Technische Universität München

Studiengang für Restaurierung, Kunsttechnologie und Konservierungswissenschaft

A 15th century polychrome wood sculpture from the Burrell Collection (Glasgow)

–

Conservation investigation and feasibility study into materials, methods and conservation ethics towards devising a surface cleaning strategy

by

Barbara Jörg

A thesis submitted in partial
fulfilment of the requirements for the
degree of Bachelor of Arts

August 2013

Supervisor: Prof. Erwin Emmerling

Abstract

The polychrome wood sculpture 50/30, a full figure sculpture from the 15th Century, is part of the Burrell Collection in Glasgow.

The sculpture was focus of a in-depth study into materials and techniques with the aim to provide more information aiding identifying the period and location of the sculpture's manufacture. Within the investigation fibre analysis to identify the fibres of employed fabric and analysis of the microscopic wood anatomy were performed. The main focus of this thesis was to develop a feasible and suitable cleaning strategy as the sculpture exhibits a dark obscuring surface soiling. Therefore cleaning tests were carried out and resulting in recommendations for the further treatment of the sculpture.

Table of Contents

List of abbreviations

CMC : critical micelle concentration

col. : column

ed. : editor

edn. : edition

e.g. : for example (from Latin “exempli gratia")

et al. : et alii (Latin, “and others”)

etc. : etcetera

fig. : figure

FTIR : Fourier Transform Infra-red Spectroscopy

Ibid. : ibidem (Latin, "the same place")

mm : millimetre

prof. : professor

SEM-EDX : Scanning Electron Microscope – Energy-Dispersive X-ray spectroscopy

TUM : Technische Universität München (Technical University of Munich)

UV : Ultraviolet

v.i. : vide infra (Latin, “see below”)

VIS : Visible Light Spectrum

List of figures

Unless otherwise indicated all photographs are produced by the author.

List of tables

Introduction

From October 2012 to April 2013 'Glasgow Museums' provided the author of this text the opportunity for an internship in the conservation of sculpture within the conservation department. A conservation survey of technical investigation and documentation of materials and construction techniques of the medieval polychrome sculptures in the 'Burrell Collection' provided the main focus of the internship program.

One of the examined examples of medieval sculpture for the survey was a standing male figure (museum acquisition number 50/30), described as either 'St John or St Stephen'. This sculpture displayed evidence for a variety of materials and working techniques employed in decorative surface practices. However these were only discernible under close investigation as the surface of the sculpture is severely obscured by soiling, giving it an overall dark, brown to black appearance. Moreover it became clear that a special surface decoration technique – an applied relief textile (an application technique employed to resemble textiles; German: *Pressbrokat*)[1] – appears to have been used to decorate the top gown of the sculpture.

The overall obscured surface is somewhat misleading the visual perception of the sculpture relating to aesthetic appreciation as well as to iconography and working details. Removal of surface obscuring matter through appropriate cleaning would allow an increased level of accessibility for observation and study to reveal evidence for authentic materials, working practices and condition of the surface decoration. Furthermore it would aid the observation and interpretation of the sculpture in regards to its iconography and origin and increase the appreciation of the sculpture itself.

With this thesis a conservation study into materials and techniques employed in medieval sculpture practices on the example of the 15th century polychrome wood sculpture was performed. Methods and equipment used for the investigation are

1 See glossary.

described. The results shall aid the overall identification process of the period and location of the sculpture's manufacture. As part of the investigative program cleaning tests were carried out in view to explore, assess and formulate a potential conservation cleaning strategy aiming safe removal of surface obscuring soiling.
Results of the investigative study are summarised and have informed the conservation treatment recommendations for the proposed re-display of the medieval sculpture as part of the overall re-display of the Burrell Collection in 2020.

Chapter 1: Art-historical aspects

1.1 Description

(Photographs: see appendix, p. ii – xiv)

The sculpture 50/30 is a wooden polychrome sculpture with dimensions of 815 mm in the height, 325 mm in the width and 185 mm in the depth.

The sculpture depicts a standing male figure in long garment, the body slightly inclined to the right and with the tonsured head looking downwards in the same direction the body is inflected. With the left hand the figure is lifting the front part of its upper garment. An indent of approximately 25mm in length and 10mm in width on top and towards the front of the head has been noted as well as evidence of red coloured paint layers (visible underneath surface soiling) along the temple on the left side of the beardless face. These may indicate a head wound and blood running down from this wound.

Most likely the figure is wearing a liturgical vestment consisting of an *alb*[2] as the undergarment, a *dalmatic*[3] with a high collar as outer garment and probably an *amice*[4] around his neck.

The reverse of the sculpture is fully carved, but the elaborate surface decoration of the outer garment – an applied relief textile – does not cover the whole back.

The shape and posture of the figure's right hand suggest that the figure could have been carrying an attribute, now missing, although no evidence such as residue of adhesive, mechanical or structural fittings have been detected.

The sculpture faces shows prominent carved physiognomic features, particularly the eyebrows and the nose. This results in a modelled and distinct emotional

2 BRAUN 1934, col. 327 ff.
3 DAMBECK 1953, col. 985 ff.
4 BRAUN 1934, col. 636 ff.

expression.

The sculpture should be viewed as a single component removed from it's original, wider context less than a comprehensive art work in itself. Probably part of a group of sculptures, it could originate from an architectural context such as an altar, screen or internal façade.

1.2 Provenance / information sources

The museums registration number for the sculpture is 50/30[5]. The inventory number is 144[6].

Despite available information relating to the sculpture's provenance, acquisition and collecting history, none of this data has been confirmed through comprehensive studies and research and therefore hindered meaningful analysis and interpretation of not only this example but the medieval sculpture collection as a whole. For this thesis the available primary sources were consulted to reconstruct the sculpture's historical context and its exhibition and conservation history since its acquisition.

Only little information concerning the provenance of the sculpture is available. The only existing documents regarding the sculpture are an entry in one of the purchase books of Sir William Burrell (9 July 1861 – 29 March 1958), collector and founder of the 'Burrell Collection', a record card and a conservation record card of the sculpture.

In the purchase book of Sir William Burrell the sculpture is described as "*An exceedingly fine carved wood figure of St John or St Stephen decorated in the original polychrome. The hands restored. From the Oppenheimer Collection. Austrian 15' Century 32'2" high*". Burrell also noted the date the sculpture was insured – 19th September 1936 – which leads to the assumption that he bought the

5 *Mimsy XG* Database: 50/30, Glasgow Museums.
6 Purchase Book 1936, p. 59.

sculpture close to this date. Under the point '*From whom bought*' he noted "*John Hunt*" and under the point '*Received*' is noted, that the sculpture was "*lent to the Ashmolean Museum Oxford October 1936*".[7]

The information provided by W. Burrell himself was transferred to the museums record card of the sculpture. Some additional facts are noted by at least two more people.
At the title "*Figure of St John (or St Stephen?)*" is a short note, that the figure is most probably depicting St Stephen. Under the point '*Artist or Place or Origin*' is noted: "*Austria*", "*Liege ~1360*", "*S.German c.1400*". The date of the 15th Century, provided by Burrell, is also noted.
Notes referring to its exhibition history: "*On loan to the Ashmolean Museum, Oxford (Oct 1936 – Aug 1946)*", "*Jan 1968 on* [?] *South Balcony (registered at Kelvingrove)*", "*Glasgow 1951 no. 47*", "*Edinburgh (RSM) 1959*", "*Glasgow A6+MUS Glasgow's European Treasures 21 Dec 72 – 31 Jan 73*" and "*Ardrie* [?] *Public Library, Art Treasures from the Burrell Collection 1954*".[8]

Additional notes and a photograph in the museum object record[9] provided additional information. On the reverse of the photograph of the sculpture is written "*Saint John*", while on one of the sheets in noted:

"*Burrell Figure in deacons clothing 50/30*

v. likely to be St. Stephen:

1) Salzburg museum Carolino Augusteum has a late 15th Century kneeling St. Stephen from the Tyrol. This one is kneeling on both knees with head slightly on one side + hands together in prayer. Could Burrell example have hands originally like this?

2) Innsbruck, Tiroler Landesmuseum Inv.P.1005 A St. Stephen in same garb as deacon but with stones in his hand. Could Burrell one have the same thing? Attributed to sculptor Lenhard von

7 Purchase Book 1936, p. 59.
8 Record card of 50/30.
9 Record card of 50/30.

Brixen. is from church of St. Lawrence in Pustertal, c. 1460 ill. in Spätgothik in Tirol cat.

3) Prof. Peter Bloch [?] *+ Dr. Elfriede Baums* [?] *separately said S.German. NOT Austrian.*"[10]

On the other sheet of paper under the topic "*Visit of Norbert Jopek (Curator of German Sculpture, V&A, London)*" is noted for the sculpture 50/30:

"*- early C15th (because in #soft# style of that period)*
- definitely Austrian School (Vienna), part of a group by an unidentified Master
- cf figs in Vienna (exh., c.1998/9): Untere Belvedere, Vienna; Liebieghaus, Frankfurt ('Colli' Madonna [check sp.])"[11]

1.3 Iconography

The sculpture depicts a beardless man. The tonsure indicates that the depicted figure is a monastic or clerical person. Furthermore the figure's dress, a liturgical vestment identifies the depicted figure as a clerical person, most likely a deacon[12] as the vestment can be identified as an amice, an alb and a dalmatic (see: **1.1 Description**). The indent on the front of the figures head and blood along the left hand side of the temple indicates that the figure probably portrays a martyr.

According to the artworks 'title' from the museum's records, the sculpture depicts either St John or St Stephen.
St Stephen was a deacon in the early church at Jerusalem ordained by the Apostles and the first martyr of Christianity (protomartyr). Generally he is depicted as a young deacon wearing an amice, alb, stole and dalmatic, though in the Medieval Ages and the Renaissance the dalmatic changes to a colourful and often richly ornamented garment. St Stephen's attributes depicting him as a deacon are the palm branch and the Gospel Book, but also other sacral objects used by deacons in the liturgical service. As he was stoned to death the attribute referring to his martyrdom are stones, placed either in his halo, on his head, in his hands,

10 Record card of 50/30, Appendix.
11 *Ibid.*
12 PAULUS 1954, col. 1377 ff.

on the book he is holding or in his garment.[13]
St John is also normally depicted as a young man. But his attributes are generally the eagle or a chalice sometimes with serpents in it. In some cases he is depicted with a vat of oil as according to the legend he was thrown into a vat of boiling oil what miraculously did no harm to him.[14]

As the sculpture is not possessing more explicit attributes the figure's identification as St Stephen cannot be fully confirmed. However, according to the sculpture's noted characteristics the depicted man is more likely St Stephen than St John.

13 BRAUNFELS/KIRSCHBAUM 1976, p.395 f.
14 STADLER/HEIM/GINAL 1869, col. 274-287.

Chapter 2: Art technological aspects

2.1 Construction

An initial examination and investigation of the sculpture was carried out during the sculpture survey previously to this thesis (see appendix, p. xviii – xxii).

The sculpture is carved out of a single log of wood with some additional wooden components (see appendix, p. xxi).
It seems that the collar of the dalmatic was carved separately and attached to the sculpture, probably to facilitate the carving. The collar is put together out of two pieces as a vertical joint on the back of the collar between the the left and the right side can be found. Moreover a wooden wedge was inserted between the collar and the neck of the figure.
Both hands were made separately. This can be seen at the joints around the wrists and at a joint between the fingers of the left hand and the lifted gown. Adding the hands after carving them facilitates the process of carving.
Furthermore there is a quadrangular insertion at the front of the sculpture's left shoulder. The reason why this insertion was made couldn’t be determined.
On the reverse of the sculpture a long vertical component is fixed to the middle of the lower half of the sculpture. This component covers a recess in the back of the main body where perhaps a part of the wood was removed to prevent the wood from cracking.
Another additional component can be found on the right side of the sculpture, from the bottom up to the undergarment.
Moreover there are six partially wedge-shaped insertions in the base of the sculpture.
All of the components described, with exception of the vertical component at the back, are supposedly just fixed with an adhesive perhaps in combination with wooden dowels, however no evidence of wooden dowels could be found by investigation of the surface. Only the vertical component on the reverse is fixed in addition to adhesive (adhesive residue can be found) with two nails what was confirmed by the existing X-Ray image.

There is a circular shaped hole (diameter: ~ 25 mm; depth: ~ 100 mm) in the middle of the base, most probably linked to the circular dowelled hole (diameter: ~ 20 mm) in the calvaria of the head. Both derive presumably from the fixing to the carver's workbench during the making of the sculpture.

In some areas a woven fabric can be found on the wood under the ground. It was most likely applied to cover joints or other disruptions in the wooden structure. (see appendix, p. xxiv, xxvi)

On the front of the sculpture four small holes can be found, two located on the chest and two on the collar, one on each side. The presence of these holes and their arrangement may be an indication of a fixture of four now missing components. These could have been some added gemstones or pearls.

The sculpture also displays two holes in the middle of the back. In one of these the remains of a broken nail or screw are visible. These holes seem to originate from a former mounting of the sculpture, perhaps to secure it during display.

2.2 Wood identification

Identifying the wood species can help to locate the sculpture to a specific region as there were different trends and preferences in using particular wood species for carving sculptures in different regions and of course the availability of diverse wood species was in some regions higher than in others. Moreover the identification of the used wood can also help to allocate the sculpture to or to separate it from probable figurative groups of sculptures of similar style on the assumption that wood employed would be from the same or similar species.

For the identification of the wood species sampling of the wood is necessary. Ideal would be a sample of about 10 mm length that contains at at least two growth rings in depths or width.[15] From these samples thin slices of each anatomic section (transversal, radial and tangential) are cut for the identification of the wood species

15 On the recommendation of Dr. Diplom-Restauratorin Isabell Raudies.

by examination under the light/optic microscope.
The microscopic identification of wood is based on observations of characteristics in the wood anatomy, such as the growth rings, resin canals, vessel (pores), wood rays, fibres, tracheids and parenchyma.[16]

To minimise intervention into the original material it was decided to first try to obtain the needed wood sections directly from the sculpture as all of the three anatomic sections required for identification could be accessed directly. For the sampling a sharp flexible razor blade was used to accomplish cutting the wood sections. The cut surface was moistened with a drop of water.[17]

The samples were taken in Glasgow, Scotland, embedded and packed for transport to Munich, Germany, for the analysis at the Technische Universität München (TUM; *Technical University of Munich*) for reasons of availability of required materials, literature and equipment. The samples were embedded in Meltmount™ (refractive index: 1,662)[18], between a glass slide and a cover slip for secure transport from Glasgow to Munich. Previously to the embedding the samples were dehydrated by putting them first in pure ethanol, than in ethanol/xylene 1:1 and last in pure xylene[19], each time for about 10 minutes.[20]

The microscopic examination of the wood sections identified the wood of the sculpture's body to be *spp. populus* from the *salicaceae* family (see appendix, p. xcii f.). The exact *populus* species cannot be determined through microscopy on the basis of the wood anatomy.[21]
The wood anatomic features of the genera *populus* and *salix* (also from the family of the *salicaceae*, and not distinguishable by species by the microscopic wood anatomy) are quite similar; the only distinguishing feature between both is the homogeneous wood ray of the *populus* and the heterogeneous ray of the *salix* genus. A homogeneous ray consists in the radial section only of lying cells; in a

16 Grosser 2003, p. 13–40.
17 Grosser 2003, p. 50.
18 Meltmount™ 1,662 (thermoplastic mounting media).
19 As pure xylene was not available 'Xylene 96%, pure, mixed isomers with ethylbenzene' was used instead.
20 On the recommendation of Diplom-Restauratorin Isabell Raudies.
21 Grosser 2003, p. 176 f.

heterogeneous ray the margin cells of the ray are different from the lying internal cells and of a square or upright shape.[22]
Although the investigated wood sections of the sculpture 50/30 showed homogeneous wood rays and therefore were identified as *spp. populus* it cannot be fully ruled out that the sculpture may be made out of wood of the *salix* genus, as it sometimes may happen that the margin cells of the *populus* are more of a square shape, just as the margin cells of the *salix* may be occasionally absent.[23]

2.3 Examination of present fabric and fibre identification

Presence of textile under the surface decoration is another characteristic of the sculpture. This can also help to allocate the sculpture as it can be assumed that sculptures that were made in the same workshop to the same time for the same purpose are likely to have similar construction techniques. The examination of the textile and identifying the used fibres can help to separate the sculpture from or allocate it to other sculptures of a similar style where fabric applications can also be found.

