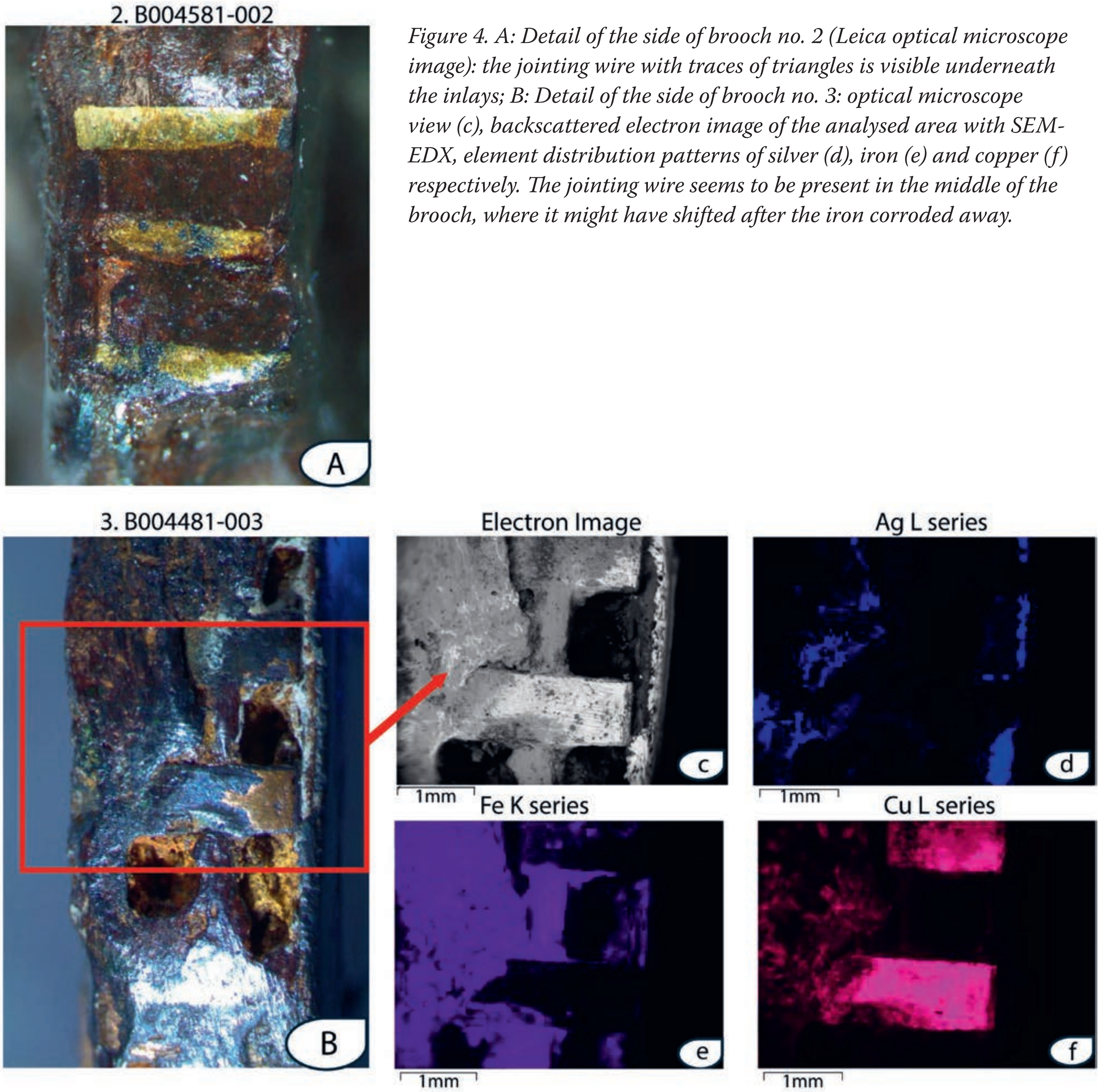

Figure 4. A: Detail of the side of brooch no. 2 (Leica optical microscope image): the jointing wire with traces of triangles is visible underneath the inlays; B: Detail of the side of brooch no. 3: optical microscope view (c), backscattered electron image of the analysed area with SEM-EDX, element distribution patterns of silver (d), iron (e) and copper (f) respectively. The jointing wire seems to be present in the middle of the brooch, where it might have shifted after the iron corroded away.

beneath sections of the cloisons (Figure 3). These strips performed the same function as fully circular bases, albeit with potentially less stability, but they required less material.

