Journal of Conservation & Museum Studies

Wijnhoven, M A 2015 Filling in the Gaps: Conservation and Reconstruction of Archaeological Mail Armour. *Journal of Conservation and Museum Studies,* 13(1): 8, pp. 1–15, DOI: http://dx.doi.org/10.5334/jcms.1021226

RESEARCH ARTICLE

Filling in the Gaps: Conservation and Reconstruction of Archaeological Mail Armour

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Mail armour is made of many interlinking metal rings. It has been a popular type of defensive gear through the centuries, and this popularity has in part been due to mail armour's flexibility. However, this very flexibility today hinders its conservation, interpretation and display. Mail pieces retrieved from archaeological contexts are often in such poor state of preservation that their original shape is unrecognizable. This poses a challenge not only for conserving these artefacts, but also for understanding them. This paper describes a conservation technique for flexible mail that involves restoring preserved rings to their original position and filling in the remaining gaps with dummy rings. In addition to stabilizing the mesh of mail, this measure also aids the artefact's interpretation. The advantages of using this method with archaeological specimens are presented by means of a case-study concerning the remains of a Roman mail coat found near Novae, Bulgaria. The case-study shows that the choice of conservation technique greatly influences the amount of information that researchers can obtain from this material.

Keywords: mail armour; Roman armour; military archaeology; mail armour conservation; mail construction

1. Raggedy Mail: The State of Archaeological Mail Fragments

For over two millennia mail armour (sometimes erroneously called chainmail) was the defensive gear of choice in Europe and beyond. Consisting of many interlinking metal rings, mail is a versatile type of armour. Its flexible nature, in particular, seems to have been one of the key factors in its popularity, as it allows mail armour to adapt easily to the body without restricting movement. In this sense, mail almost behaves like a heavy textile.[1] However, the same qualities that made mail popular render its conservation, interpretation, and display problematic. Its large surface-area-to-volume ratio makes mail highly susceptible to oxidation. This is especially evident in mail items recovered from archaeological contexts, which are often so heavily corroded that the mesh has lost its flexibility and become a solid block where only the outlines of the rings can be observed. It is mail from these contexts, i.e. which has been retrieved by excavation, that will be the focus of this article, as opposed to 'historical' mail which has been passed down and preserved in armouries, churches and other places.

It must be noted that not all of the mail specimens that are recovered archaeologically are heavily corroded. Some remains still preserve their original flexibility, with movement of the individual rings. One of the best-known examples is a coat of mail from Vimose, Denmark, that dates back to around the second half of the 2nd century or the early 3rd century AD. This specimen is almost complete and still entirely flexible, which makes it one of the highlights of the National Museum in Copenhagen. Admittedly, the Vimose coat is perhaps the best-preserved example of archaeological mail, but it is not the only one. Other examples of well-preserved, flexible remains include those from the Iron Age site of Radovanu in Romania, the Roman Iron Age site of Thorsberg in Germany, and the Viking Age site of Gjermundbu in Norway (Raddatz 1987; Vike 2000; Vulpe & Căpitanu 1971).

Although archaeological mail retains its flexibility with some frequency, the completeness of its condition is a different matter. In most cases, mail retrieved from archaeological contexts is fragmentary. This is mainly due to two reasons. The first is simply preservation. Some areas of a complete mail garment will be more affected by corrosion than others, often resulting in differential survival. The second reason is fragmentary deposition, meaning that the mail garment had already been taken apart at the time that it was discarded or buried. It has been suggested, for example, that the mail fragments frequently found in and around Roman forts could have been pieces meant for repurposing or recycling (Bishop & Coulston 2006: 63), while the fragments found in the graves of women and children outside the Roman Empire may have had an apotropaic or memorial function (Czarnecka 1994; Hansen 2003: 78–83).

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Whether fragmentary or not, mail is invariably affected by the loss of rings, the extent of which can vary. A few missing rings will result in holes in the mail, but serious loss will cause the mail weave to come apart completely. Historical mail, passed down through the centuries, generally shows little loss of rings, so that its original shape and function can still be observed – for instance, whether it makes up a mail coat, a hood, a mantle, etc. In contrast, archaeological mail which has retained its flexibility often suffers from heavy ring loss, causing the mail weave to break up into entangled strings of rings, giving the fragment a ragged appearance (**Figure 1**). Usually, the loss of rings in archaeological mail is so great that the original shape and function of the piece are no longer identifiable. That makes it difficult for researchers to discern a garment, understand its design, and establish the original position of the fragments in a whole.

In addition to hampering interpretation, extensive ring loss makes mail vulnerable to further deterioration. When mail is intact, each mail ring connects with four others. This pattern nestles the rings into place and, at the same time, gives them strength. When the mail is strained, the force is distributed throughout the interlinked rings. But when mail has fallen apart because of ring loss, any straining force, including that of its own weight, is no longer distributed evenly among the remaining rings but falls on a small set, or even on a single ring. Sections of mail can thus easily become detached (e.g. Checksfield *et al.* 2012: 230–231) and, once they are apart, it becomes difficult and often impossible to reconnect the rings in their original position.

2. Filling in the Gaps: Mending Historical and Archaeological Mail

Many of the issues mentioned above may be remedied, at least to some degree, by applying a technique that consists in filling in missing areas of material with dummy rings. The basic procedure involves three steps (**Figure 2**). The first is to place the mail piece on a flat surface, where it can be manipulated with ease. The aim at this point is to disentangle the mail and lay it down as horizontally as possible. This will be easier with some fragments than with others, depending on the amount of ring loss and general condition. The second step involves repositioning the rings in their original place. Fortunately, the repetitive nature of the mail pattern often makes it possible to deduce the original position of the rings. This step, however, is still probably the most challenging: it can rapidly become confusing, especially in the absence of experience handling mail. The third and final step consists of actually filling in the missing parts using dummy rings. This should be done by carefully following the weaving pattern of the mail fragment so that each new ring will precisely replace an original, missing ring. It is important that the dummy rings can be distinguished from the originals to prevent one type of rings being mistaken for the other.

The technique of filling in with replacement rings has occasionally been applied to historical mail. For example, the Victoria and Albert Museum in London recently used several replica riveted rings to repair the mail section of an arm guard. To identify them, the modern rings were each stamped with the letters 'VA' (Metcalf 2005). However, this technique has rarely been used on flexible

Figure 1: Flexible mail from an archaeological context that suffered extensive ring loss, giving it a ragged appearance. Photograph MA Wijnhoven.