Most parts of the areas where fabric could be found are still covered with paint layers and/or ground as well as the textiles are still intact. Thus not every detected fabric could be sampled without destroying intact surface decoration or harming the unscathed textile. Therefore samples where taken from two areas where the layers of paint and ground were that far damaged that the fabric was exposed and where the fabric itself was damaged so a piece of thread could be cut off the frayed rim of the textile.

In the areas where the fabric is exposed or at least the structure of the textile could be seen the applied fabrics have a plain weave, also called linen weave.
The weave density of the individual fabrics could not be identified as not enough textile was exposed. Only the piece of fabric on the right side of the back of the sculpture near the bottom could be assessed that far that the weave density is assumed to be between 12 to 13 threads in each direction.

22 GROSSER 2003, p. 176 ff.
23 SCHOCH / HELLER / SCHWEINGRUBER / KIENAST 2004, *Salix alba L.*, *Populus alba L.*

Both yarns of the fabric observed at the exposed textile at the back of the collar are twisted in a Z direction[24].

Small pieces of some fabric threads were removed under microscopic magnification, holding the yarn with tweezers and separating the samples from the woven fabric with a scalpel or small scissors. The samples were then untwisted and divided into their individual fibres under the stereo microscope. Preliminary to the microscopic identification several of the fibres were embedded between a glass slide and cover slip using Meltmount™ 1,662 as embedding medium[25].

For the analysis under the optic microscope the refractive index relative to the embedding medium, the morphological characteristics of the fibres in transmitted light and the optical properties of the fibre under cross-polarized light are decisive. The identification characteristics under cross-polarized light are the birefringence of the fibre, the position of extinction and the Herzog test.[26]
Birefringence in fibres means the fibre has different refractive indices in different directions of the fibre. In 'optical positive' fibres the refractive index parallel to the fibre's longitudinal axis is bigger than perpendicular to the long axis. In 'optical negative' fibres it is vice versa.[27]
The 'Herzog test' is a optical test developed to differentiate flax fibres from hemp fibres as they have similar morphological characteristics. The test is based on the specific sequence of interference colours by rotating the fibre under cross-polarizes light with interposed First Order Red Plate (also: retardation plate). The fibres of flax, nettle and ramie are showing then a orange interference colour (first-order orange) in the vertical (north to south) position and a blue interference colour (second-order indigo) in the horizontal (east to west) position. In contrast hemp and jute fibres are showing a blue interference colour in the vertical and a orange interference colour in the horizontal position.[28]

24 Twist in Z direction means that by holding the thread upright the fibres of the yarn run parallel to the aslant middle piece of the letter Z. The opposite of a twist in Z orientation is twisting in S orientation, where the fibres run parallel to the aslant middle piece of the letter S.
25 WÜLFERT 1999, p. 264.
26 WÜLFERT 1999, p. 275–290.
27 With the usage of Meltmount™ with a refractive index of 1,662 a good optical contrast can be achieved between the fibre and the embedding medium (WÜLFERT 1999, p. 284).
28 WÜLFERT 1999, p. 290.

The fibre samples were taken from the exposed textile at the back of the collar as this was the only spot were both yarns of the fabric could be accessed. In addition another sample was taken from the textile around the vertical component at the back of the sculpture to spot-check if the used fabrics are made of the same fibres.

The microscopic analysis of the fibre samples was carried out at the TUM, Germany, and resulted in the identification of flax fibres[29] for all tested samples. (see appendix, p. xciv ff.)

2.4 Surface decoration

The examination of the surface decoration was carried out macroscopic visually by eye and microscopically employing a stereo microscope. In addition, cross sections of samples taken from some specific areas offered more information about the layer sequence and the structure of different surface decoration areas. As the samples were mainly taken to investigate the top layer for the presence of soiling or discoloured coating material not every polychrome area was sampled.

The cross sections were examined under an optical microscope with reflected light of the Visible Light Spectrum (VIS) and the Ultraviolet (UV) spectrum. The examination of the samples in the VIS is needed to examine the layer sequence and colouration of the individual layers. Observation of the cross sections under UV light supports differing layers and helps to recognize (multiple) layers not visible under the VIS. Though the examination under the UV light cannot be used as a diagnostic tool, it may give some evidence for the usage of some substances and therefore can contribute to further investigation into used materials. Furthermore the examination under brightfield reflected light can aid to discern metal foils present in the cross-section.

The dark blackish layer that can be found on top of the surface decoration is obscuring the polychrome appearance of the sculpture and precluded the full examination of the sculpture's surface through the stereo microscope.

29 WÜLFERT 1999, p. 275, 281, 285, 288, 290.

2.4.1 Polychromy

It seems that on the entire sculpture a white coloured ground lies directly on top of the wood or on the fabric in areas with applied textile. The examination of the cross sections confirmed that observation. (see appendix, p. xlix – xci)

The hair of the sculpture is gilded. The examination under the stereo microscope indicated that two successive layers of gilding are at least in some areas present. In other areas it seems that the lower layers of gilding ground[30] plus gilding are partially or even fully missing.
The cross section of BC-50/30-CS-7 (see appendix, p. lxxiv f.) shows the following layer sequence: Starting from ground to surface a layer of white ground can be seen. An orange coloured layer (under the stereo microscope this layer has a greenish to yellow colouration), probably a gilding ground[31] with gilding on top is following. Over this gold layer, lies a likely multilayered layer package of white to brow colouration (through the stereo microscope a yellow to brown colouration). Followed by an orange to red coloured layer, most likely another layer of gilding ground, that is again followed by a layer of gilding. The top layer displays a blackish coloured layer (in conformity with the observed black layer covering the whole polychromy). Under UV light a slightly fluorescent layer can be seen in some areas beneath the black layer, what could give evidence that the black coloured layer is not simple accumulated dirt, but a (probably discoloured) coating.
Some assumption of the nature and extent of gilding and overpaintings on the hair can be made. The white to brown coloured layer lies in crevices between the damaged lower gilding layer what confirms the assumption that the gilding of the hair was once renewed, leading to suggest presence of over-paintings in other areas of the sculpture.

The tonsure is flesh coloured. Through the stereo microscope the ascertained layer sequence begins with a white coloured ground followed by a translucent yellow layer (probably the priming). On top of this follows a bright white coloured paint layer and a pink coloured paint layer displaying distinctive paint brush

30 See glossary.
31 See glossary.

strokes. On top, a similar dark black layer as recorded for other sections was observed.

In the lighter flesh coloured area of the sculpture's face a white ground layer was noted, followed by a yellow translucent layer (probably the priming layer). Then a white coloured paint layer followed by a pink coloured layer, corresponding to the cross section analysis of the tonsure.
The cross-section BC-50/30-CS-6.1 (see appendix, p. lxviii ff.), taken from the area of the temple on the left side of the face displaying red coloured paint application, contradicts this observation. At the very bottom a white ground is visible, consisting of a minimum of two layers. On top of it is a translucent and fluorescent layer (under UV light), probably the priming. Then a thin layer of light red colouration with deep red coloured particles is following under a white but in comparison with the ground pink appearing layer with individual big particles. Above lies a translucent deep and dark red coloured layer containing big particles. Another white layer with pink hue enclosing small red particles and a second successive red coloured layer with small red opaque particles follow. Just as detected for the other samples a dark blackish 'soiling' layer on top is present. The observed multilayer build-up and the rough boundary line between the first red layer and the following whitish layer suggests that the upper two paint layers are an overpainting.
Obtained data from qualitative and semi-quantitative spot analysis of elemental composition of the ground layer in the sample BC-50/3-CS-6.1 through SEM-EDX[32] showed measurements for magnesium ('Mg') and calcium ('Ca'), probably as part of a calcium magnesium carbonate like dolomite ('$CaMg(CO_3)_2$' or '$CaCO_3 \cdot MgCO_3$'). This leads to the assumption that the ground is most likely a chalk ground comprising dolomitic limestone.

The layer sequence of the decorative surface area of the hands display a different, more whitish colouration in comparison to the face. Examination of the layer sequence under the stereo microscope provides evidence for a two-layer build-up with one layer of white paint lying over a layer of white ground.

32 Scanning Electron Microscope – Energy-Dispersive X-ray spectroscopy.

Close examination of the sculpture provided evidence of an applied relief textile applied over the main surface area of the dalmatic (see **2.4.2 Applied relief textile**). On a vertical strip of the damlatic at the back of the sculpture, where no applied relief textile is present, evidence of polychromy has been noted, also on the inside of the gown. Evidence of gilding has been noted on the collar, the hem and the openings of the sleeves.

The area with polychromy on the back the sculpture (see appendix, p. xlix f.; sample BC-50/30-CS-1) displays a sequential layer structure: lowermost lies a medium-rich and therefore bright fluorescent layer under UV light. Purpose of this layer is probably adhesive medium or sealant of the wood surface prior to application of ground. The ground layer contains coarse grains and appears white. It is probably multi-layered. It is assumed that a priming layer was applied on top of the ground, in the cross-sections only represented by a bit darker and a bit more translucent area. The next layer under microscope observation displays an orange to red colouration, which under UV light fluoresces yellow, a potential indication for a medium rich layer. The majority of the enclosed particles are showing a deep red colouration. The top surface layer appears dark black and a minor degree of fluorescence has been detected. It seems like the black layer has partially a interlayer that displays no fluorescence under UV light.

The surface of the hem of the dalmatic, the collar and the openings of the sleeves display burnished gilding. Examination through the stereo microscope indicates a yellow to orange colouration of the poliment of the collar whereas the poliment of the hem is of a red colour. Along all gilded areas a decorative line of bright yellow colouration has been noted on top (see mapping; appendix, p. xxiii, xxv).

The inside of the dalmatic has a blue colouration. Analysis of a cross section from a small detached fragment (BC-50/30-CS-13) displays the layer sequence from ground to surface: a layer of white coarse-grained particles as the ground, above a pigmented layer of yellow brown colouration with blue pigment particles is visible. The upper layer is mixed-grained, varying in regards to the intensity of the blue colouration of the particles. The behaviour of this layer during polishing the cross section, as particles were breaking out of the surface, implicates that the paint medium of this layer has low adhesive qualities affecting the condition and cohesive strength of the paint layer. No evidence of an obscuring dark black layer

could be detected in the cross section of the blue inside of the dalmatic. This observation was backed up by the examination of the surface through the stereo microscope.

In the cross section of the alb (BC-50/30-CS-2; appendix, p. li f.) the lowermost layer is a thick white coloured ground layer, coarse-grained with some huge particles. The following thinner layer is of a brighter white colouration and has smaller particles. Under UV light it has a more yellowish fluorescence compared to the layer below. This layer could be either a white paint layer or another smoother layer of ground. Above lies a very thin greyish, slightly translucent layer, that does not show fluorescence under UV light. An inhomogeneous layer of greyish colouration is following, with darker smaller particles and bigger lighter (nearly white) particles. On top lies a grey to black coloured layer, probably correlating to the obscuring dark blackish layer on the whole surface of the sculpture. This layer seems to be partially medium-rich, as it contains some more fluorescent spots or lines under UV light. As the fluorescent areas are lying mostly at the bottom of the blackish layer it could be possible that they form a separate medium-rich layer. Under the stereo microscope the two upper layers with grey to black colouration appeared as one and could not be differentiated.
The hem of the alb is gilded. Examination of the layer sequence through the stereo microscope revealed a build-up starting with a thick layer of white ground followed by a thinner and a bit brighter white coloured layer, similar to the layer sequence of the rest of the undergarment. Over these a thin orange to red coloured layer followed by gilding are present, what leads to the conclusion that the red layer is probably a gilding ground. On top lies again a dark blackish layer.

The observed layer sequence of the base of the sculpture consists of a white coloured ground layer, followed by another white layer (by examination through the stereo microscope it could not be determined if it is another layer of ground or if it is q white coloured paint layer). Above lies a slightly translucent paint layer of green colouration. The obscuring black coloured layer forms again the top layer.

The shoe showed a simple build-up under the stereo microscope. Here a single

red coloured paint layer is lying over the white ground layer. Again, the paint layer is covered with a dark black layer.

2.4.2 Applied relief textile

Close examination of the dalmatic provided evidence of an applied relief textile as surface decoration. (see mapping; appendix, p. xxiv, xxvi)
Observation through the stereo microscope and examination of cross sections (BC-50/30-CS-3 and BC-50/30-CS-4.2; see appendix, p. liii ff., lx f.) indicated that there are two layers lying under the applied relief textile: lowermost a white coarse-grained ground layer followed by a brownish orange coloured and mixed-grained layer whose orange particles have a deep dark red colouration under UV lighting.

The appearance of the relief mass[33] visual by eye and under the stereo microscope indicates the mass consists at least partially of wax. Observed characteristics such as translucency, bright fluorescence and structural composition of the relief mass support this observation. Furthermore the relief mass could also contain resin with or without a drying oil as an admixture[34]. Data obtained from SEM-EDX spot analysis on the cross-section BC-50/30-CS-3 showed a detection for lead ('Pb') (about 40%) as a component of the relief mass (see appendix, p. liii ff.). This may support the assumption that oil was used as a admixture as lead, e.g. in the form of lead white, was used as a drying agent for oils.

Investigation of the applied relief through the stereo microscope provided evidence of silver coloured metal foil used for the applied relief textile (see appendix, mapping, p. xxvii). Most areas additionally show a dark grey to black coloured layer lying on top of the relief mass. By investigating the cross-section of sample BC50/30-CS-3 (see appendix, p. liii ff.) the observed dark layer on top of the relief mass appeared to consists of two separate layers. The lower one, with a greyish black appearance by macroscopic examination, was identified as a silver coloured

33 See glossary.
34 See: WESTHOFF / HAHN 1996, p. 27.

metal foil. The deep red colouration of the metal foil under UV light indicated that the foil could be made out of tin. With a SEM-EDX spot analysis the metal could be clearly identified as tin (Sn). Oxidation of the tin would explain the dark greyish black appearance of the layer through the stereo microscope. Additionally a black coloured layer was detected in the cross section directly on top of the metal foil, that is assumed to be some sort of soiling.