Figure 2, elements 6, 7, and 8, represent the side plate, jointing wire and baseplate, which constitute the outer case. The side plate and base plate are approximately 1.5mm thick and confirmed, with XRF, to be made of iron. These components could be joined by welding, similar to the technique used for weapons such as swords (Scott 2009). In addition, a copper alloy ring is present on some of the brooches, often exhibiting traces of characteristic triangles (Figures 3 and 4). This jointing wire might function to securely connect base- and side plate, acting as a solder when heat was locally applied. In one case, brooch no. 13 (Figure 1), two silver rivets were added to keep the different components together.

When still present, the side plates often exhibit decoration consisting of brass or copper alloy wire inlay (Figure 4), hammered in notches engraved in the surface around the perimeter of the plate at regular intervals. In a second variant, in the case of brooches no. 6, the notched side was silver plated and gilded. Although the decoration was executed in different ways, the same visual effect was intended as with the inlay wires. Brooches nos. 7, 8, 11, 12 and 14 remained undecorated.

Figure 2, elements 9, 10 and 11 represent the spiral - and pin holder, and pin, which constitute the fastening elements of the brooch. They were often only partially preserved, likely due to their needing to withstand the rigours of use and the fact that small, protruding elements are more vulnerable to post-depositional degradation processes. Unfortunately, radiography provided little information about these elements' shape or original surface.

The depicted spiral- and pin reconstruction is based on brooches from Torgny and Grez-Doiceau (Belgium). Nevertheless, certain patterns emerged regarding their material composition and construction techniques. Exclusively constructed from iron, the pin, as the most fragile element of the brooch, is most often lost. The spiral and pin holder, found in conjunction with the pin, exhibit a material composition similar to that of the base plate, in this case, iron. They are consistently attached horizontally to the base plate along a straight line.

Due to the state of preservation of the pin construction, it is unclear, in most cases, how these components were originally joined. Microscopical analysis of brooches nos. 3 and 5 revealed a fine, lighter-coloured rectangular copper line on the base plate, indicating the former position of the now-missing pin holder (Figure 3, brooch 3 and 5). This copper alloy was likely used as a solder to join the component to the base plate. Whilst this use has rarely been attested, Pleiner (2006, 115–20) discusses the presence of copper in archaeological Iron Age metal slag, which he interprets as evidence of copper being used as a soldering material.

A developing repertoire of brooch forms

By the late 6th century, cloisonné brooches had gradually disappeared from graves and were replaced, first by pairs of small filigree disc brooches, described as the "Marchélepot" type (Graenert 2007, 167), which then evolved into one large filigree disk brooch from MR1 (600/10–630/40 CE). The gradual transition from cloisonné to filigree brooches was exemplified by the pairing of a smaller filigree brooch with a larger cloisonné brooch, demonstrating their contemporality. Some of these newer brooches featured iron base plates, indicating the continuation of certain material use over time. Additionally, these filigree brooches often incorporated backing foils with a waffle pattern, a common characteristic in the cloisonné brooches. Notably, one of the larger filigree disc brooches found at Harmignies, displays notches on its wide projecting edge, reminiscent of iron sides inlaid with metal wire, further suggesting the continuation of certain designs. The transition from cloisonné to filigree brooches thus reflects a development in jewellery design, where one type gradually transformed into the other.