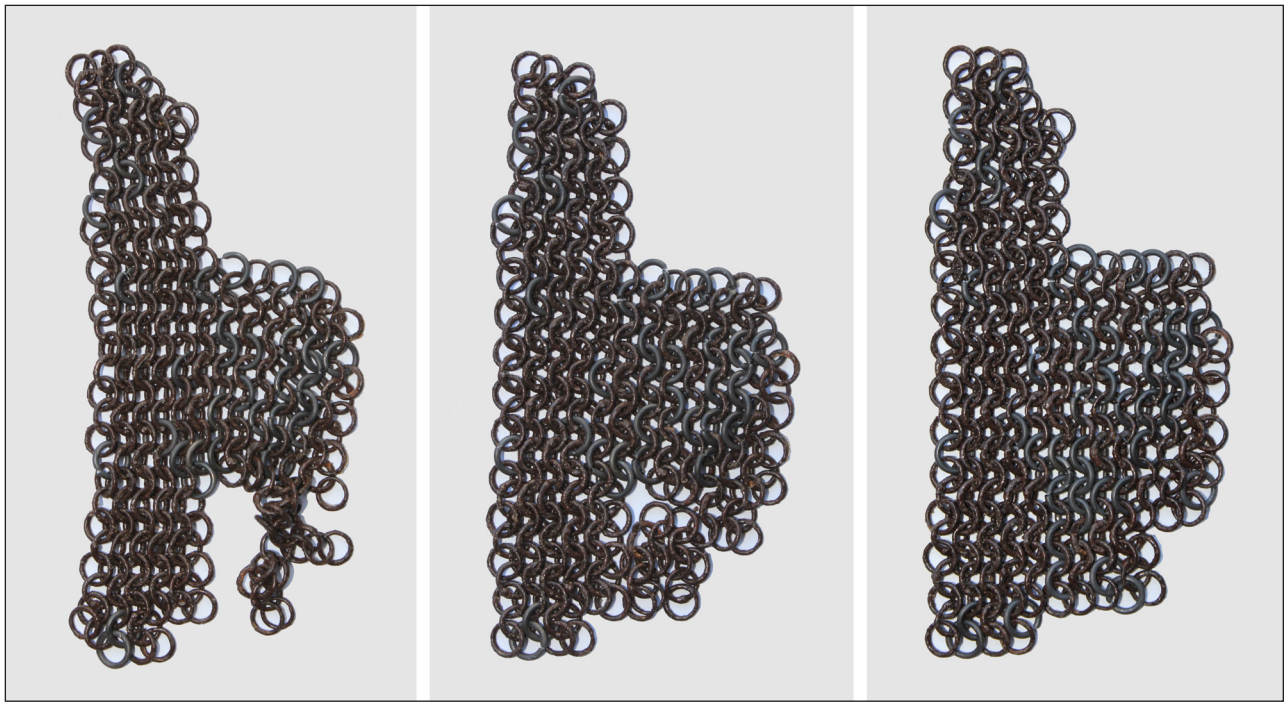

Figure 2: Process of filling in the missing rings. **Left:** Fragment almost entirely filled in with dummy rings, except for the section on the bottom right of the fragment. **Middle:** The surviving rings are put back into their original positions. **Right:** The missing parts are filled in with dummy rings. Photograph MA Wijnhoven.

archaeological mail, in spite of the fact that the method has great potential and value for this type of material.

To appreciate the advantages of using this technique on archaeological mail, the ways in which archaeological mail differs from historical mail must be laid out. The first difference is time range. Handed-down historical mail is relatively young; it generally belongs to the late medieval age or the early modern period. There are some rare examples from the 14th century AD, and almost none from an earlier date (Checksfield *et al.* 2012: 232). Mail armour has, however, been around since the 4th or 3rd centuries BC (Hansen 2003: 122). Therefore, historical mail provides only a limited glance at a long tradition that lasted two millennia. Archaeological mail, in turn, can provide information about the origin and development of mail armour and about its cultural and temporal variations.

Another important difference between historical and archaeological mail is condition. As mentioned above, historical mail tends to be in a good general state of preservation that allows the shape and garment type to be easily identified. Many details may still be visible, such as past alterations, construction methods, and the use of tailoring techniques for fitting the garment. Studies of historical mail often describe these observations exhaustively (e.g. Burgess 1953; 1957; 1958; Burgess & Robinson 1956; Chapman 2004; Reid & Burgess 1960; Schmid 2003; Wood *et al.* 2013). In contrast, the condition of archaeological mail is mostly poor. This makes it difficult for researchers to make sense of archaeological mail pieces. The information that can be retrieved from artefacts in this condition is usually meagre. For instance, it is often impossible to determine the type of garment that the fragment(s) may have come from – for example, whether they came from a mail coat, an aventail (a type of mail 'curtain' that attached to a helmet), a hood, or other. Currently, the consensus is that when the weight or bulk of the fragments is fairly large, the remains are taken to be a coat of mail (e.g. Caldwell *et al.* 2005: 99–100; Gilmour 1999: 159; Rasmussen 1995: 73–75; Weinberg 1979: 85).

When the technique of filling in is used with flexible mail, the impact is immediate and the effects are manifold. Firstly, it assists the conservation of the piece. By inserting dummy rings, the mail weave is stabilized and any force applied to it gets distributed evenly throughout the whole, instead of falling on just certain areas. Admittedly, there are other techniques that aid conservation in a similar way. Nylon (or metal) wire is sometimes employed to hold together sections of mail and patch up large holes. This method is frequently applied to historical mail, for example in the mail coat attributed to St Wenceslaus (Checksfield *et al.* 2012: 229, **Figures. 1, 3–8, 9–11** & **14**).

The use of nylon wire may be considered a less intrusive manner of restoring mail, as it allows the observer to appreciate the actual state of preservation of the piece. However, the filling-in technique aids not only the conservation, but also the interpretation of the mail artefact, making it a more desirable mode of treating archaeological mail. Once archaeological mail has been filled in, it may reveal details otherwise difficult or impossible to discern in heavily damaged specimens. For instance, this technique can restore fragments to their original shape and return separate strands of rings back to their initial mesh form. Filling in can also reveal the edges of a

garment, something that other techniques would not achieve. In the best of cases, it can also expose details of mail construction and tailoring. Lastly, it has the potential of turning an indeterminate collection of rings into a recognisable garment.

Given the differences in preservation between historical and archaeological mail highlighted above, the technique of filling in should be particularly suitable for treating the latter. Its effects should be especially appreciated in two areas: a) in research, as specific details of the material are revealed, and b) in display, offering observers the possibility to envision how the artefact would have been originally, as opposed to looking at just an ensemble of disarranged rings.

The choice of conservation technique will, then, influence the kind of information that the studied object may yield. Within the array of existing methods, the two techniques discussed in this paper, the use of nylon wire and filling in with dummy rings, are both entirely reversible, non-destructive methods that should be familiar and available to researchers and conservators.

3. Case-Study: Roman Archaeological Mail

This section will illustrate the kind of information that can be obtained through the filling-in technique by means of a case-study of several archaeological mail fragments from the Roman period, found in the mid-20th century near a legionary base at Novae, by the modern town of Svishtov, in Bulgaria. The remains in question were retrieved from the Danube River and are now part of a private collection in Italy. It is known that the Romans maintained a military presence in that region of Bulgaria from AD 44 until well into the 5th century, which sets an age range for the material. In the past, river finds were often explained as the result of occasional loss (e.g. Künzl 1999/2000). However, more recently, many of the Roman militaria retrieved from rivers have been interpreted as deliberate depositions, for example by soldiers upon discharge of the army in gratitude to a deity for the protection received (Nicolay 2007: 189).

The Novae mail

The mail remnants consisted of 21 fragments and various loose rings (**Figure 3**). The largest fragment measured 63 cm by 38 cm at its widest point. The others varied in size, from considerable to a small cluster of rings. The condition of the fragments was, in general, good, despite the presence of ring loss, as expected. All of the fragments retained their flexibility; some of the remains still had fairly large sections of the original mail weave intact, while in others the weave had broken up due to extensive loss of rings. Despite the relatively good preservation, it proved impossible at this stage to identify with any certainty the type of mail garment the remains had come from or the original connections between them. Nonetheless, the mere quantity of surviving material strongly suggested that the fragments had once formed a coat of mail.

The rings in the mail fragments were linked in a 4-in-1 pattern (**Figure 4**). That is, each ring was originally connected to two rings above and two below, creating rows of rings. As typical in Roman mail, the fragments consisted of riveted and solid rings, arranged into alternating rows throughout the garment. The riveted rings had been made by shaping metal wire into a circle with overlapping ends of a few millimetres that were subsequently pierced and closed with a small rivet. In contrast, the solid rings had been fashioned by punching out sheet metal. The riveted links had an outer diameter of 7.3 mm on average, making them slightly larger than the solid ones, which had an outer diameter of 7.1 mm on average. In several places, there were a few solitary riveted rings of significantly larger size, almost 9 mm in outer diameter (**Figure 5**). In addition, most of these solitary riveted rings diverged from the 4-in-1 pattern around them, indicating that they likely were repairs for mending holes during the use-life of the mail. This shows that the loss of rings is a problem that also afflicted soldiers in antiquity.