Analysis of samples taken for cross sections also provided evidence that some parts of the tin-relief textile were accentuated with a red glaze. The cross-sections BC-50/30-CS-9, BC-50/30-CS-10, BC-50/30-CS-11 and BC-50/30-CS-12 (see appendix, p. lxxx ff.) are all displaying a red translucent to transparent coating over the metal foil.
UV lighting reveals that this coating consists in some of the samples of two layers: in BC-50/30-CS-9 a layer in the thickness of the tin foil with a brownish translucent colouration under UV light lies over a thin layer with light orange fluorescence. BC-50/30-CS-11 shows a bright but pale orange fluorescent layer in the thickness of the metal foil over a layer with a darker orange fluorescence including red fluorescent particles under UV light. In BC-50/30-CS-12 a pale red to pale purple fluorescent layer a little bit thicker than the tin foil lies over a thinner, orange fluorescent layer. Only the cross-section BC-50/30-CS-10 shows under VIS a thin single-layered and red coloured coating with a faint (white or pale orange) fluorescence under UV light.
It seems as if the thin orange fluorescent coating layer directly over the tin foil matches in the individual samples and is most likely an authentic layer. To what extent the other described glaze layers are original and correlate with each other could not be cleared so far. However there is evidence that the upper red glaze in sample BC-50/30-CS-9 does not derive from the same period as the tin foil and thin glaze layer underneath since this glaze encloses parts of the broken tin foil and lies directly on the metal foil in areas where the thin lower coating layer is missing.

Furthermore investigation of three samples (BC-50/30-CS-8.1, BC-50/30-CS-9 and BC-50/30-CS-12) provided evidence for a layer of wax lying over the tin foil.

Observation of cross-section BC-50/30-CS-12 recorded this mass in the crack of the red glaze suggesting that the layer was not applied until the glaze got damaged and is therefore in all probability not an original layer.

BC-50/30-CS-12 is also showing another layer lying on top of the upper ceraceous mass. This layer is transparent and nearly colourless, above a thin grey soiling layer is visible.
The cross-section BC-50/30-CS-11 is showing a more complicated layer sequence where two layers of tin foil can be found. The upper metal foil derives probably from a overlapping of the applied relief textile as the sample was taken from the armpit where overlapping of the application can be expected. Yet it could not be clarified where the thick brownish layer on top and the ochre coloured layer between the upper metal foil and the red glaze derive from.
The layer sequence of cross-section BC-50/30-CS-10 deviates partially from the other samples. The sample was taken from the applied relief textile where a golden coloured metal foil could be observed through the stereo microscope. Over the already described layer build-up (brownish orange coloured layer, waxy relief mass, tin foil, red glaze) lies an opaque light ochre coloured layer that is not fluorescent but appears brownish under UV light. On top two small spots of golden coloured metal leaf can be seen in the cross section. Therefore the ochre coloured layer is probably a gilding ground. It seems that the golden metal leaf was applied on a layer of adhesive with a dark black colouration in the VIS and no fluorescence under UV lighting. On top of the gilding lies a partially quite thick dark black layer that contains some small red particles. However it could be possible that this black layer consists of two separate layers: a dark black coloured one with no visible particles and dark black coloured layer including small red particles on top. This build-up leads to the conclusion that the tin-relief textile was once overpainted by applying a gilding.

All this evidences that the outside of the dalmatic was once decorated with a tin-relief textile that was applied over a brownish orange coloured gilding ground lying on top of a white ground layer. In all probability the applied relief was made of a casting from a mould using thin tin foil and wax as relief mass. It is possible that

the mass was filled into the mould in more than one layer (see cross-section BC-50/30-CS-3). After the relief unit was taken out of the mould it was not gilded but applied in its silver coloured form onto the sculpture. Parts of the applied relief were accentuated with a red glaze.
As outlined above the cross-sections also indicatinge that at least parts of the tin-relief textile were once overpainted or made over.

The size of the relief units could not be determined. The pattern of the tin-relief textile consists of six to seven lines ('threads') per cm with of approximately 0.7 mm thickness.

For the investigation of the pattern photographs with grazing light were taken (see appendix, p. xxx ff.). Anyhow only a small part of the relief pattern could be reconstructed (see appendix, p. xxix) since the applied relief is overall heavily damaged and only little of the original ornament is still intact.
According to Record Card[35] the sculpture could be located to South Germany or Austria. Therefore the reconstructed pattern part was compared to other applied relief textile patterns from that region, that can be found in WESTHOFF (1996)[36] and FRICK (2003)[37]. No positive match could be found.

35 Record card of 50/30.
36 WESTHOFF (et al.) 1996.
37 FRICK 2003.

Chapter 3: Condition and conservation history

3.1 Condition

The sculpture is overall structurally sound and stable. Particularly on the forehead, the left arm, the bottom and base of the sculpture evidence for woodworm infestation (inactive) in the shape of round flight holes could be noted. The wooden structure of the sculpture exhibits in some areas physical damage. Thus two fingers of the figure's left hand are broken off and missing. Damaged areas are: two spots on the edge of the dalmatic on the right side of the sculpture, a part of the back of the collar and a the right side of the base. Additionally a fragment fitted into the front of the base is loose at one side. The surface decoration is heavily damaged in some areas, particularly on the alb, the left side of the face and on top of the head, so that the wood is exposed. The polychromy around the vertical component at the back of the sculpture is cracked and damaged. Furthermore, the sculpture shows various areas of loss in the surface decoration. The overall surface of the sculpture displays a dull dark and obscuring brown to black colouration.[38]

In the cross section of the samples it can be seen, that a thin dark layer of blackish colouration is lying on top of the surface decoration. This soiling layer is probably either a discoloured coating and/or accumulated dirt and is obscuring the appearance of the sculpture to an extent that the colouration of the polychromy and even the presence of the applied relief textile cannot or just hardly be seen when the sculpture is on display.

The flesh coloured areas of the face and the hands as well as the tin-relief textile have a less dark appearance compared to the rest of the sculpture. By close examination it can be seen that the surface of these areas shows traces of mechanical cleaning (see photographs, appendix, p. xv ff.). It can be assumed that the dark soiling layer was mechanically removed in these areas leading to the damage on the subjacent paint layers.

38 Sculpture survey: appendix, p. xviii ff.

The tin-relief textile is heavily damaged. The impairment of the relief lines results in the illegibility of the depicted pattern/ornament in large parts. In some areas the lines ('threads') of the relief are even missing completely. Only at the back of the sculpture the applied relief remained in a state where few parts of the original pattern design can be still identified. (see photographs, appendix, p. xiv ff.)
The examination of the cross sections has showed that the dark grey to black layer on top of the applied relief textile consists out of the tin foil of the applied relief plus a dark coloured surface soiling. Thus it appears that in all areas where no blackish layer is present the tin foil is lost. Furthermore it seems that in areas of the applied relief textile without pattern lines the tin foil is completely missing as the colouration of the dark surface layer there differs from the dark and dense layer on the pattern lines. Furthermore no tin foil is present in the samples taken from these areas. The same applies for the red glaze identified in some of the cross sections that was most probably lying on areas without pattern lines and got lost together with the tin foil.

3.2 Conservation history and alterations

Only few written information according the conservation history of the sculpture can be found.

Sir William Burrell noted in his Purchase Book that the "*The hands [are] restored*"[39].

Under the section 'Condition' in the 'Conservation Record Card' the following is recorded: "*Jan '85: Polychromy + gesso layer – dry + flaking in places – surface has become blackened. Hands restored. Wedge shaped insertion in plinth. Back of the collar broken – wedge inserted between the robe and neck.*"[40]
The same information can be found in the 'Record Card' of the sculpture under 'Condition and Restoration': "*The hands restored; The plinth seems to have been partly renewed with wedge shaped insertions, the back of the collar is broken and a wedge has been inserted between the robe and the neck in this part*". And under

39 Purchase Book 1936, p. 59.
40 Conservation Record Card of 50/30.

the point 'Description, notes, etc.' is recorded that "*there are remains of darkened paint in most areas.*"[41]

According to the 'Conservation Record Card' the only conservation treatment the sculpture was subjected to was in the year 1991 and comprised "*removing of dirt from the surface*" with Shellsol T, the consolidation with Paraloid B72 and "inpaintings of damaged areas"[42].

Beside these written information, more evidence can be found by examination of the sculpture. Thus the comments on the restored hands seems to be verifiably as the hands are of a different colouration as the sculpture's face. Moreover the palms are not fully covered with paint and the left hand displays residue of an adhesive. This all leads to the conclusion that the hands are restored or even a later addition.
Two modern nails were used to reattach and fix the broken vertical component on the back of the sculpture. Adhesive residue around the crack also gives evidence of a previous 'treatment'.
It could not be cleared if the inserted components in the base of the sculpture are later repairs or authentic insertions as the surface is obscured by a dark colouration. However the wood can be observed from below and has a slightly different appearance as the main wood the sculpture is made of. The adhesive used to glue the components to the base has a light fluorescence under UV light.
More evidence for man-made modifications is given by the examined cross section as described in **2.4.1 Polychromy** and **2.4.2 Applied relief textile**. It can be assumed that the face, the hair and the tin-relief textile were at least partially overpainted respectively made over. As this thesis does not include further research into the specific build-up of each surface decoration area it could not be clarified to what exact extent the sculpture was overpainted.

41 Record card of 50/30.
42 Conservation Record Card of 50/30.

Chapter 4: Development of a feasible cleaning strategy

Along with the study into materials and techniques the aim of this thesis was to devise a feasible cleaning strategy to remove the obscuring dark layer on the sculpture. This would reveal the sculpture's surface decoration (polychromy and applied relief textile) and help to improve the perception and interpretability of the sculpture.

The reasons for developing a cleaning strategy are therefore primarily of an aesthetic derivation. Nevertheless it should not be underestimated that cleaning can also function as a preventive treatment for the reason that people do more care for artworks in good condition.

4.1 Definition of cleaning and soiling

4.1.1 Soiling

Generally soiling can be defined as any material, organic or inorganic, that has a negative impact on the stability, appearance, flavour or smell of a manufactured article. According to this definition soiling is matter that is out of place.[43]

As soiling can consist of diverse materials and is mostly inhomogeneous and very complex in its composition a systematic classification of soiling is hard to achieve. To make matters worse soiling and patina – a purposefully applied layer of various materials (often pigmented animal glue[44]) – cannot be clearly distinguished from each other in many cases as the transition between patina and soiling can be seamless[45].

JÄGER (2006) makes the following approach to classify soiling:

- Soiling deriving from air pollutants ('airborne pollutants'),
- Incidentally or purposeful applied substances, e.g. signs of handling and usage or materials of previous treatments,
- Substances introduced by biological activity,

43 SCHEIDEMANN 2006, p. 229.
44 CREMONESI 2006, p.36.
45 JÄGER 2006, p.14.

- Chemically caused changes in the material (e.g. corrosion reactions) or segregation from the object (e.g. 'blooming').[46]

Disregarding the type of material another categorization can be made after the degree of surface soiling:

- Purposefully applied artificial patina,
- Solid matter deposited during storage,
- Dirt as matter applied over the time,
- Changes in the surface material by extraneous cause.[47]

Soiling and patina, if not an essential and original part of the object[48], are sings of ageing and can therefore be part of the artworks authenticity. But soiling as well as patina can also have negative influence on the authenticity of an artwork as they can distort and obscure the artistic and formal aspects as well as the content of the object. Furthermore the artwork can become optically and aesthetically unsatisfactory.[49]
To evaluate a present surface soiling and to distinguish between a patina that should be preserved and a soiling layer that can or should be removed an in depth investigation of the object is essential. Besides the significance of the objects' history and the original appearance compared to the aged and soiled surface, the physical composition and the objects properties and sensitivity have to be considered.[50]

4.1.2 Cleaning

Cleaning in general can be defined as the “separation of one material from another”[51]. In a more precise definition cleaning can be classified in three categories:

46 JÄGER 2006, p. 14.
47 MAIER 2011, p. 177.
48 SCHEIDEMANN 2006, p. 228 ff.
49 JÄGER 2006, p. 14.
50 *Ibid.*
51 WOLBERS 2004, p. 56.

- The removal of soil bound to or accretions[52] from the object's surface,
- Removing of an altered patina (exceeding deposited dirt or soil)
- Thinning or (partial) removal of unwanted layers of varnish, overpaintings, and so on. [53]

Cleaning, particularly the removal of altered patinas or overpaintings (etc.), is normally more driven by aesthetically reasons than by the preservation of the object.[54] Especially for that very reason one must be aware that cleaning is an irreversible procedure. Thus, a cleaning treatment should only be carried out if "the benefits outweigh the risks of damage to the object".[55]

4.2 Objective of the cleaning treatment

Examination of the surface through stereo microscope and by cross-sections gave evidence that the black coloured obscuring soiling layer on the sculpture polychromy most probably consists of an accumulated dirt and a discoloured coating or artificial patina indicated by fluorescence under UV light suggesting a medium-rich layer (see: **2.4.1 Polychromy**).

The objective of the cleaning treatment was to remove this obscuring and dark layer on the surface to reveal the sculpture's polychrome surface decoration. The aim is to reveal the sculpture authentic surface so the formal and artistic aspects as well as the intended meaning can be seen.

The aim of every cleaning procedure is to (at least partially) dissolve and to remove the material without harming the object's surface that has to be preserved. Therefore it is essential to find a cleaning method/strategy that works very selective.[56]

52 KHANDEKAR 2004, p. 1.
53 CREMONESI 2006, p.32.
54 KHANDEKAR 2004, p. 1.
55 CAPLE 2000, p. 98.
56 JÄGER 2006, p. 20.

4.3 Cleaning tests

4.3.1 Preliminary considerations

To find a feasible cleaning strategy cleaning tests have to be carried out. Preliminary to the cleaning tests a profound investigation of the sculpture's surface and layer build-up has to be accomplished. The surface needs to be examined through the stereo microscope and by cross-section to get a insight into the surface structure. Examination of the surface under UV light and FTIR[57] analyses could help to gain more information for developing a suitable cleaning strategy.

There needs to be awareness that every cleaning treatment irrespective of the material to be removed and of the used method will stress the object[58] and will very probably unintentionally remove original material that provided evidence of the object's past[59].

All observations during the cleaning test as well as the results have to be documented very thoroughly as everything noticed is helpful to determine an eligible and applicable cleaning method. Moreover, as every cleaning treatment is an iterative process evidence recovered during the cleaning procedure (e.g. regarding the layer build-up of the surface decoration or the composition of the material that is to be removed) has to be recorded and documented. Therefore all cleaning tests should be carried out under a stereo microscope.

Last but not least one must be aware that in the case the results of the cleaning tests lead to the conclusion that cleaning of the sculpture is not feasible at all or just not passable at the given time and with the given materials and tools it is still an important and acceptable conclusion. The preservation of the sculpture has always to be the top priority.

57 Fourier Transform Infra-red Spectroscopy; used to analyse pigments and organic materials, e.g. binders (see: CAPLE 2000, p. 81 f.).
58 PIETSCH 2005, p. 170.
59 CAPLE 2000, p. 97.

4.3.2 Methodology of the cleaning tests

The cleaning tests with solvents and aqueous solutions are based on the system described by Annik PIETSCH.[60] She developed a method of systematic cleaning tests mainly predicated on the studies of Feller, Wolbers and Masschelein-Kleiner.[61]

The first step in this progressive method is to identify the solubility range of the substance that should be dissolved. The solubility range is the region in the solvent and solubility triangle – a triangular graph introduced by J. P. TEAS in 1968 (hence 'Teas chart') – in which the material is soluble or at least swellable. The Teas chart uses a set of three parameters, *fd*, *fp* and *fh,* to characterize a solvent or the solubility range of a substance; *fd* stands for the percentage of Dispersion forces, *fp* for the percentage of Dipole-dipole forces and *fh* for the percentage of Hydrogen bonding forces. To determine the solubility range of a substance 12 to 24 different solvents (mixtures) varying in their Teas parameters are tested for their ability to dissolve the substance.[62] The cleaning tests are started with the most unpolar solvent, the one with the highest *fd*-value, subsequently testing solvents with higher polarities, having lower *fd*-values but higher *fp*- and *fh*-values. A list of all 24 test solvents can be seen in table 01 in the appendix (p. cii).