Discussion

By analysing the iron-cased brooches from Harmignies, we identified a remarkable variety of precious and non-precious materials and techniques such as alloying, inlay work, notching, soldering, and stamping. These findings highlight the technical prowess involved in working with different materials and the sophisticated craftsmanship employed.

Regarding technological knowledge, we identified distinct differences and similarities in the material-technical, constructive, and decorative aspects of the items. As documented by Vielitz (2003, 18, 97) the distribution of iron-cased cloisonné brooches, as well as the general cloisonné brooch distribution, extend far beyond the cemetery of Harmignies, indicating that the general and iron-cased design was widespread. A significant feature distinguishing the items under discussion from the rest of the corpus is the iron case surrounding the silver frame with garnet stone inlays or the copper alloy/brass mount frame with glass inlays. Despite their apparent uniformity, each item (or pair) exhibits distinct variations in techniques (e.g., jointing wire with additional triangles or not), decorations (e.g., inlays on the sides or not), and materials (e.g., gilded silver vs. copper alloys, garnet vs. glass).

In terms of materiality, cloisonné brooches incorporate materials from diverse origins. For instance, garnet stones were imported from India and Sri Lanka, while it is likely that the iron had a more local origin, given the presence of iron smelting and smithing sites in Wallonia (van Wersch et al. 2022). Regarding the gold, silver and copper, a valuable avenue for future research would be to determine through chemical analyses whether these materials were recycled or processed as raw materials, an investigation not undertaken in the present study. The use of a multiplicity of materials, blending local and external resources, attests to a rather complex supply chain.

While specific workshop activities remain unidentified based on the Harmignies sample, the consistency in production techniques, such as the implementation of iron cases with metal inlays on the side, the size of the brooches and the use of silver mount frames, suggests the presence of a shared network of knowledge among the artisans who produced these jewels. The complexity of the assembly process and variety of materials used in these pieces, raise questions as to whether the jewels were produced by one artisan who mastered and assembled all different materials and production techniques, by multiple artisans who may have worked within the same workshop each specialising in different aspects of the production process, or by different workshops producing separate parts of a brooch. Combining the working of iron, presumably by a blacksmith, and the goldsmithing to obtain an iron-cased cloisonné brooch, seems unique and goes against earlier observations of different artisans active in separate workshops as suggested by Hjärter-Holdar et al. (2002). On the other hand, the uniform nature of backing foils possibly suggests that they came from one source that continuously used the same stamping dies. The juxtaposition of different technologies and import of diverse materials in one workshop must have facilitated sharing and exchange of goods, materials, tools, knowledge and ideas.

The knowledge applied to create iron-cased cloisonné brooches likely adapted to the *zeitgeist* as filigree brooches became the preferred style. As observed at Harmignies, these larger disk brooches regularly feature iron baseplates and decoration techniques similar to those of the earlier cloisonné brooches. Thus, continuity in knowledge of decoration techniques may be present, even if the overall look of brooches changed significantly.

Conclusion

This article focused on iron-cased cloisonné brooches with key questions regarding the study of material-technical craftsmanship and possible distinct artisanal practices, focusing on techniques and stylistic choices. Due to the limited size of our sample, drawing definite conclusions remains premature. However, the Harmignies site provides critical insights into Merovingian jewellery production, more specifically of iron-cased brooches, highlighting a complex interplay of different materials, sophisticated craftsmanship, and evolving cultural practices. The continuity and adaptation of production techniques reflect the ingenuity and resourcefulness of early medieval artisans. Whilst certain decoration techniques and structural components, such as the inlay work on the side plates and pin construction, were similar between brooches, other components displayed more diversity, such as the use of thin strips of silver to secure the mount frame, jointing wire, various backing pastes and the use of various inlays made of garnet, glass, metal or amber. Further research will continue to refine our understanding of these complex mixed-material artefacts, contributing to a richer narrative of Early Medieval material culture. One important step will be the detailed investigation of the material composition of the different components and the techniques employed to investigate these brooches' supply chain and assembly process.

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