Treatment

The fragments were treated by filling in with so-called 'butted rings', which were made of iron wire shaped into a circle with their ends 'butted' together. Since butted rings were generally not used in Roman mail, as they are not strong enough to withstand the action of battle, this makes them easy to identify as replacements. Butted rings have occasionally been reported in mail from the Roman period; however, these concern copper alloy rings that were used as a decorative trim (James 2004: 110–111; Matešić 2011: I, 247). The wire used for making the replacement rings for the Novae mail was black annealed iron, which is rust resistant and whose dark colour blends well with the original mesh, while still being distinctive enough to tell both types apart. The butted rings also differ from the originals in that they are made from modern wire, which is characterized by a perfect circular cross-section, a smooth surface with almost invisible draw-marks, and having little variation in diameter (Burgess 1953: 194). Taking into account all these differences, the dummy rings should remain discernible, even after patination.

As a first measure, the large mail fragment was filled in. **Figure 6** illustrates various stages, from start to finish. During this process two of the original edges were identified: one vertical and one horizontal, together constituting a corner. The horizontal edge measured approximately 50 cm, confirming the initial suspicion that the remnants belonged to a coat of mail, with this edge corresponding to the lower hem.

The hem also contained a small diagonal step, only two ring rows in depth, a feature previously unknown in Roman mail. It is possible to corroborate that the step was part of the original design, because it was made intentionally, using a technique that involves a simple and effective manner of creating a smooth diagonal shape at a subtle angle. Normally, apart from the rings at horizontal or vertical edges, which only attach to two other rings, each mail ring connects to four others: two above, and two below. To create a diagonal edge, the rings are connected only to three others (two above and one below or *vice versa*, depending on the direction of the diagonal). That is, the diagonal is formed by leaving one ring out on each row,

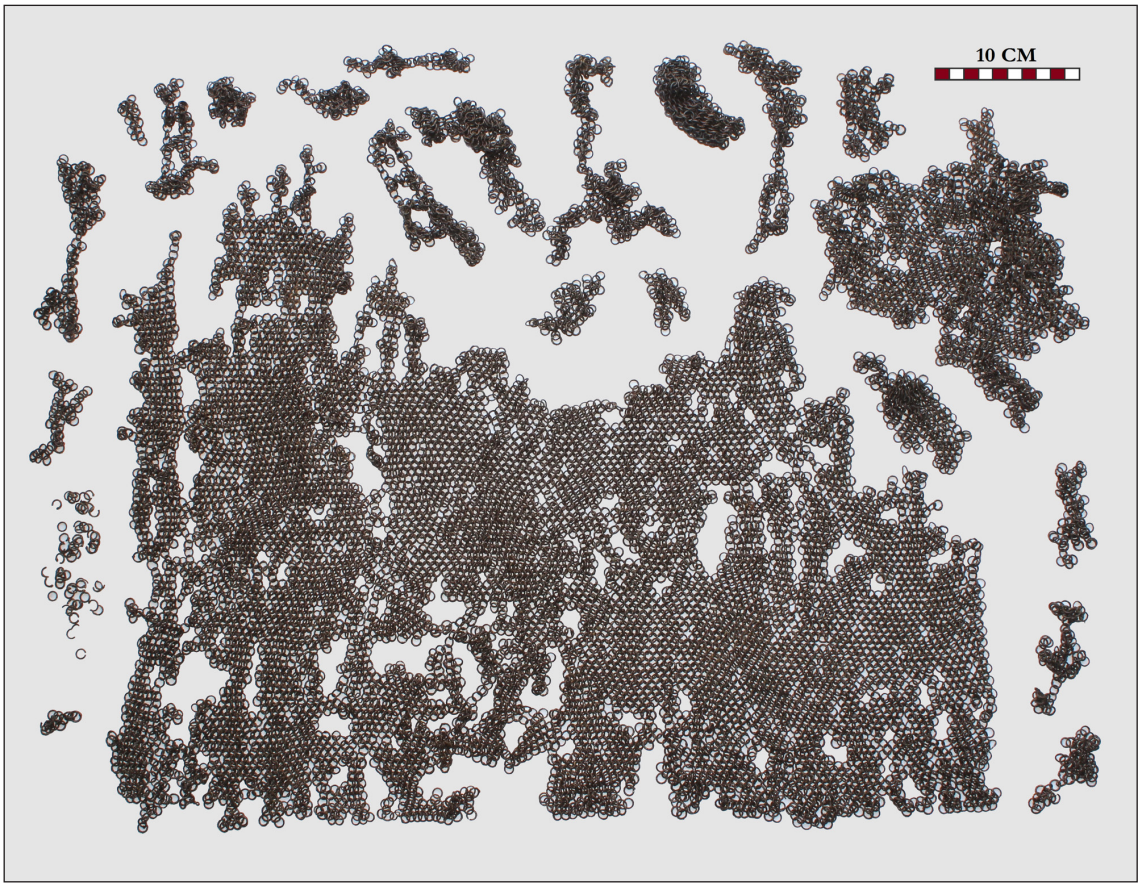

Figure 3: Original condition of the mail remains prior to filling in. Photograph MA Wijnhoven.

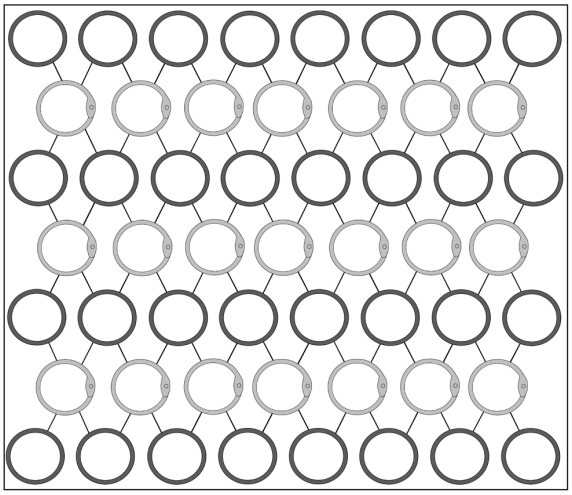

Figure 4: Representation of the 4-in-1 pattern with lines indicating which rings interconnect. The solid rings are shown in dark, and the riveted rings in light grey. Drawing MA Wijnhoven.

Figure 5: Larger riveted ring among regular sized ones. The larger rings are probably repairs made in antiquity. Photograph MA Wijnhoven.

resulting in a 45-degree shape; a shallower angle can be obtained by leaving out a ring every second row, instead of every row. This technique, however, has the disadvantage of creating a staggered outline. The solution is to abandon the 4-in-1 pattern and insert the 'staggering' ring through three rings in the row above, instead of two (**Figure 7**). This causes the ring to be slightly lifted (when compared to those that only connect through two rings in the upper row), producing a smooth shape.

Besides the hem, the large fragment also contained a vertical edge. This was probably one of the two side splits usually found at the bottom of the mail coat, the function of which was to allow the wearer to move around freely with no leg restriction. Depending on the length and width of the coat of mail, these splits could prove essential when running, sitting down, or riding a horse. Roman