It should be noted that the first step of PIETSCH's[63] cleaning tests is very similar to initial cleaning tests WOLBERS[64] describes in his cleaning methodology. The difference is that WOLBERS uses 14 solvent mixtures made out of three solvents, while PIETSCH uses 24 solvent mixtures made out of six different solvents. It may first be seen as an advantage that WOLBERS only uses 14 different solvents instead of 24 for the initial cleaning tests, but it must be noted that the solvent mixtures of PIETSCH cover, as they also include water as a test solvent, a bigger area in the Teas chart in comparison with the WOLBERS test solvents. Furthermore, if testing of all 24 solvents should not be feasible, it is possible to start with only 12 of the

60 PIETSCH 2005, p. 155 ff.
61 PIETSCH 2005, p. 155, 163, 165.
62 PIETSCH 2005, p. 120, 155.
63 PIETSCH 2005, p. 155 ff.
64 WOLBERS 2004, p. 57 f.

solvents (test solvents #1 to #12) for initial cleaning tests. Depending on the results, more precisely on the determined *fd* value, some more of the remaining solvents (test solvents #13 to #24) can be selectively tested to identify the solubility of the substance as exact as possible.

The first step of PIETSCH's methodology helps to distinguish the solubility range of the substance that should be removed. If one of the test solvents can selectively dissolve the material it can be used for the cleaning procedure[65]. If the substance is swellable or slightly soluble in water, further tests involving aqueous methods are carried out (v.i.). If neither water solubility could be detected nor a feasible solvent could be found to dissolve the material some more solvents can de tested with Teas parameters between the parameter of the already tested solvents to determine the solubility range of the substance as close as possible. If non of the test solvents could actually dissolve the substance, but etching or swelling could be observed, further cleaning tests are performed modifying the solvents while always staying in the detected solubility range. The same applies if the solvent in the detected solubility range is too strong and attacks not only the substance that should be removed.[66]

The modification of the solvents starts with varying the solvent strength (= step 2). A solvent that is 'too strong' does not operate selective enough and dissolves more than intended. A 'too weak' solvent cannot fully dissolve the material irrespectively of the application time. In both cases the strength of the solvent has to be modified, what can be achieved by exchanging the solvent or one of the solvents of the mixture by another solvent of the same chemical class that has a higher respectively a lower Snyder polarity parameter P`[67], a measurement for the strength of a solvent based on all intermolecular forces (excluding dispersion forces) that are relevant for the interactions between the solvent and the solid.[68] If a stronger solvent is needed and the exchanging of solvents chosen by their P`

65 Note: If possible toluene and particularly cyclohexane should be exchanged for the final cleaning process as both are harmful to health. Instead of cyclohexane white spirit should be tested; for exchanging toluene white spirit or xylene can be tested (PIETSCH 2005, p. 156).
66 PIETSCH 2005, p. 157 f.
67 The Snyder polarity parameter ranges between 0 for aliphatic hydrocarbons and 10.2 for water.
68 PIETSCH 2005, p. 122.

parameter does not lead to a satisfactory result amounts of very strong solvents with similar Teas parameters as the determined in the first step – normally diacetone alcohol, dimethylformamide, benzyl alcohol, *N*-methylpyrrolidone or formamide are sufficient – can be added to improve the solubility, whereas the amount should not exceed 50 % of the solvent mixture.[69]

If it is not possible to find a solvent that selectively dissolves the substance to be removed by identifying the Teas parameters and varying the solvent strength the next step (= step 3) is to modify the application time and/or method of applying the solvent. To alter the application time either a more or less volatile solvent can be added or the method of application can be changed.[70]
A solvent can be 'too fast' in two ways: either it is too volatile and does not stay long enough on the surface (what can cause residues on the surface or condensation effects) or the solvent penetrates into lower layers before completely dissolving the substance that should be removed. In this case it can be tested to use (in addition or as a replacement) a solvent with a bigger molecular mass that is less volatile, like a solvent of the same homologous series (e.g. propanol instead of ethanol) or a less volatile solvent with similar Teas parameters. Besides it it also possible to retain the solvent using it in a poultice or as a gel.[71]
A solvent that is 'too slow' needs a longer application time to dissolve a substance. However, extending the application time can cause penetration into lower layers that could be harmed by the solvent. Changing the application method by using a poultice or a paste can help on the one hand to extend the application time and on the other hand to retain the solvent on the surface.[72]

In cases the substance to be removed is more intractable and hardly dissoluble small amount of acids or bases can be added to the solvent (= step 4). In conservation mostly acetic acid, formic acid and ammonia or amines (= derivatives of ammonia) are used. The characteristics of these acids and bases are the deep penetration, a high retention, an average to high polarity and a high dissolving

69 PIETSCH 2005, p. 158 f.
70 PIETSCH 2005, p. 159.
71 PIETSCH 2005, p. 159.
72 PIETSCH 2005, p. 159.

capacity. With the ability of protonation and deprotonation or in higher concentrations to chemically breaks bondings, they can change the solubility of a substance, allowing to dissolve primary insoluble material. Therefore acids and bases should be used very carefully and only in low concentrations (at most 10%). Acids and bases should only be used on closed surfaces to prevent penetration into lower layers and only if the direct contact with acid or base sensitive substances (e.g. pigments) can be ruled out.[73]

PIETSCH refers in the last step of her cleaning tests involving organic solvents to the test series developed by Masschelein-Kleiner (see table 03; appendix, p. cii). This series consists of 23 different solvent mixtures, some of which are raising concerns in matters of conservation, health and safety requirements. Therefore these solvent mixtures should just be used only in special cases if all the other testes methods did not lead to satisfactory results, but only if adequate safety precautions are taken.[74]

If the initial cleaning tests provide evidence that the material to be removed is swellable or slightly soluble in water, further test are carried out involving variable aqueous methods. This again is a stepwise process with the aim to improve the water solubility of the substance.[75]

In the first step the pH value of the water is adjusted as it influences the solubility of a substance and how selective the water dissolves material. The determination of the proper pH value is an empirical process using buffer solutions of different pH values, first beginning at pH 7 (= neutral) and descending in steps of 0.5 to pH 5 (acidic), then testing basic pH values above 7 until pH 8.5. The tested pH values from pH 5 to pH 8.5 correlate with the pH range binding media are stable in. Buffer solutions are used as they keep the adjusted pH value constant.[76]

If satisfiable dissolving of the substance still cannot be achieved the next step (=

73 PIETSCH 2005, p. 162 f.
74 PIETSCH 2005, p. 163.
75 PIETSCH 2005, p. 165.
76 PIETSCH 2005, p. 165 f.

step 2) is the addition of surfactants and wetting agents. These are low-molecular compounds exhibiting structural disparities as one portion is polar while another one is non-polar. Thus, these compounds are surface active influencing the properties of the solution containing them. They lower the surface energy of a liquid and therefore enhancing the ability of the liquid to wet and spread over surfaces.[77] In conservation wetting agents (or surface-active agents) are used to enhance the wettability of a substance. As wetting agents surfactants as well as other compounds (e.g. ethanol or methyl cellulose) can be used. In addition surfactants can be also employed as detergents to solubilise substances or to prepare emulsions of immiscible solvents. To use a surfactant as a detergent the *critical micelle concentration* (CMC) must be reached, a critical concentration of the detergent in solution where micelles, spheric molecule aggregates with the hydrophilic outer layer and a hydrophobic inside, are formed. The formation of micelles has impacts on the solution properties, giving aqueous solutions the ability to solubilise water-insoluble substances. In conservation only non-ionic surfactants should be used as they can be used in lower concentrations and have a lower tendency to accumulate onto original layers in comparison with ionic (anionic, cationic or zwitterionic) surfactants. As surfactants are non-volatile substances it must be assumed that residues of the surfactant will stay on or in the objects' surface layers where they can cause harm in ageing. For that reason surfactants should only be used if the employment is indispensable and unproblematic.[78]

In cases the modification of the aqueous solution did not enhance the cleaning efficiency of the water it could be considered to use acids or bases to solubilise the substance (= step 3). Acids and bases with pH values under pH 5 or over pH 8.5 are able to chemically break bondings and thus transform an insoluble substance into a soluble form. Preferably buffered solutions should be employed, however acids and bases can be used directly with awareness of concentration and strength. Here too, mainly acetic acid, formic acid and ammonia (better: ammonium salts) should be used. Though it must be always considered that there is a risk these substances harm the original materials of the object (e.g. pigments,

77 PIETSCH 2005, p. 131, 167, WOLBERS 2000, p. 27, 29.
78 PIETSCH 2005, p. 131, 135 f., 167.

binders, textiles, etc.) and should only be applied if if contact with these materials can be ruled out. [79]

The next step (= step 4) in modifying an aqueous solution would be the employment of complexing agents (= chelating agents[80]). Complexing agents have complexing properties as they bond metal ions. As they form soluble complexes with insoluble materials (e.g. inorganic substances, salts, corrosion or organic compounds containing metal ions), these materials can be removed. Since the objects often consist of the same or similar substances as the material that is to be removed the usage of complexing agents involves the risk of dissolving and harming the objects materials that have to be preserved.[81]

Of course, all these modifications of aqueous solutions can be, similar to the organic solvents, used in a poultice or in a gelled form if the application time needs to be extended or if the solution needs to be retained on the surface.

4.3.3 Practical accomplishment

A profound investigation of the objects surface and layer build-up is the bases for every cleaning treatment. In this case a profound investigation by stereo-microscope was carried out and samples were taken for cross-section investigation. Due to delivery problems of needed materials the embedding and thus the examination of the sample cross-sections could not be carried out preliminary to the cleaning tests.
However, it was decided to carry out cleaning tests as the empirical determination of a suitable cleaning method is inevitable. Even if a substance could be analytically identified the solubility range of that substance often cannot be clearly predicted, particularly as soiling materials consist most probably of various substances that could be cross-linked. Moreover, the theoretical solubility range of a substance is too unspecific to determine a feasible solvent just by analysing the substances exemplified by the overlapping solubility ranges of various binding

79 PIETSCH 2005, p. 168 f.
80 ASHLEY-SMITH 1992, p. 122.
81 PIETSCH 2005, p. 169.

medium groups. The determination of a suitable and selectively working solvent is only accomplishable by incremental cleaning tests.[82]

By examination of the surface area of the applied relief textile through the stereo microscope the extent of surface soiling could not be determined as it was not possible to clearly distinguish the upper two layers of black colouration as soiling or surface decoration. Furthermore in some areas red coloured particles as part of the black coloured layer on top could be observed, differing this layer from the soiling observed on areas with polychromy or gilding. Therefore it was decided only to perform cleaning test on the applied relief if more observation information clarifying the build-up could be acquired.

Preliminary to the cleaning tests loose dirt on the surface of the sculpture was removed under vacuum extraction using a soft brush. Beside the chemical cleaning tests described by PIETSCH[83], mechanical removal of the soiling employing a scalpel was tested. To keep the testing area and interference as small as possible first only the test solvents #1 – #12 were tested. Then, depending on the results only specific solvents from the series #13 – #24 with a similar *fd*-value to determined in first place were tested. First only initial cleaning tests were carried out (= determination of Teas parameters), further modifications should be tested afterwards. Non-contact methods (e.g. laser cleaning) were not available for the cleaning tests.

The cleaning tests were performed at the back of the sculpture since the black soiling layer to be removed was there present, too. This had the advantage that the test areas would not be visible during the display of sculpture. However, the tested spots could still be retouched if felt necessary. If cleaning tests on the back of the sculpture lead to a suitable solvent or cleaning method, selective cleaning tests should be carried out on the different surface decoration areas on the front of the sculpture to determine the suitability for these areas.

To get comparable results each solvent was tested the same way: a small cotton

82 PIETSCH 2005, p. 155, WOLBERS 2004, p. 65.
83 PIETSCH 2005, p. 155 ff.

swab dipped into the solvent and then rolled with one rotation over a blotting paper to accomplish a equal moisture of every swab. The cleaning test itself was carried out in the first test series in small parallel downward movements with a slowly rotating swab, all for 10 seconds. In the following test series the cleaning technique was changed into small rotary movements while rotating the cotton swab for a duration of 20 seconds as the first technique caused probably a too short application time for the solvents to noticeable dissolve the soiling. The spots cleaned during the test were of the size of 2 to 3 mm^2.

The examination of the surface macroscopic under UV light prior to and during the cleaning treatment did not help to distinguish the surface soiling as no fluorescence could be noted.

Cleaning test area No. 01 – Back of shoulder, red coloured area (dalmatic)
(see appendix, p. civ)
An area on the back of the sculpture's right shoulder was chosen as the first area to be tested as it was easy accessible, provided enough space for the different test solutions and exhibited a homogeneous and continuous soiling layer, hence comparable cleaning results could be expected.

After the initial cleaning tests employing the first twelve solvent mixtures, the mixtures #5, #6 and #12 showed the best results regarding the colouration of the cotton swab afterwards. Following the solvents #14, #15, #16, #17 and #20 were tested as their *fd*-values cover the detected *fd* range of the solvents #5 and #6. To determine the solubility as exact as possible another solvent mixture (Toluene/ethanol, 60:40) with Teas parameters in the middle of solvents #5 and #6 was mixed and tested. Overall the solvents #5, #12 and #20 showed the best results. During the cleaning tests non of the solvents could actually dissolve the whole soiling layer, only the surface was partially dissolved. Thus the cleaning test method was modified for a better comparability of the solvents #5, #12 and #20. With each solvent a small spot was cleaned employing four cotton swabs at 20 seconds with small rotary movements. The degree of removed soiling was then compared. The solvents #5 and #12 showed the best results as the whole soiling

layer could be removed after using all four swabs. Besides it seemed that the upper soiling 'layer' was better soluble in water (= solvent #12) and the lower 'layer' showed a better solubility in solvent #5. By removing the soiling a brown coloured layer was exposed in its appearance indicating to consist at least partially of wax.

Observations during the cleaning tests raised the question how accurate the results are as in the initial cleaning tests only the surface of the soiling was tested for its solubility characteristics. It was decided to remove the upper soiling layer in a small area to test the solvents on the lower soiling 'layer'. Thus a 'window' was cleaned by removing the upper soiling layer with deionised water. To keep the interference as small as possible, the 'window' was cleaned over the already tested area. After initial cleaning tests using the solvents #1 to #12 the solvents with the best results (#5, #6, #7, #8, #9) and the solvents #15, #16, #17, #18, #20, #21, #22, #23, #24 as they cover the determined range of *fd*-values of #5 to #9 where compared by removing the soiling with several cotton swabs with each solvent. The results showed that all solvents removed the soiling, however # 16 showed the best results. Furthermore it was noticed that the solvent #7, #8, #9, #22, #23, #24 seem to dissolve the lower waxy layer a little bit indicated by a reduced gloss and relief. To verify the results a small test area (4 x 4 mm^2) was cleaned employing solvent #12 (= deionised water) and solvent #16. The results confirmed the outcome of the cleaning tests, however it could be noticed that the soiling could not be homogeneously and completely dissolved on the whole test area.
As toluene should be avoided for the cleaning treatment if possible as it is harmful to health a solvent mixture with xylene instead of toluene was tested (see table 02; appendix, p. cii). The results showed that this mixture worked less good than the mixture with toluene.

Observations during the cleaning tests showed that the solvent #16 could dissolve the soiling but only by using several cotton swabs and by applying some physical “force”. This and the fact that the soiling layer could not be removed completely in some areas lead to the assumption that the solvent is 'too weak'. As described by

PIETSCH the next step in the cleaning tests would be to enhance the solvent strength by using solvents with a higher Snyder parameter P' or by the admixture of amounts of very strong solvents. For exchanging a solvent with another with higher P' only benzene (P' = 2,7) instead of toluene (P' = 2,4)[84] would be a possibility, however, benzene should not be used because of its toxicity[85]. Xylene (P' = 2,5) has also a higher P' as toluene, but has a smaller dissolving capacity than toluene[86]. Acetone (P' = 5,1) has the highest P' in its chemical class[87]. For the admixture of a strong solvent diacetone alcohol or *N*-methylpyrrolidone are a possibility as they have Teas parameters near to the parameters of solvent #16.

However, further tests with modified solution could not be executed as these specific materials were not available. As the polychromy exhibited many cracks and damaged spots further tests involving aqueous solutions were also suspended as the risk was rated too high to harm the polychromy. Mechanical cleaning employing a scalpel was assessed as not suitable as removing of the soiling was not possible without damaging or removing the layers below, too. Therefore it was decided to stop the further modified test at this point and to go on to other areas of surface decoration to determine the solubility range of the soiling material on these surfaces.

Cleaning test area No. 02 – Back of sculpture, red coloured area (dalmatic)
(see appendix, p. civ)
The next area to be tested was also part of the red vertical strip at the back of the sculpture, but this area located on the lower part of the dalmatic exhibited a less dark and less thick soiling layer compared to the area tested prior to this. To get comparable results from the cleaning tests and to determine the solubility range of the soiling as exact as possible the same cleaning test method as described for the first test area was employed.
The initial cleaning tests indicated that solvent #12 (= deionised water) dissolved the soiling the best, followed by the solvents #5 and #6, however none could

84 PIETSCH 2005, p. 103 f.
85 PIETSCH 2005, p. 42.
86 PIETSCH 2005, p. 99.
87 PIETSCH 2005, p. 103.

dissolve the soiling completely. As #5 and #6 showed good results, the solvents #14, #15, #16, #17 and #20 were also tested. In the end solvent #15 followed by #16 could be identified as the solvents with the best soiling dissolving properties. Besides all solvents mixtures were also tested on a small separate spot of exhibited red coloured paint layer to check if they harm the polychromy. It could be assessed that all solvents dissolved the paint layer to a greater or lesser extent with the sole exception of water.

Cleaning test area No. 03 – Back of sculpture, gilded rim (dalmatic)

(see appendix, p. cv)

Initial cleaning tests on the gilded rim of the dalmatic at the back of the sculpture showed that only the solvent #12 (= water) could slightly dissolve the soiling layer. The dissolving properties of the deionised water was tested by trying to cleaning a small area of approximately 4 x 4 mm^2: the water only dissolved the soiling surface to a small extent resulting in a slightly brightened appearance, however, the soiling layer could not be fully removed. The cleaning movements had to be very cautious as the gilding exhibits all over small cracks and little spots of damage exposing layers of water soluble poliment and ground layers. Too much pressure leads to unintentional removing of the gilding. Longer application times to facilitate the soiling removal also increased the risk of removing the gilding as the poliment and/or ground layers were dissolved.

The next step described by PIETSCH, systematic cleaning test employing water modified in the pH value, could not be performed due to inaccessibility of needed buffer solutions. However, some more cleaning tests involving available material were carried out. Tests employing saliva and warm water resulted in a similar performance like deionised water and did not noticeable enhance the solubility of the soiling. As the soiling was (at least slightly) soluble in water it could be possible that the soiling medium is glue. Therefore it was tested if removal or reducing of the layer could be achieved by using heat employing a heat spatula to soften the supposed glue, with no positive outcome. To see if a higher pH value would enhance the solubility of the soiling layer cleaning tests employing ammonium hydroxide (pH 8 and pH 8.5) were carried out. Furthermore to see if a detergent

could aid to remove the soiling layer cleaning tests employing *Vulpex*[88] were performed. According to the technical data sheet for an aqueous solution one part detergent was mixed with six parts of water, for a non-aqueous solution one part detergent was mixed with ten parts of white spirit. *Vulpex* in white spirit could not dissolve the soiling layer, *Vulpex* in water dissolved the surface of the soiling (appeared slightly better than pure water) but was not able to dissolve the whole layer. In both cases the surface was rinsed afterwards to remove detergent residue. Triammonium citrate (1% in deionised water) was also tested procuring no better results than pure water. Here again, the surface had to be rinsed to remove residues.

Besides cleaning tests showed that mechanical removing of the soiling is not possible as it could hardly be avoided that little bits of the delicate gilding were also taken off. This leads to the assumption that the adhesion between the soiling and the gold leaf is better than the adhesion between the gold lead and the layer of poliment.

Cleaning test area No. 04 – Back of sculpture, undergarment (alb)

(see appendix, p. cv)

Cleaning tests on an area of the alb where the ground layer is exposed were carried out with the aim to remove the yellowish grey appearance.

Initial cleaning tests provided evidence that non of the tested solvents (#1 to #12) could selectively remove the grey surface soiling: either the soiling could not be dissolved (solvents #1 to #3), the solvents reduced some binding media present in the top layer of the ground (probably some sort of priming) reducing the cohesive strength of the upper ground layer (solvents #4 to #10) or the ground itself was dissolved (solvents #10 to #12).

Cleaning test area No. 05 – Back of sculpture, undergarment (alb)

(see appendix, p. cv)

More cleaning tests were performed on an area of the undergarment (alb) displaying a dark, greenish grey appearance.

Water was the only solvent able to remove the dark greenish grey, coloured layer

88 Vulpex Liquid Soap = Pottasium methyl cyclohexyl oleate.

revealing a lighter grey coloured layer not soluble in water. At cracks in the surface the water could penetrate into deeper layers where it slightly dissolved the water-sensitive ground causing risk of unintentionally breaking off and removing little bits of the paint layer during cleaning with the cotton swab.

Cleaning test area No. 06 – Back of sculpture, undergarment (alb)

(see appendix, p. cvi)

Another area of the undergarment (alb) was tested as it displayed a different surface appearance with a dark black colouration. As the solvent #5 was determined as the best working solvent after the initial cleaning tests the solvents #15 and #20 were tested, not showing as good results as #5. Subsequent exchanging toluene by xylene in the solvent mixture was tested resulting in a less good solubility of the soiling material. Removing of the dark black coloured soiling material exposed a dark brown coloured layer, not noticeably soluble in the tested solvents.

4.3.4 Results and Discussion

Cleaning test area No. 01 – Back of shoulder, red coloured area (dalmatic)

The solubility characteristics of the soiling as it is partially soluble in solvent #12 (= deionised water) and partially soluble in solvent # 16 (= toluene / acetone 33 : 66) provides evidence that the soiling as it can be observed at the back of the shoulder is probably multi-layered with at least two layers. These layers can be assumed to consist of different binding media: the water-solubility indicates a proteinaceous or carbohydrate-containing medium, the solubility in solvent #16 indicates resin or oil as binding medium[89]. Furthermore it can be assumed that the soiling is most probably inhomogeneous in its composition as the solubility in the tested solvents varies.

Reducing the soiling layer with water showed the risks of harming the original surface decoration as the water penetrated through the cracks of the damaged surface into deeper layers and partially dissolved the water soluble ground causing small particles to break out of the surface.

89 PIETSCH 2005, p. 172.

Cleaning test area No. 02 – Back of sculpture, red coloured area (dalmatic)

The cleaning tests are indicating that the soiling contains more than one binding medium: the water-solubility indicates again a proteinaceous or carbohydrate-containing medium, the solubility in the solvents #15 and #16 indicates an oil or a resin based medium.[90]

Cleaning test area No. 03 – Back of sculpture, gilded rim (dalmatic)

The cleaning tests indicate that water is the only solvent that is able to at least reduce the soiling layer. Again, the water-solubility indicates a proteinaceous or carbohydrate-containing binding medium[91].

Cleaning tests using heat and modified aqueous solutions employing saliva, warm water, ammonium hydroxide (pH 8 and pH 8.5), *Vulpex* (diluted in water or white spirit and triammonium citrate (1% in deionised water) did not lead to better cleaning results as using unmodified deionised water.

However, cleaning with aqueous solutions enhances the risks of damaging the surface decoration as the gilding exhibits a heavily damaged surface with many small cracks and spots exposing the water-sensitive poliment and ground layers.

Cleaning test area No. 04 – Back of sculpture, undergarment (alb)

The performed cleaning tests at the area of exposed ground on the undergarment provided evidence that the solvents #4 to #10 dissolved the medium present in the upper layer of the ground, probably some sort of priming. Assumptions over the type of medium cannot be made as the Teas parameters cover a huge range. The solvents #1 to #3 did not dissolve the medium in the top of the ground, but only dissolved a small amount of soiling material. The noticeable colouration of the cotton swab after the cleaning tests could derive from loosely bonded and removed dirt on top of the actual soiling layer. The solvents #10 to #12 dissolved the ground layer itself.

Cleaning test area No. 05 – Back of sculpture, undergarment (alb)

Information obtained trough the cleaning tests on the undergarment showed that the greenish grey surface soiling was only soluble in water. The water-solubility of

90 PIETSCH 2005, p. 172.
91 PIETSCH 2005, p. 172.

the soiling indicated that the binding medium in the soiling layer is probably proteinaceous or contains carbohydrates[92]. It is not clear if the light grey coloured layer revealed by removing the surface soiling is also a part of the soiling or if it is a paint layer that is part of the surface decoration.

Cleaning test area No. 06 – Back of sculpture, undergarment (alb)

The cleaning tests performed on the area of the undergarment with a black colouration showed that solvent #5 dissolved the dark soiling best. The Teas parameters of solvent #5 are leading to the assumption that the binding medium of the soiling layer is probably based on resin or oil[93]. It is not clear if the exposed dark brown coloured layer that is not noticeably soluble in the tested solvents is part of the soiling or a part of the surface decoration.

Applied relief textile

The breaking of the taken samples from the applied relief textile are indicating that the layers, both soiling and surface decoration layers, do not have a good adhesion between each other and are likely to break of under mechanical stress.

4.4 Summary and recommendations

It can be seen that a solvent that is suitable for all areas could not be found as nearly every area reacts differently to the tested solvents as to the soiling itself. As an example the red paint layer on the back of the sculpture reacts sensitive to all tested solvents except water, as the cleaning tests on area no. 02 indicate. In other areas, like the test area no. 01 where a brown (waxy) layer can be found under the soiling, cleaning with solvents is unproblematic whereas water can cause problems. In some areas the removing of the soiling at this juncture even has to be rejected as any of the tested solvents would have negative effects on the layers of the surface decoration as it can be seen on cleaning area no. 04.

92 PIETSCH 2005, p. 172.
93 PIETSCH 2005, p. 172.

As the cleaning tests described by PIETSCH could not be finished due to unavailability of certain materials it would be reasonable to continue with the systematic cleaning tests if needed materials are available to determine a suitable solvent to selectively remove the surface soiling.

For all water-sensitive areas and surfaces avoiding aqueous cleaning method would be preferable to minimise the risk of unintentionally dissolving and removing parts of the surface decoration as parts of the object would be irreversibly destroyed.
As the overall surface decoration of the sculpture is not a closed but exhibits lots of cracks and small damages the application of aqueous solutions for cleaning can risk to unintentionally remove original surface decoration as the water can penetrate into deeper water-sensitive layers. Employing poultices or gels for the cleaning process could help to retain the solvent on the surface and prevent it from penetrating into deeper layers. However using aqueous solutions on water-soluble layers is not advisable. In some areas the surface decoration is damaged to an extent that exposing the water-sensitive layer to the cleaning agent can hardly be avoided, even under the stereo microscope. For cleaning these water-sensitive surfaces aqueous methods employing emulsions described by WOLBERS[94] could be tested for suitability.
The employment of poultices and gels could also help to reduce the mechanical impact on the surface.
The removal of the soiling has to be carried out under a stereo microscope to guarantee a controlled cleaning process.

Further investigation of the layer build-up by cross-section, pigment analysis and/or FTIR would aid to distinguish between actual soiling layers and paint layers as part of the surface decoration as can be seen for example on the undergarment. FTIR analyses identifying the binding media of the different layers could also help to determine a suitable cleaning agent as the results would provide evidence for the solubility of a material. However, empirical cleaning tests will be still inevitable.

94 WOLBERS 2000, p. 92 ff., p. 104 ff.

If the finally determined solvent mixture contains toluene or cyclohexane it should be tested in any cases if these solvents can be exchanged by xylene or white spirit. Even if the initial cleaning tests provided evidence that exchanging these solvents would not lead to better cleaning results the solvent mixture could be still suitable if used in a gel or poultice or in a modified solution.

Mechanical cleaning has to be declined in the most areas as the adhesion between the soiling and the upper paint of decorative layer is often bigger than the adhesion between the layers of the surface decoration themselves. Thus the risk is too high to unintentionally remove parts of the surface decoration during mechanical cleaning.

The areas of the applied relief, as observed during the sampling, do not have a sufficient adhesion to be cleaned mechanically without accompanied consolidation of the surface layers. Furthermore, non-contact methods like laser cleaning could be considered and evaluated for their suitability. Besides more investigative analyses (FTIR, pigment analysis, more cross-sections) have to be done to determine whether a layer is surface soiling that should be removed or some sort of overpainting or decorative layer that should be preserved.

Conclusion and critical reflection

Based on the performed cleaning tests, the resultant findings and the investigation and examination of the surface structures a cleaning treatment cannot be recommended at this time with the current available informations.
Both, surface decoration and soiling layers exhibit a complex structure and build-up that necessitate further investigative analyses. More cross-sections to investigate layer sequences and FTIR analyses to identify the used binding media are inevitable, in particular for the not yet tested surface decoration areas. Furthermore pigment analyses to compare examined layer build-ups, particularly to aid the determination of existing overpaintings and alterations are advisable.

A cleaning treatment cannot be recommended until a suitable cleaning method is found preferable for each surface decoration area as the sculpture has to be seen as an artwork in its entirety. An optically diverging sculpture exhibiting surface areas of different and particularly not balanced cleaning states should be excluded.

Even if no suitable and feasible cleaning strategy can be found in the future a virtual reconstruction of the sculpture can be considered to illustrate the former appearance and formal and artistic aspects of the sculpture. More investigative analyses, particularly cross-sections and pigment analyses would be necessary to achieve this aim.

Furthermore another method of investigating the pattern of the tin relief textile could be tested as the examination by grazing light could not be sufficient. Therefore a soft and flexible tin foil could be placed on and gently pressed onto the structured surface so that the pattern leave marks in the tin foil.[95]

Irrespective of the systematically and theoretically profound methodology of cleaning tests provided by Annik PIETSCH it has to be noted that in practice difficulties arise particularly in matters of availability of needed materials. As the

95 Oellermann 1993, p. 209.

solubility range of a substance is not known at the beginning of the test it can hardly be achieved to have all the necessary solvents and materials on hand. Even if the solubility range can be narrowed down by preliminary analysis of the binding media the range of supposable needed materials is still quite extensive.
Moreover, occurring problems were that little feedback could be gained during the cleaning test from each individual tested spot. The only usable and comparable information received during the cleaning tests were the colouration of the cotton swab and the appearance of the cleaned spot after the cleaning test as the tested spots did not react noticeable different in matter of change in tactile properties. And as the thus received information was often quite similar or almost identical it could hardly be determined which solvent worked better. Furthermore it must be noticed that a slight difference in the solubility between the tested spots could also derive from an inhomogeneous soiling layer or small differences in the cleaning technique even if it was tried to perform each test identically. Besides it should be noted that as the author performed this specific cleaning test for this thesis the first time the routine and confidence in performing the cleaning tests may have been missing.