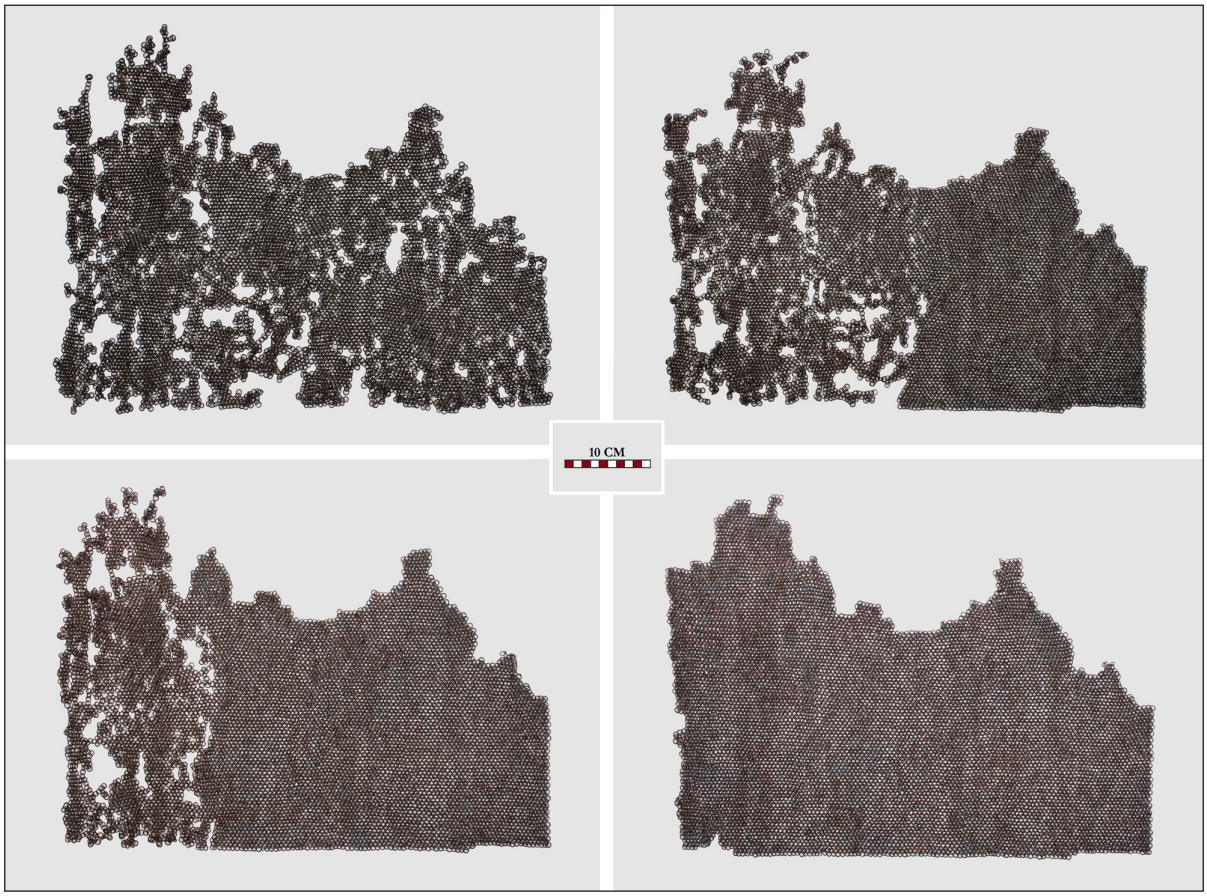

Figure 6: Filling in of the large fragment of mail at various stages. Photograph MA Wijnhoven.

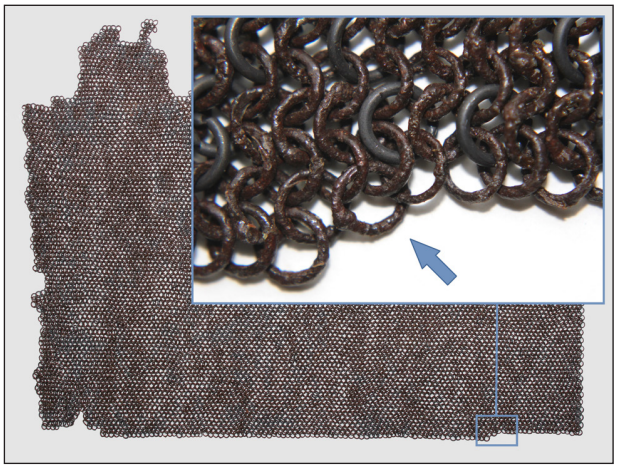

Figure 7: Close-up of the stepped hem with the ring that passes through three rings in the row above instead of the usual two. Photograph MA Wijnhoven.

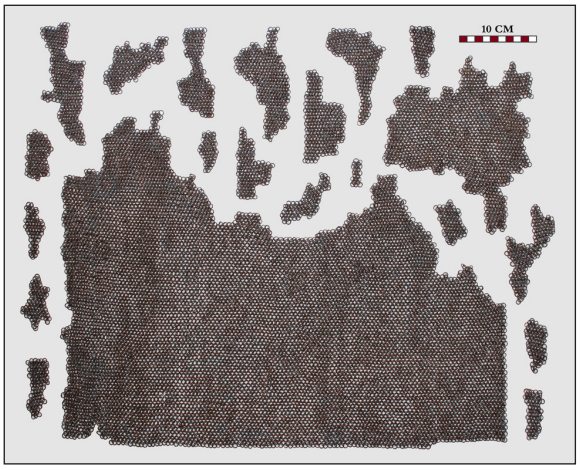

Figure 8: The fragments after filling in. Photograph MA Wijnhoven.

depictions of mail armour often show splits, which were almost invariably located at the sides (e.g. Schleiermacher 1984). The archaeological evidence for splits in Roman period mail is scarce, but does exist. The coats of mail from Vimose and Thorsberg both seem to have had them (Matešić 2011: I, 246; Wijnhoven 2015).

After filling in the large fragment, the remaining smaller fragments were treated in the same manner (**Figure 8**). Unfortunately, none of them presented any clear diagnostic features that offered more information about the construction of the mail shirt. Since no edges were found among these fragments, it was impossible to determine their exact original position on the mail garment. The only possible exception was the fragment illustrated in **Figure 2**, which may have been part of a vertical edge, perhaps from one of the two splits positioned at the hem, but the fragment was too small to be certain.

Comparative observations between the Novae mail and Vimose coat

Further observations of the large mail fragment helped to determine the original width of the coat, as well as the location of the split opposite to the one already identified. Both features were established through an apparently insignificant but in fact crucial detail that revealed the way in which the coat was constructed. Like almost all Roman mail, these pieces consisted of alternating rows of riveted and solid rings. The row-by-row alternation of ring types was necessary in order to form a mesh. Solid rings, as their name suggests, could not connect to each other but needed to be linked with the riveted rings. In mail studies, it is therefore assumed that each row consisted of just one type of ring along the entire circumference. European historical coats of mail from the late medieval period that are made up of riveted and solid rings do indeed show this pattern of one ring type per entire row. This indicates that the medieval mail maker worked 'in the round' – that is, adding rows while working his way downwards (Burgess 1953: 198; 1958: 202).

However, recent examination of the mail coat from Vimose (**Figure 9, left**), probably the best preserved example of archaeological mail, has suggested that the medieval way of making mail was not necessarily employed during the Roman period (Wijnhoven 2015). The Vimose coat was found in Funen, Denmark, in a bog containing thousands of artefacts, most of them military, and formed part of the tradition of war-booty sacrifices, a practice that throve in Southern Scandinavia during the first five centuries AD (Pauli Jensen 2007). Although Vimose was situated outside the Roman Empire, many of the objects from Vimose were of Roman origin. The coat of mail itself contained a blend of Germanic and Roman elements, but was likely manufactured outside the Roman Empire.

In the Vimose garment, each row suddenly shifts from riveted to solid (and *vice versa*) in a vertical line underneath the armpit (**Figure 9, right**). That is, each single row containing riveted rings on the front of the garment consists of solid rings at the back, and rows with solid rings at the front contain riveted rings at the back. This is different from what is seen in medieval and later mail coats, where each row only contains one type of ring for the entire circumference (Burgess 1958: 202). This detail indicates an important difference in construction, showing that, whereas medieval mail was made by adding rings 'in the round', the Vimose coat was made 'in the flat', meaning that it was constructed as a single large flat panel that included both sides of the garment and the sleeves. Once finished, the large flat sheet of mail would have been folded at the centre, creating a front and a back, and closed with riveted rings at the sides of the trunk and the undersides of the sleeves, finally forming a true coat of mail. The shift in ring type is observed where front and back meet.

The two-dimensional way of working 'in the flat', observed in the Vimose coat, corresponds closely to the manner in which sleeved tunics were confected in the

Figure 9: Left: Vimose coat of mail. **Right:** The rows shift from solid to riveted and *vice versa* underneath the armpits, downwards in a vertical line. Photograph and drawing MA Wijnhoven.

Roman period (**Figure 10**) (Wijnhoven 2015). These were woven to shape on a loom as single pieces of textile that were later folded over and sewn at the sides and under the sleeves (Granger-Taylor 1982; Hald 1946: 67–69). The fact that working in the flat was standard in tunic confection and that the technique was also used in making the Vimose coat of mail strongly suggested that this may have been the customary method of mail construction in Roman times both in and out of the Empire. The large fragment of mail from Novae seems to corroborate this suggestion.