Glossary

Technical terms for relief decoration, gilding technique, grounds and coatings used by Jilleen NADOLNY[96].

adhered relief — A type of relief made by addition. Made by the painter and adhered to the substrate.
Includes: Cast relief, paper relief, other

applied relief — May be used as a general term for both adhered relief and applied ornament; for example, as in applied relief textiles.

burnished gilding — One of the two basic gilding finishes (as defined in the primary sources – the other is matte gilding); its defining feature is that it is highly polished with a purpose-made tool (commonly of stone or animal tooth); both metal and underlayers are compressed, producing an extremely flat, even finish. The adhesive/gilding ground must be based on an aqueous binder (whether pigmented or unpigmented) which must be laid onto a glue-bound ground-base. The use of aqueous media is necessary for burnished gilding because oils and resins dry too slowly (they cannot be burnished in a plastic state) and are too strong and inflexible to allow for burnishing once dry.

cast relief — A form of applied relief. Relief units that are made by the painter, pre-formed by casting, which are adhered to the substrate (paint, gilding or the ground-base).
Includes: simple cast relief, tin-relief, cast paper.

gilded relief — All additions made primarily by the painter that have had a layer of either metal leaf or foil applied to their surface, encompassing also tin-relief which has only been coated with vermeil or glaze or where the tin foil is left exposed.

gilding adhesive — A general term for a medium-rich layer upon which metal leaf is adhered/seated, irrespective of the finish.
Includes: mordant (if unpigmented; if pigmented, see gilding ground)

gilding ground — A general term for a pigment-rich layer upon which metal leaf is adhered/seated, irrespective of the finish.
Includes: poliment, pigmented mordants.

96 NADOLNY 2000, p. 39–45.

glaze A medium-rich transparent or translucent coloured coating (containing dyes or pigments) applied to metal leaf or to a paint layer to modify its appearance.
Includes: vermeil, coloured coatings.

mate gilding One of the two basic gilding finishes (defined in the primary sources); its defining feature is that the metal leaf is not burnished, only smoothed. The adhesive/gilding ground may be composed of any combination of materials and may be applied to either ground or paint layers.
Includes: mordant gilding, stencil gilding.

mordant The seat used for matte gilding. Layer(s) of any composition (oil- or water-based; pigmented or unpigmented) which is/(are) painted out, and, when still tacky, function to adhere metal leaf or foil, which, when dry, is not burnished. In some cases, through less common, the mordant consists of two layers - a mordant-undercoat and a mordant-base. A mordant undercoat is presumably applied to better obscure the colour of the underlying layers and/or prepare the substrate to receive the mordant (much like a sealant or priming).

oil gilding A type of mordant gilding. This term should only be used if the binder of the mordant has been analytically identified a oil-based. Otherwise, the general designation mordant gilding is more appropriate.

poliment The seat used for burnished gilding. A pigment-rich layer bound with an aqueous binder, to which metal leaf is applied, and when dry, burnished. Because the colour of the underlayer effects the final colour of the gilding, poliments are generally brightly coloured, usually in orange to red tones, although brown, purplish, black and green variants have also been observed.
See also poliment gilding, adhesive-poliment gilding and bole.

poliment gilding A type of burnished gilding. Metal leaf or foil is applied to a poliment moistened with a dilute layer of aqueous adhesive (or simply wet slightly to activate the glue binder) which has been laid over a glue-bound ground-base; when dry it is burnished.
See also adhesive poliment gilding and poliment.

priming A component of the ground. A layer applied over the ground-base of an entire object that serves to seal the ground-base so that the media of the overlying layers are not absorbed into it.

sealant A component of the ground. An application of pure medium, or very medium-rich material, which serves to saturate the substrate, thus preventing leaching of the medium of subsequent layers and simultaneously facilitating the adhesion between the substrate and the ground.

simple cast relief A type of cast relief. A form taken from a mould which does not utilise a foil of tin as a support/release layer, which is adhered to a substrate (either paint, gilding or the ground-base) with an adhesive. Simple-cast relief is, as a rule, thicker than tin-relief as it must support its own mass.

tin-relief A form of cast relief. A casting taken form a mould which utilises a foil of tin as a support/release layer for the relief mass, which is adhered to a substrate (either paint, gilding or the ground-base) with an adhesive. Most commonly mordant gilding, although examples of vermeil coatings and exposed tin have been identified.

tin-relief textile A stylistic application of tin-relief, where the technique is employed for rendering textiles. The most characteristic types imitate the appearance of golden threads by using parallel rows gilded of raised lines. the term most often used in the past - "pressed brocade" (from the German *Pressbrokat*) - is both technically (the relief was cast) and stylistically (brocade refers to a type of weave; it is overly specific) incorrect.
Commonly used older terminology - German: *Pressbrokat*; French: *Brocart appliqué*

List of used materials

Material:	Supplier:
Acetone	Acros Organics
Ammonium hydroxide (pH 8)	?
Ammonium hydroxide (pH 8.5)	?
Cyclohexane	Fisher Scientific UK
Deionised water	-
Ethanol, absolute	Fisher Scientific UK
Meltmount™ 1,662	Cargille Laboratories, Inc.
Triammonium citrate (1% in deionised water)	?
Technovit® 2000 LC	Heraeus Kulzer GmbH
Toluene	VWR International Ltd.
Vulpex Liquid Soap	Conservation Resources (UK) Ltd.
White spirit (Stoddart solvent)	Mcquilkins
Xylenes, 96%, pure, mixed isomers with ethylbenzene	Acros Organics

Bibliography

ASHLEY-SMITH, Jonathan: *Cleaning*, Science for Conservators, Vol. 2, Abingdon, 1992 (2nd edn.)

BRAUN S.J., Joseph: *Albe* in: SCHMITT, Otto (ed.): *Reallexikon zur deutschen Kunstgeschichte* (RDK), Vol. I, Stuttgart 1934, col. 327 ff.

BRAUN S.J., Joseph: *Amikt*, in: SCHMITT, Otto (ed.): *Reallexikon zur deutschen Kunstgeschichte* (RDK), Vol. I, Stuttgart 1934, col. 636 ff.

BRAUNFELS, Wolfgang / KIRSCHBAUM, Engelbert : *Lexikon der christlichen Ikonographie*, Vol. 8: *Ikonographie der Heiligen : Metetius bis Zweiundvierzig Martyrer. Register*, Freiburg im Breisgau 1976, p. 395 f.

CAPLE, Chris: *Conservation Skills : Judgement, method and decision making*, London, 2000

Conservation Record Card of 50/30, Burrell Collection, Glasgow Museums

CREMONESI, Paolo: *An Approach to Cleaning*, in: WEYER, Cornelia (ed.): *Oberflächenreinigung - Material und Methoden; Surface Cleaning – Material and Methods*, VDR Schriftenreihe, Volume 2, Stuttgart 2006, p. 31–38

DAMBECK, Franz: *Dalmatik*, in: SCHMITT, Otto (ed.): *Reallexikon zur deutschen Kunstgeschichte* (RDK), Vol. III, Stuttgart 1953, col. 985 ff.

FRICK, Michaela: *Musterschablonen in der österreichischen Tafelmalerei des 15. Jh.*, Unpublished dissertation, Leopold-Franzens-Universität Innsbruck, Innsbruck 2003

GROSSER, Dietger: *Die Hölzer Mitteleuropas : Ein mikrophotografischer Lehrstlas*, Remagen, 2003

JÄGER, Elisabeth: *Oberflächenreinigung – Eine systematische Annäherung; Surface Cleaning – A Systematic Approach,* in: WEYER, Cornelia (ed.): *Oberflächenreinigung - Material und Methoden; Surface Cleaning – Material and Methods*, VDR Schriftenreihe, Volume 2, Stuttgart 2006, p. 12-26

JÖRG, Barbara: 50/30, Sculpture survey, Nov. 2012

KHANDEKAR, Narayan: *Introduction*, in: DORGE, Valerie (ed.): *Solvent Gels for the Cleaning of Works of Art : The Residue Question*, Research in Conservation, Los Angeles 2004, p. 1–4

MAIER, Sabine: *Reinigung von Fassungen. Anmerkungen zur Behandlung polychromer und monochrom-holzsichtiger Retabelskulpturen*, in: EIPPER, Paul-Bernhard (ed.): *Handbuch der Oberflächenreinigung*, München 2011, p. 175–182

Mimsy XG Database: 50/30, Glasgow Museums

NADOLNY, Jilleen: *The techniques and use of gilded relief decoration by northern European painters, c. 1200-1500,* Unpublished PhD thesis (2 volumes), The Courtauld Institute, Department of Conservation and Technology, London University, London 2000

OELLERMANN, Eike: *Zur Imitation von Brokatstoffen in der Faßmallerei und die Möglichkeit der Identifizierung der Faßmalerwerkstatt*, in: GUILLOT DE SUDUIRAUT, Sophie : *Sculptures médiévales allemandes. Conservation et restauration. Actes du colloque organisé au Musée du Louvre par le Service Culturel, les 6 et 7 décembre 1991* Paris 1993, p. 201 – 222

PAULUS, Herbert: *Diakon*, in: SCHMITT, Otto (ed.): *Reallexikon zur deutschen Kunstgeschichte* (RDK), Vol. III, Stuttgart 1954, col. 1377 ff.

PIETSCH, Annik: *Loesemittel : Ein Leitfaden für die restauratorische Praxis*, VDR Schriftenreihe, Volume 7, Stuttgart 2005

Purchase Book 1936, Purchase Books of Sir William Burrell, Glasgow Museums Resource Centre (GMRC), Glasgow Museums

Record card of 50/30, Burrell Collection, Glasgow Museums

SCHEIDEMANN, Christian: *Schmutz als wesentlicher Bestandteil in Kunstwerken; Dirt – An Essential Part of Artworks*, in: WEYER, Cornelia (ed.): *Oberflächenreinigung - Material und Methoden; Surface Cleaning – Material and Methods*, VDR Schriftenreihe, Volume 2, Stuttgart 2006, p. 228–233

SCHOCH, W. / HELLER, I. / SCHWEINGRUBER, F. H. / KIENAST, F.: *Salix alba L.*, in: *Wood anatomy of central European Species*, 2004, http://www.wsl.ch/land/products/dendro/mic_tang.html, (August 2013)

SCHOCH, W. / HELLER, I. / SCHWEINGRUBER, F. H. / KIENAST, F.: *Populus alba L.*, in: *Wood anatomy of central European Species*, 2004, http://www.wsl.ch/land/products/dendro/species.php?code=PPAL, (August 2013)

STADLER, J. E. / HEIM, F. J. / GINAL, J. N.: *Vollständiges Heiligen-Lexikon*, Volume 3, Augsburg 1869, col. 274-287, http://www.zeno.org/nid/20003002195, (August 2013)

WESTHOFF, Hans / HAHN, Roland: *Verzierungstechniken in Malerei und Skulptur*, in: WESTHOFF, Hans (et al.): *Graviert, Gemalt, Gepresst : Spaetgotische Retabelverzierungen in Schwaben*, Stuttgart, Ulm 1996, p. 18–31

WESTHOFF, Hans (et al.): *Graviert, Gemalt, Gepresst : Spaetgotische Retabelverzierungen in Schwaben*, Stuttgart, Ulm 1996

WOLBERS, Richard: *Cleaning Painted Surfaces : Aqueous Methods*, London 2000

WOLBERS, Richard: *A Methodological Approach to Selecting a Cleaning System*, in: DORGE, Valerie (ed): *Solvent Gels for the Cleaning of Works of Art : The Residue Question*, Research in Conservation, Los Angeles 2004, p. 54–65

WÜLFERT, Stefan: *Der Blick ins Bild : lichtmikroskopische Methoden zur Untersuchung von Bildaufbau, Fasern und Pigmenten*, Ravensburg 1999

Appendix:

- Photographic documentation
- Mapping
- Mapping of located Metal foil
- Photomontage: reconstruction of the pattern of the applied relief textile
- Sample analysis: cross sections, fibre analysis, microscopic wood anatomy
- Survey records of 50/30 (Barbara Jörg)
- List of test solvents employed in the cleaning tests [PIETSCH, p. 156]
- List of test solvents mixed by the author during cleaning tests
- List of test solvents mixtures provided by Masschelein-Kleiner [PIETSCH, p. 160]

Photographic Documentation

Unless otherwise indicated all photographs are produced by the author

Fig. 01: 50/30, front

Fig. 02: 50/30, back

Fig. 03: 50/30, side

Fig. 04: 50/30, side

Fig. 05: 50/30, top

Fig. 06: 50/30, bottom

Fig. 08: 50/30, detail, face

Fig. 07: 50/30, detail, face

Fig. 09: 50/30, detail, face

Fig. 10: 50/30, detail, hands

Fig. 11: 50/30, detail, hands: missing poychromy on the palm

Fig. 12: 50/30, detail, base

Fig. 14: 50/30, detail, right side of sculpture, rim of dalmatic, yellow decoration line along the gilding

Fig. 13: 50/30, front, detail, folds of dalmatic

Fig. 15: 50/30, back, detail, shoulder area

Fig. 16: 50/30, back, detail, damaged collar with inserted wedge

Fig. 17: 50/30, back, detail, base

Fig. 18: 50/30, back, detail, base, applied textile

Fig. 20: 50/30, back, detail, dalmatic, pattern of the applied relief textile

Fig. 19: 50/30, back, detail, vertical component

Fig. 22: 50/30, front, detail, fold of dalmatic, damaged applied relief textile

Fig. 21: 50/30, front, detail, shoulder, dalmatic, damaged applied relief textile

Fig. 23: 50/30, front, photomicrograph, dalmatic, applied relief textile, traces of mechanical cleaning

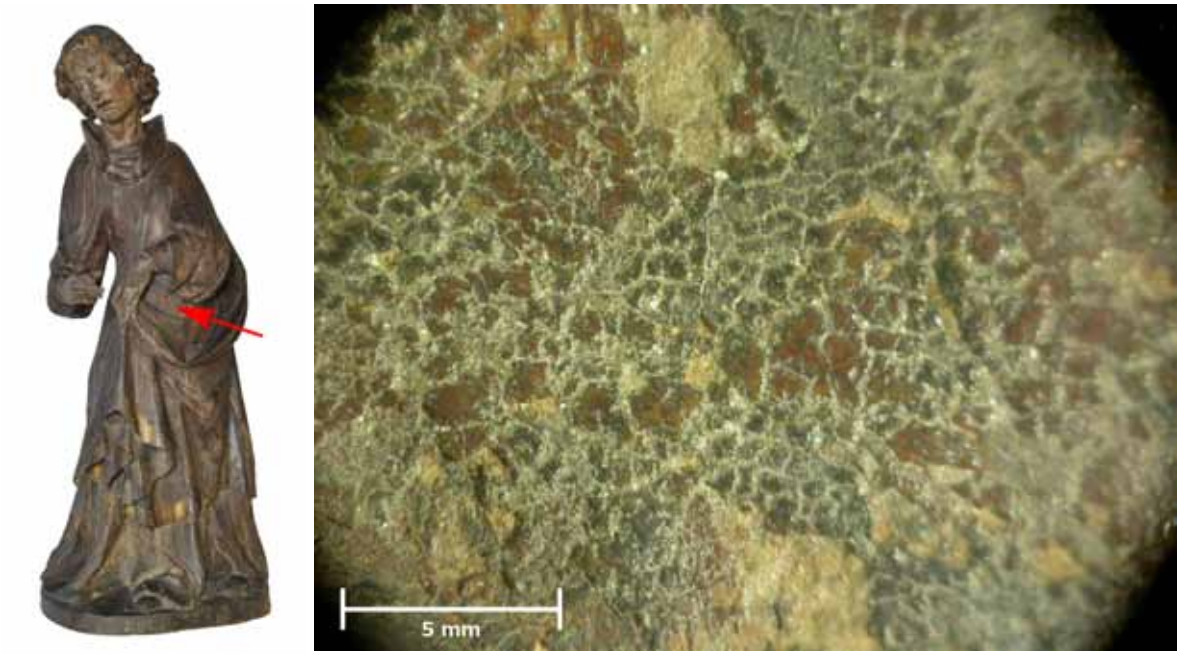


Fig. 24: 50/30, front, photomicrograph, dalmatic, applied relief textile, damaged surface decoration

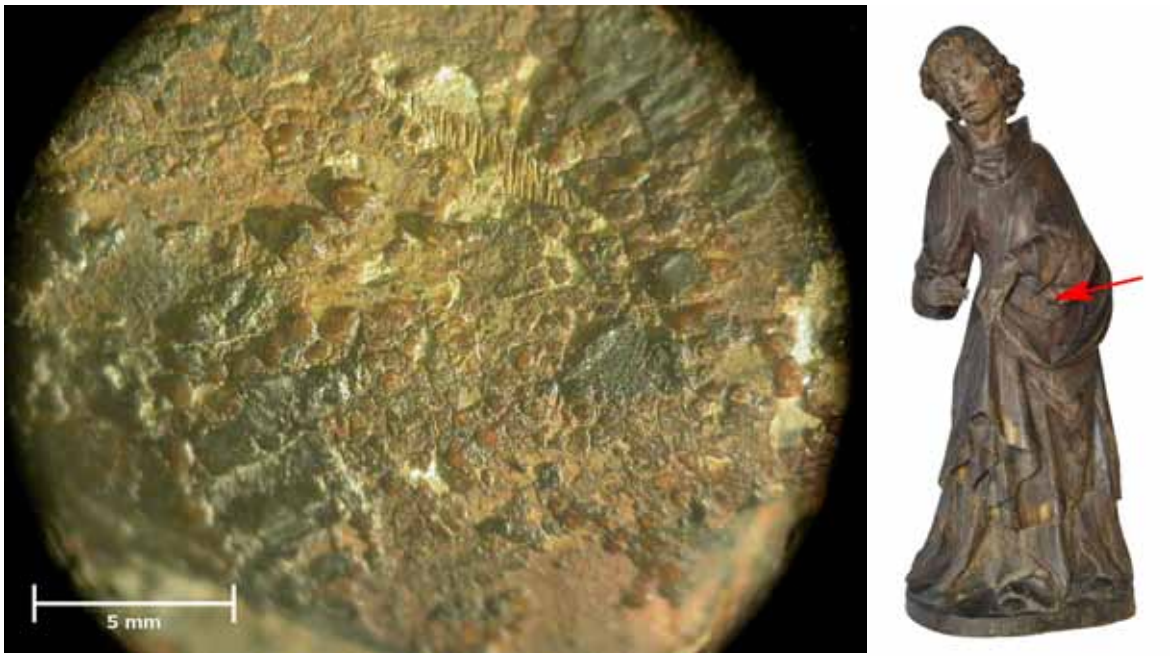


Fig. 25: 50/30, front, photomicrograph, dalmatic, applied relief textile, damaged surface decoration

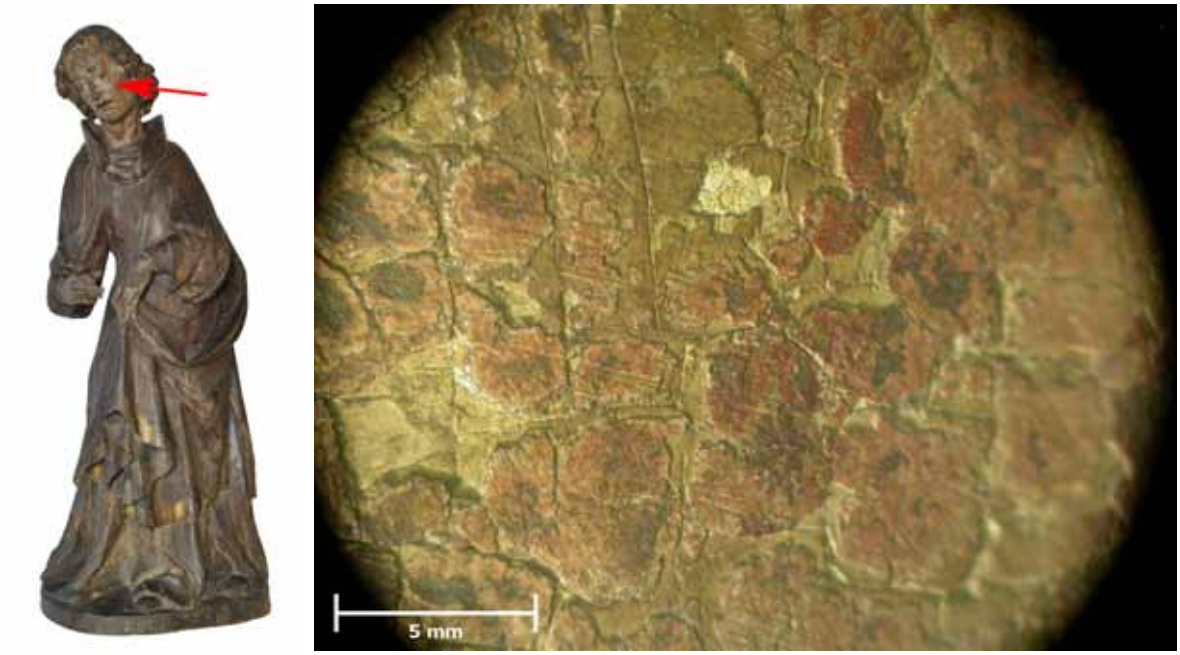


Fig. 26: 50/30, front, photomicrograph, face, traces of mechanical cleaning

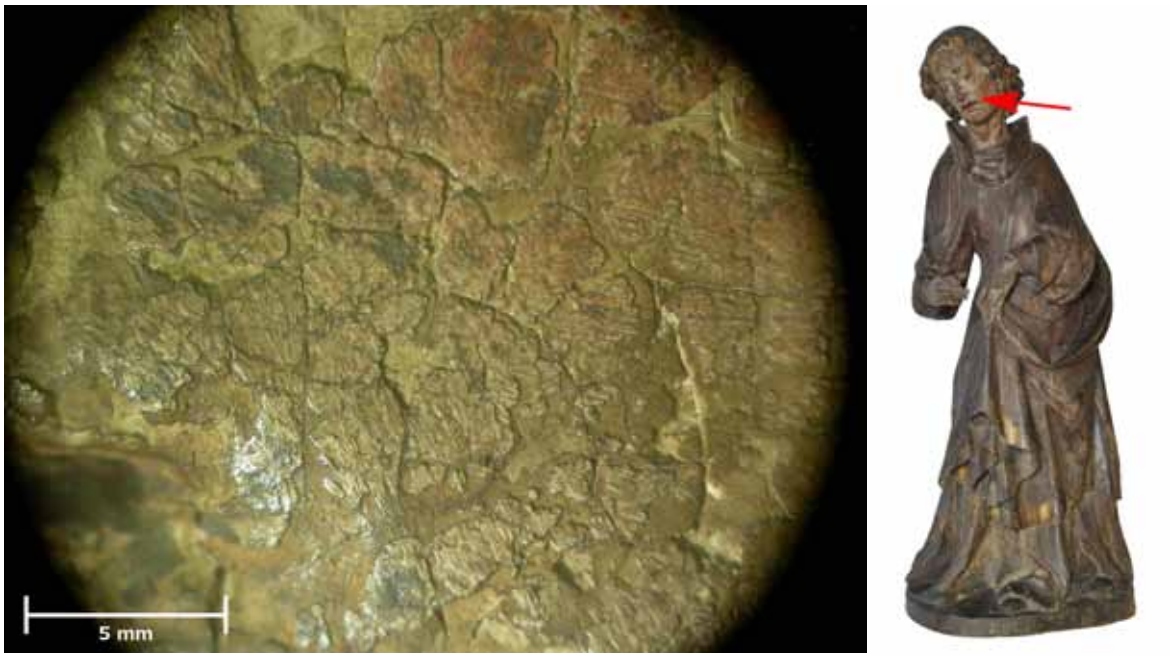


Fig. 27: 50/30, front, photomicrograph, face, traces of mechanical cleaning

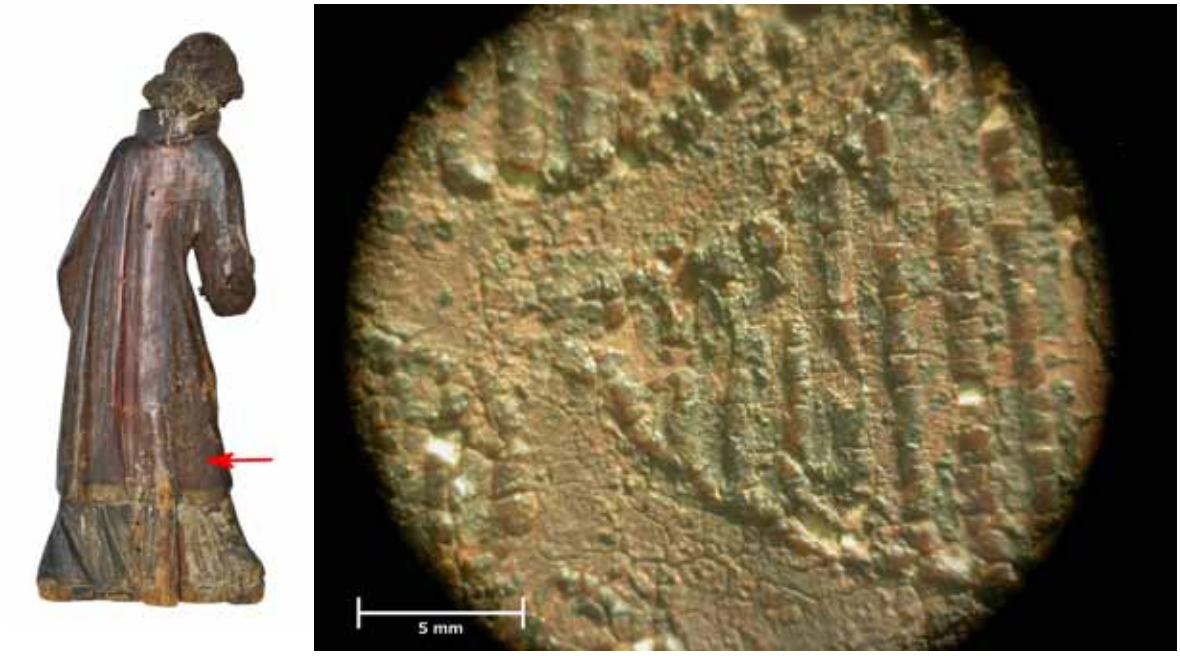


Fig. 28: 50/30, back, photomicrograph, dalmatic, applied relief textile

museums

Burrell Collection - Sculpture

Barbara Joerg
Nov 2012

Registration Number:	Object name:	Location:
50/30	St. John or St. Stephen	BC: 006; C11

Photographs:

Description:

Wooden 3-D structure with ground, polychromy and gilding;

Full figure sculpture of a standing male figure with tonsure (monk/ saint) dressed in long robe lifting cloak towards front with left hand. Shape and posture of both hands suggest carrying of 'attributes' which are missing.

Polychromy: not fully descernible for close examination by eye due to surface and detail obscuring dark colour appearance and surface soiling (requires examination and further identification)

*Hair: visual by ey observed colouration: mid/ dark brown with traces of gilding noted. Tonsur area displays flesh coloured surface.
*Face: flesh colouration (Inkarnat)
*Hands: displaying dark grey surface colouration assumed to be a discolouration of white surface colour;
*Gown: *outside: red/brown colouration with irregular dark "spots" >> raised decorative areas noted, that indicate surface decoration technique referred to as 'Pressbrokat' (application). Rim of hem line displaying band of gilding;

*Inside: blue colouration;
*Undergarment: green brown yellow surface colouration, assumed to have darkened and become soiled;

Dimensions (mm): including base

H: 815
W: 325
D: 185

Examination:

visual by eye; macroscopic

1. Materials:

1.1. wood, 1.2. ground, 1.3. gilding, 1.4. polychromy, 1.5. textile, 1.6. application technique ('Pressbrokat')

2. Construction Techniques: **see additional diagrams/ drawings**

2.1 Carved from one single log, with some additional wooden components
2.2 In some areas a wooven fabric/textile can be seen under the paint and ground layers. It's covering the wood and was probably attached at these areas to cover joints or other 'disruptions' in the wooden surface.
Areas where a textile coverage could be noted:

* on each side of the backside of base near the bottom;
* over the joints of the vertical component at the back of the sculpture;
* collar;
* egdes of the folds of the gown;
* fold of the undergamrent around the figure's visible foot;

3. Tool marks/ marks: **see additional diagrams/ drawings**

back: yes

bottom: yes

top: yes

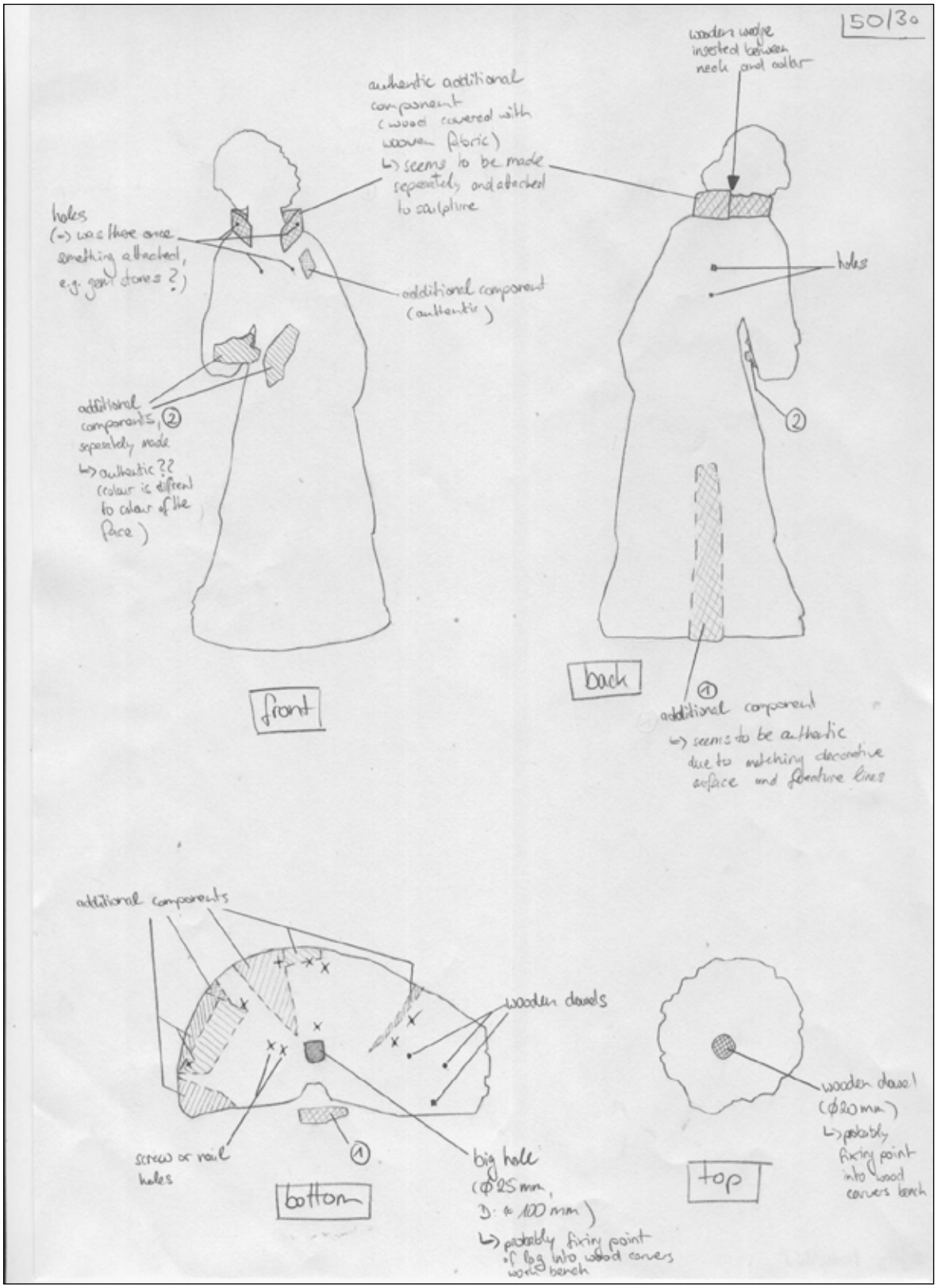
4. Condition:

	biological	chemical	physical
Structure			
Body	X		X
Ground layer	X		X
Surface decoration	X		X