Reconstruction

Just as the coat from Vimose, the large fragment from Novae displays a shift of ring type in each row, indicating that it was constructed in the flat. The alternation of ring types throughout the rows can be traced in a vertical line located at the upper left section of the large fragment (**Figure 11**), not only indicating the manner in which the coat was made, but also pinpointing the position of the large fragment in the original coat (**Figure 12**).

In addition, the alternation of ring types made it possible to establish the width of the coat (**Figure 12**). As mentioned above, the mail coat would have been made as one large panel that was consequently folded over and closed at the sides, with the bottom splits created by leaving part of those sides open. The shift of ring types in the upper left of the fragment, then, must have been located exactly underneath the armpit, delimiting the left end of the total width, with the preserved split on the right side of the fragment indicating the other end. In this way, the distance between the right split and the alternating rings on the left provided the width of the garment, which consisted of 122 rings measuring approximately 59 cm. The section where the shift of ring types would be expected above the right split was missing because of damage. Likewise, damage on the lower left side hindered determination of the outline of the split, but it could easily be reconstructed once the width of the garment had become clear (**Figures 12** & **13**).

Once the position of the side splits was determined, the lower left part of the fragment could be filled in by

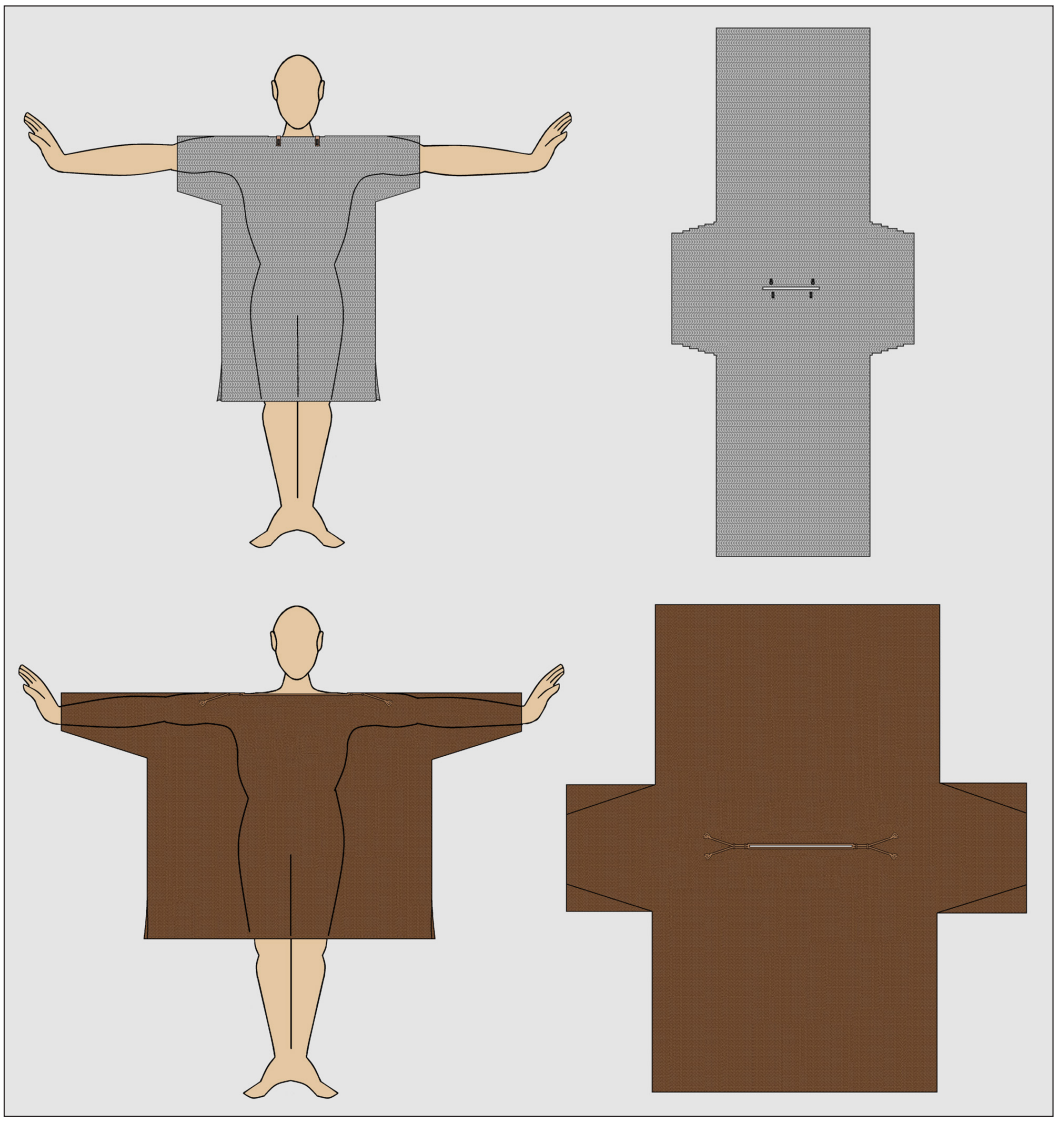

Figure 10: Top: Vimose coat when worn and its constructional lay-out. **Bottom:** Roman period tunic from Reepsholt, Germany, and its constructional lay-out. Note that the tunic and the coat of mail are constructed in a similar manner. Drawing MA Wijnhoven; Reepsholt tunic adapted from Schlabow 1976: Figure 158.

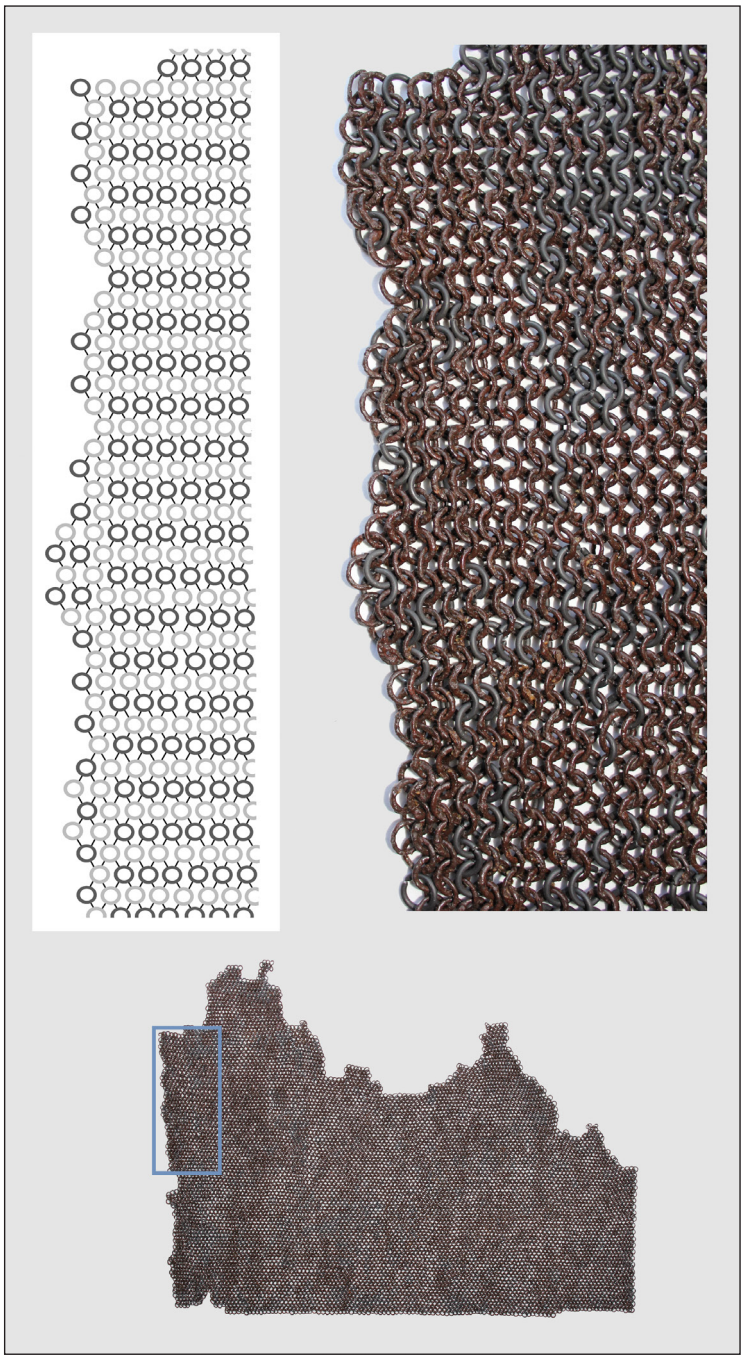

Figure 11: The shift of ring type within the same row can be traced down in a vertical line. **Top left:** Schematic representation of the section of mail where this shift occurs (solid rings in dark and riveted rings in light grey). **Top right:** Photographic representation of the same section. **Bottom:** Location on the larger fragment of mail. Photograph and drawing MA Wijnhoven.

mirroring the staggered right side of the hem. The distance between split and step on each side differed in width by some rings, with namely 15 rings on the left and 19 rings on the right. In general, lack of precise symmetry and the presence of maker's mistakes are not uncommon on Roman military artefacts (e.g. Paddock 1985: 145; Vanden Berghe & Simkins 2001/2: 76) and can be observed quite often, for example, in Roman helmets (cf. catalogues in: Miks 2014: 191–237; Vogt 2006: 192–300). The exact length of the side splits remained uncertain. In the present condition, the right split spanned 45 rows straight from the lower hem, which is approximately 18 cm. It might have originally been shorter, since damage could later have caused ring loss in a straight line. But it could not have been longer than 45 rows, since the shift of ring types started exactly at the 46th row, counting from the bottom hem, indicating that, at least from that row, the front and back of the coat were connected.

Once the outline of the large fragment had been followed and filled in as far as possible, the next step was to connect the smaller loose fragments to it (**Figure 13**). In contrast to other archaeological materials such as pottery sherds, in mail there is no clean break. Mail sections only get detached when the interlinking rings are lost. This means that no two loose fragments can fit together

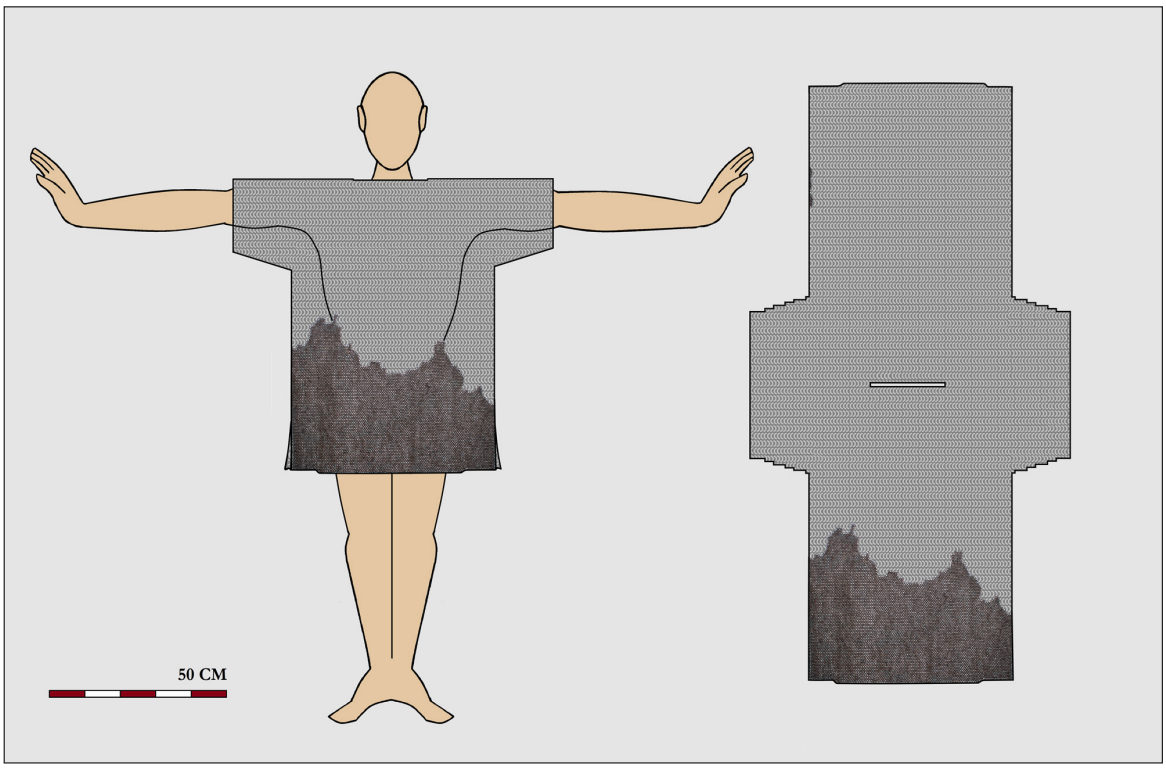

Figure 12: Left: The construction plan of the coat of mail in relation to the large fragment. Note that the majority of the fragment belongs to one side and only a small section comes from the other side. **Right:** Original location of the large fragment in the coat of mail (with left split and entire hem restored). Drawing MA Wijnhoven.

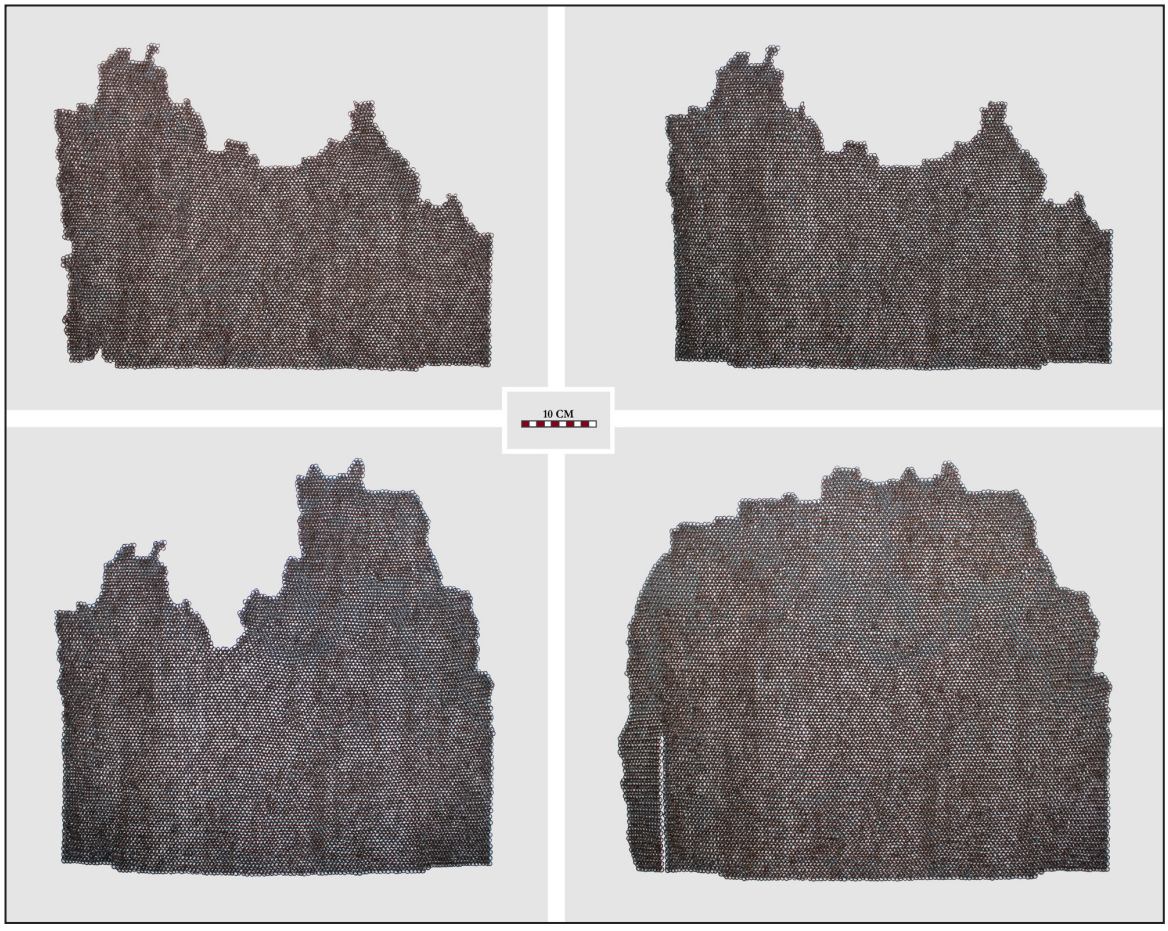

Figure 13: Various stages of the process of connecting the loose filled-in remnants into a single composite piece. Photograph MA Wijnhoven.

perfectly. Therefore, when a piece becomes separated, it is very difficult to tell where it would have been placed. However, the outline of one fragment can more or less follow (parts of) that of another, suggesting a probable fit. Some of the smaller remnants were fitted to the larger and other fragments in this way. Nevertheless, others were simply too small to contain any distinctive outlines. After connecting the fragments with a possible fit, the spaces in between were filled in using the remainder of the loose fragments. The small piece from **Figure 2** that may have contained a vertical edge was positioned at the left side of the large fragment to make up the other side of the reconstructed split.

The final result was a single large fragment (**Figures 14** & **15**). The procedure of filling in the missing rings and the subsequent connection of the fragments altered, of course, the dimension of the artefact, which after treatment provided a better indication of its original size and shape. In total, just over 1,900 dummy rings were needed to fill in the 21 fragments from the case-study. Almost the same number of dummy rings was used to connect the fragments into a single piece of mail.

Figure 14: The final result is a single composite fragment of mail. Photograph MA Wijnhoven.

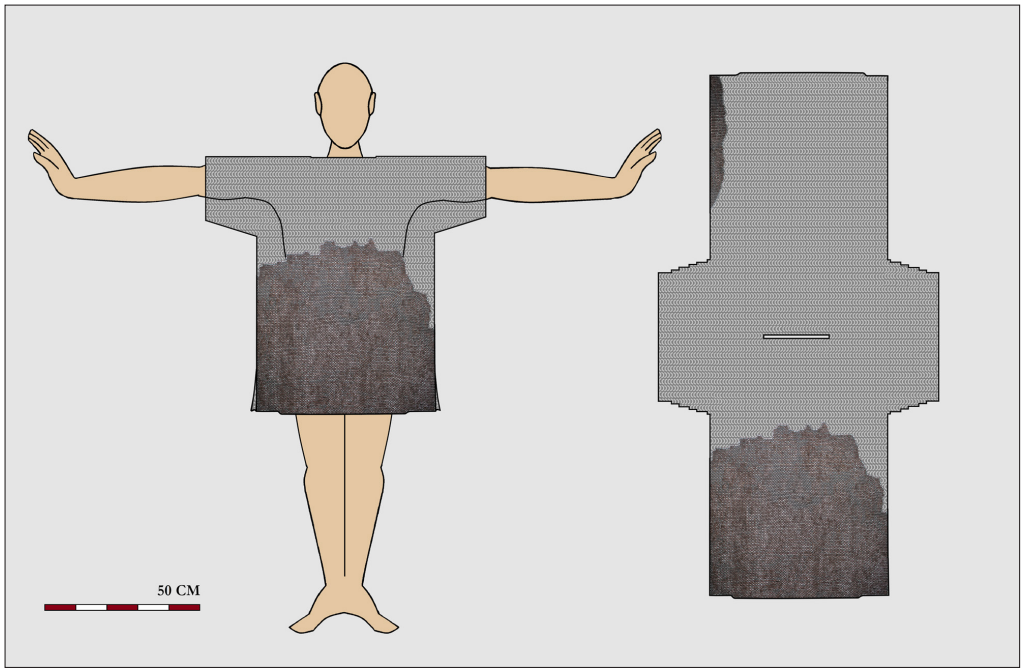

Figure 15: Left: The construction plan of the coat of mail in relation to the composite fragment. **Right:** Location of the composite fragment in the coat of mail. Drawing MA Wijnhoven.

4. A Comparison with European Historical Mail

The result of the case-study has provided a good deal of interesting information that would have not been revealed by the use of other, less labour-intensive, techniques. The use of dummy rings to fill losses and assist with the rejoining of the fragments helps both to stabilize the mail and to facilitate its interpretation. Most especially, it has increased our knowledge on the construction and tailoring of mail coats in the Roman Period, knowledge which was very limited. Much of what has previously been concluded on this subject has been based almost exclusively on conjecture from studies of historical mail dating from the 14th century onwards.

European historical mail from the late medieval and early modern period was meticulously designed to balance protection, weight, and mobility. To obtain that balance, the mail maker put various techniques to use. One of these involved shifting the rings' heaviness, or gauge, throughout the garment, placing the heaviest rings on the trunk of the body, which required the most protection, while using lighter rings on the sleeves, the bottom part covering the legs and, sometimes, the back of the shirt (e.g. Reid & Burgess 1960: 51; Wood *et al.* 2013: 210). In this way, the garment would offer proper protection, while reducing the weight where possible.

Documentary evidence demonstrates that mail was made to order and could even be tailored to the individual client (Blair 2005; Frangioni 1978: 485–492). Tailoring was also achieved through a series of different techniques. For example, by inserting triangular sections, the mail maker could widen or take in the garment where necessary. The use of triangular insertions was a common way of shaping a coat of mail (Checksfield *et al.* 2012: 238–239) and other mail items for the neck and shoulder areas, such as mantles and standards (e.g. Laking 1920: 522–525, 530–531; Schmid 2003: 11–14).

Another, more complex, technique consisted in increasing or decreasing the number of rings following a predetermined plan, as in knitting (Burgess 1953: 197–200; Wood *et al.* 2013: 210–218). This was accomplished using 'idle links' that passed through only three rings (two above and one below or *vice versa*) instead of four, increasing or decreasing the weave below the idle link (**Figure 16**). To tailor the coat of mail, the maker would insert extra rings in the area of the shoulder blades to give more room for movement of the arms and shoulders. Similarly he would often decrease the weave at the trunk, to reduce the weight of the garment, and expand it from the hips down, to offer greater mobility to the legs and the lower torso. The use of idle rings made it possible not only to change the number of rings in a single row, but also to modify the number of rows itself (**Figure 17**). Row number reductions were usually applied to the sleeves as a means of tapering in order to cut weight and avoid loose material. Reduced numbers of rows using idle links were sometimes placed in the body of the mail coat, where their function was to extend the length of the back while keeping the hem perfectly aligned. The extra length on the back of the shirt gave extra room to bend over easily.

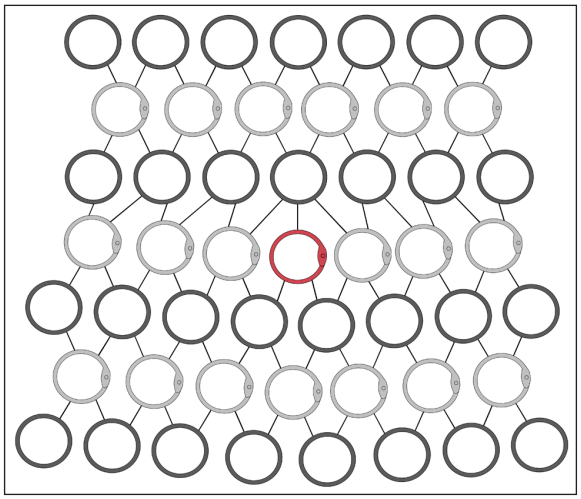

Figure 16: Representation of the use of an idle link to change the number of rings in a row. Drawing MA Wijnhoven.

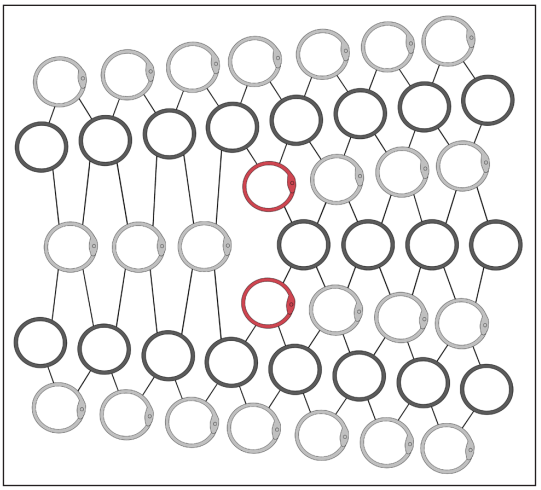

Figure 17: Representation of the use of idle links to change the number of rows. There are two manners in which idle links can be employed to this aim; one leaves a small hole, the other a knot. The former is illustrated here. Drawing MA Wijnhoven.

The purposeful placement of idle links throughout the shirts suggests that the mail maker started at the top and worked his way downwards (Burgess 1953: 198; 1958: 202). It seems unlikely that he would have employed drawn patterns, and it is more probable that he worked from memory, applying different constructional techniques where necessary as he worked on the garment (Burgess 1953: 199–200).

In short, the mail makers of the late medieval and early modern period in Europe could use different techniques to tailor and modify a mail garment. The array of variation they achieved was very large, as attested by the many surviving examples of historical mail housed in the collections of the Royal Armouries Museum in Leeds, the Wallace Collection in London, and the Metropolitan Museum of Art in New York City, among others. Almost all historical mail garments present at least one of the techniques described above.

Through examination of the Novae mail in the case-study above, it has been possible to note that while fragments of Roman mail and its historical counterparts may look alike, there are important differences. It revealed, for example, that the technique of using rings of various heaviness or gauge in a single garment, to even out protection and weight, was not applied to the Novae mail coat. Instead, all the fragments contained rings of similar size and gauge. Evidence of tailoring was equally not found in this archaeological specimen, while it is very often observed in European historical mail. No triangular sections or idle links to shape the garment could be observed. The lack of tailoring means that the Novae coat must have been a rectangular-shaped garment, more closely resembling historical mail from the Middle East and India than European examples. Like the Novae coat, oriental mail rarely shows tailoring (Burgess 1960: 152). The implication is not that there is a particularly strong link between Roman and oriental mail, but that European mail from (at least) the 14th century onwards is exceptional. Nor is it true that tailoring techniques were necessarily unknown to the mail maker from the Roman period. For example, the coat of mail from Vimose has tapered sleeves, which were achieved by the use of idle links located in the underside (Wijnhoven 2015). These links make the sleeves 10 rows narrower at the hem than at the shoulder. But apart from this, the Vimose coat is also completely rectangular, with no tailoring to the trunk. Unfortunately, the Novae remains are not complete enough to determine whether it also had sleeves, tapered or otherwise. However, its similarity to the Vimose coat in all other aspects would suggest that it did.

Also differing from European historical mail, the construction of the Novae and Vimose coats does not seem meticulously planned to maximize the weight-to-protection ratio. This does not mean, however, that this aspect was not considered in Roman mail. In fact, the Novae coat shows two characteristics related to this aspect. First, it was kept relatively slim, measuring approximately 59 cm in width, with a total circumference of 118 cm. This had to fit over the soldier's body, layers of clothing, and a padded garment worn underneath the mail, while still leaving room for movement of the upper body. Second, as there was no tailoring to the trunk of the coat, two side splits were needed to allow the wearer to move without hindrance while keeping the coat relatively slim and light.

The Novae coat also contained a stepped hem, which is a feature that had never been recorded before among Roman mail remains. It could be suggested that this type of hem had some function related to additional protection to the front of the garment. The side splits allowed the wearer to move freely and to run, sit down, or ride a horse with ease; the stepped hem would also have essentially enlarged the splits to offer greater mobility. While these considerations may be valid, it is unlikely that the steps, no larger than two rows deep, would have made any actual difference regarding protection or mobility. It is more probable that the stepped hem was an embellishment, added for fashion or personal taste.

Finally, there is sufficient evidence to suggest that instead of resembling medieval coats of mail, both the Novae and Vimose pieces were modelled after a non-military textile garment, the tunic. The strongest evidence is found in the shift of ring types following a straight line underneath the armpits. This feature reveals that both coats were, like a tunic, made from a single large panel – including the front, back and sleeves, which would afterwards be folded over and connected at the sides to form the final garment. In sum, during the Roman period the mail maker's manner of constructing a mail coat differed substantially from that of his European late medieval counterpart.

5. Conclusions

The case-study presented in this paper has demonstrated the advantages of filling in the gaps in flexible archaeological mail – one of them being that, after the treatment, the remains from Novae have become less vulnerable to future deterioration. The risk of further ring loss has been reduced and the probability that complete sections get detached again has been almost reduced to zero. The main advantage of using this technique with archaeological mail, however, lies in the information that it makes available towards the interpretation of the garment. As we have seen, filling in can help make sense of previously unintelligible mail remains. In this way, it can reveal a great deal of new data to complement our current knowledge of mail armour, which until now has been limited and conditioned by material dating only from the 14th century and later.

The choice of conservation treatment greatly influences the prospects of retrieving detailed information from archaeological mail. By filling in the fragments from Novae, it was possible to identify with certainty that the remains belonged to a mail coat. The treatment also made visible the surviving edges and allowed the location of the main fragment, which was the lower half of the coat, to be determined. What is more, it made it possible to establish the original width of the mail garment, something which is very rare for the Roman period. Lastly, the technique revealed details about the construction of the mail coat and the manner in which the Roman mail maker approached his work.

As a final observation, the technique of filling in can also make it easier to display an otherwise difficult-to-exhibit object. During treatment for the case-study, not only was the surviving part of the mail coat brought closer to its original appearance, but the once loose fragments also became more suitable for display. How far the treatment of the artefact should go once the remains have been filled in will depend on the wishes of the institute, the curator, or the owner of the piece. For some, connecting the loose fragments without knowing their original position may be a step too far. For others, re-creating the entire mail shirt around the surviving parts will be considered appropriate. To a large extent, the choice will correspond to

the aim to which the technique is applied and to the information that the researcher wants to obtain and display. Nevertheless, since the filling-in technique is reversible and non-destructive, it can withstand future changes of perspective and adapt to newly discovered insights.

Competing Interests

The author declares that they have no competing interests.

Acknowledgements

I would like to thank M Saliola in Italy for permitting the examination of the Novae mail armour retrieved from the Danube River and the subsequent publication of the results.

Note

[1] This paper uses terminology associated with textile garments for certain characteristics of mail armour, such as 'weave' and 'hem'. There is much evidence in the literature that the coat of mail was considered in antiquity as a sort of clothing, albeit one of metal. For example, the Roman author Varro (1938: V.24) in the 1st century BC speaks of *ex anulis ferrea tunica*, or the 'iron tunic made of rings', when referring to the mail coat. The association between clothing and mail can also be seen in much more recent sources, such as the records of issues and payments from 1544/5 to John Malte, King Henry VIII's tailor (Blair 2005), where mail is likewise referred to as a *tunica de maile*. The relationship with clothing also extends to the archaeological evidence. This can for instance be observed in the Vimose coat of mail, which was constructed as a sleeved tunic (Wijnhoven 2015).

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How to cite this article: Wijnhoven, M A 2015 Filling in the Gaps: Conservation and Reconstruction of Archaeological Mail Armour. *Journal of Conservation and Museum Studies*, 13(1): 8, pp. 1–15, DOI: http://dx.doi.org/10.5334/jcms.1021226

Published: 08 October 2015