4.1 Structurally sound and stable
4.2 Evidence in the shape of flight holes for woodworm infestation (inactive) noted; particularly over surface of forehead, left arm, bottom + plinth
4.3 Surface decoration (and ground) in some areas heavily damaged (particularly on the undergarment, right side of the face (seen from front) and on top of the head) >> indicates vulnerability of surface;
4.4 Various areas of paint, ground and substrate loss display exposed woven fabric often used to cover joints;
4.5 Physical damage, particularly at fragile parts: two fingers of left hand broken and missing; edge of gown on left side of sculpture damaged at two areas; upper egde of the collar damaged; right side of the

base damaged;
4.6 Left hand vertical side displays residue of adhesive
4.7 Evidence of previous repair at the vertical component at backside of sculpture (>> glue redidue, modern nails) >> seems like the component was broken off and re-attached;
4.8 a fragment fitted into wedge shaped area at bottom appears structurally loose.
4.9 Overall surface displays a dull dark brown colouration assumed to be a discoloured surface varnish/ coating;

Conservation recommendations		
1. Documentation:		special photography
		structure (x-ray)
	X	polychromy (pigment analysis): *compare pigment and media of hands/ face to investigate evidence of later addition of the hands; differing areas of 'Pressbrokat'*
		media/varnish (FTIR)
	X	microscopic wood anatomy
2. Preventive meassures:	X	documentation *examination of the application technique ('Pressbrokat') to investigate pattern repeat ('Rapport') (>> could help to locate region or artist)*
		environmental
		packaging/storage/handling
3. Interventive:	X	cleaning *Dusting with brush under vacuum extraction; cleaning with solvents to remove/reduce dark appearance of sculpture;*
		stabilisation
		consolidation
		restoration: gap filling / retouching


50/30
wooden wedge inserted between neck and collar
authentic additional component (wood covered with woven fabric)
↳ seems to be made seperately and attached to sculpture
holes
(→ was there once something attached, e.g. gear stores ?)
additional component (authentic)
holes
additional components, ②
seperately made
↳ authentic ??
(colour is differnt to colour of the face)
front
back
① additional component
↳ seems to be authentic due to matching decorative surface and structure lines
additional components
wooden dowels
screw or nail holes
big hole
(ϕ 25 mm, D: ≈ 100 mm)
↳ probably fixing point of leg into wood carver work bench
bottom
top
wooden dowel
(ϕ 20 mm)
↳ probably fixing point into wood carvers bench

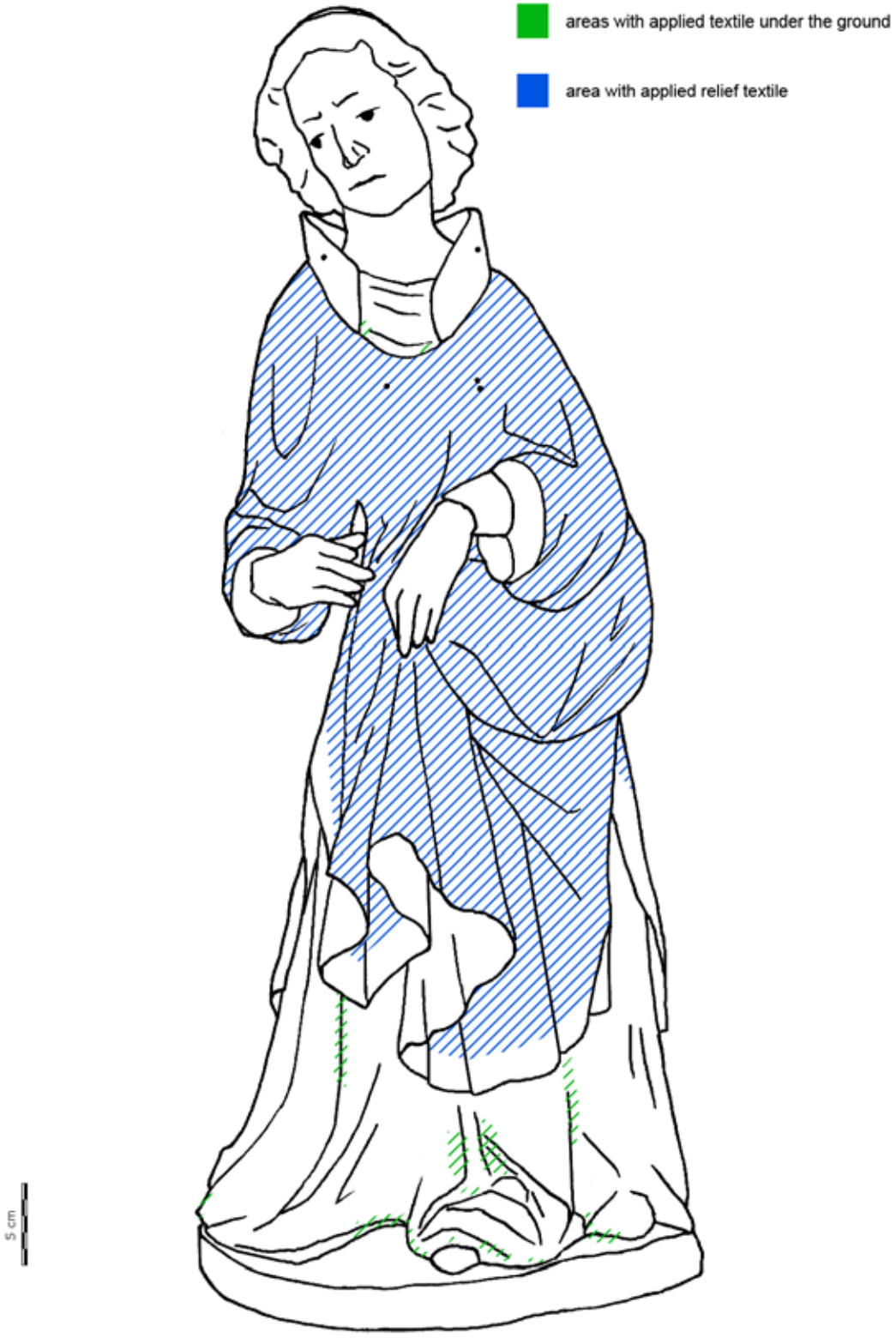
50/30

bottom tool marks

bottom fractured and loose part of the base
(↳ only fixed at left side)

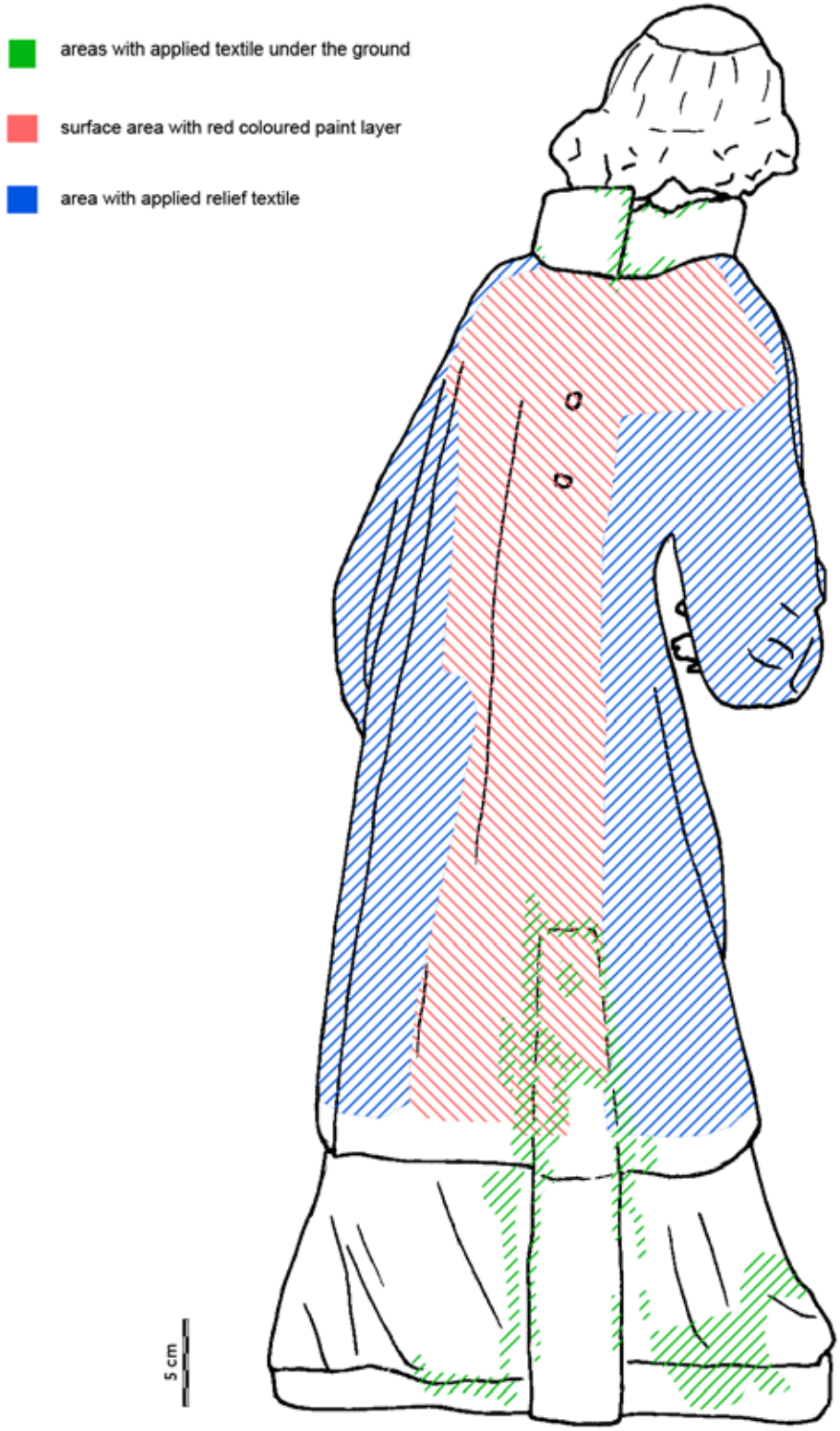

areas with gilding
yellow coloured decorative line
5 cm

Mapping of special surface decoration and applied textile

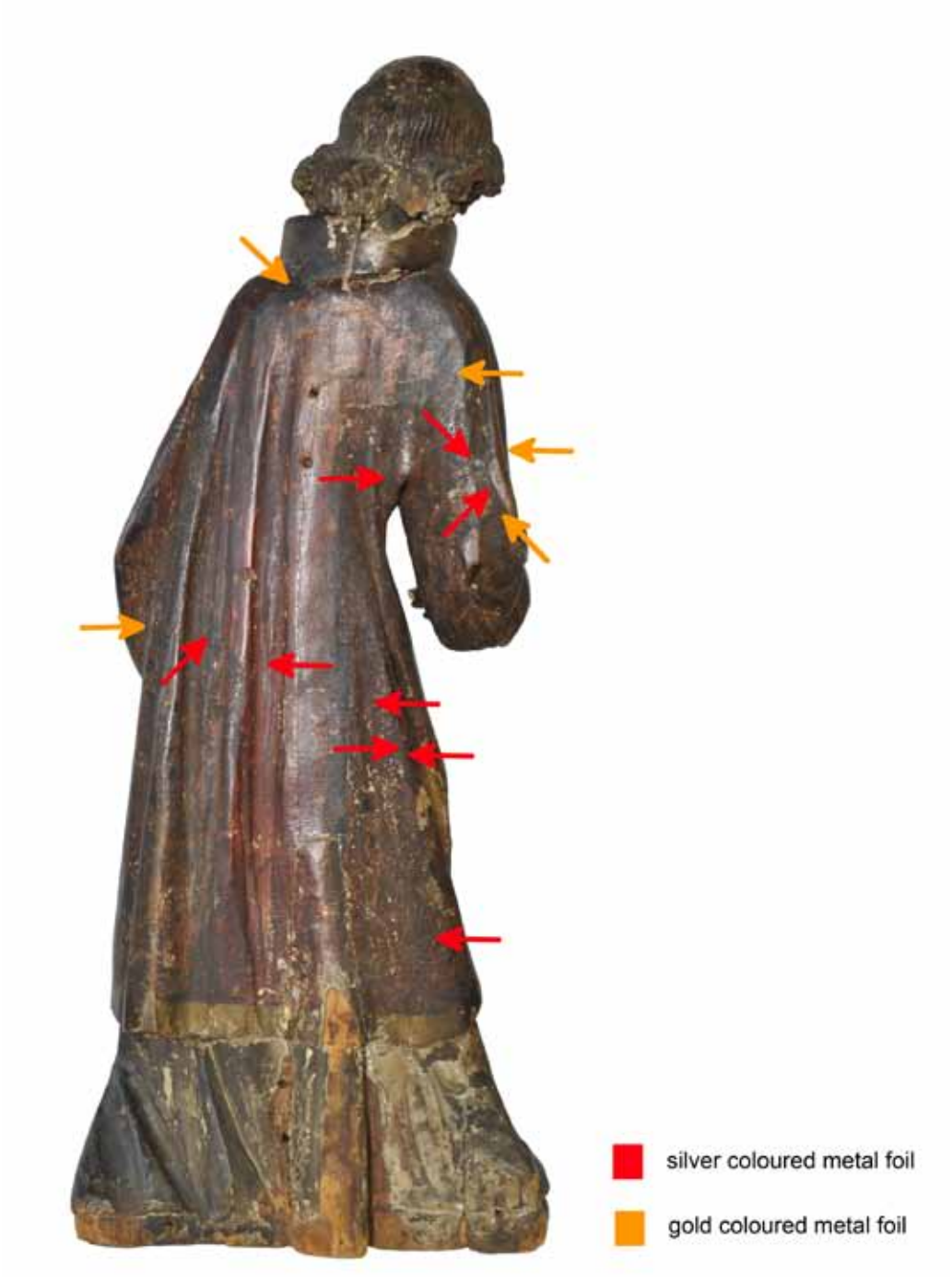



areas with gilding
yellow coloured decorative line
5 cm

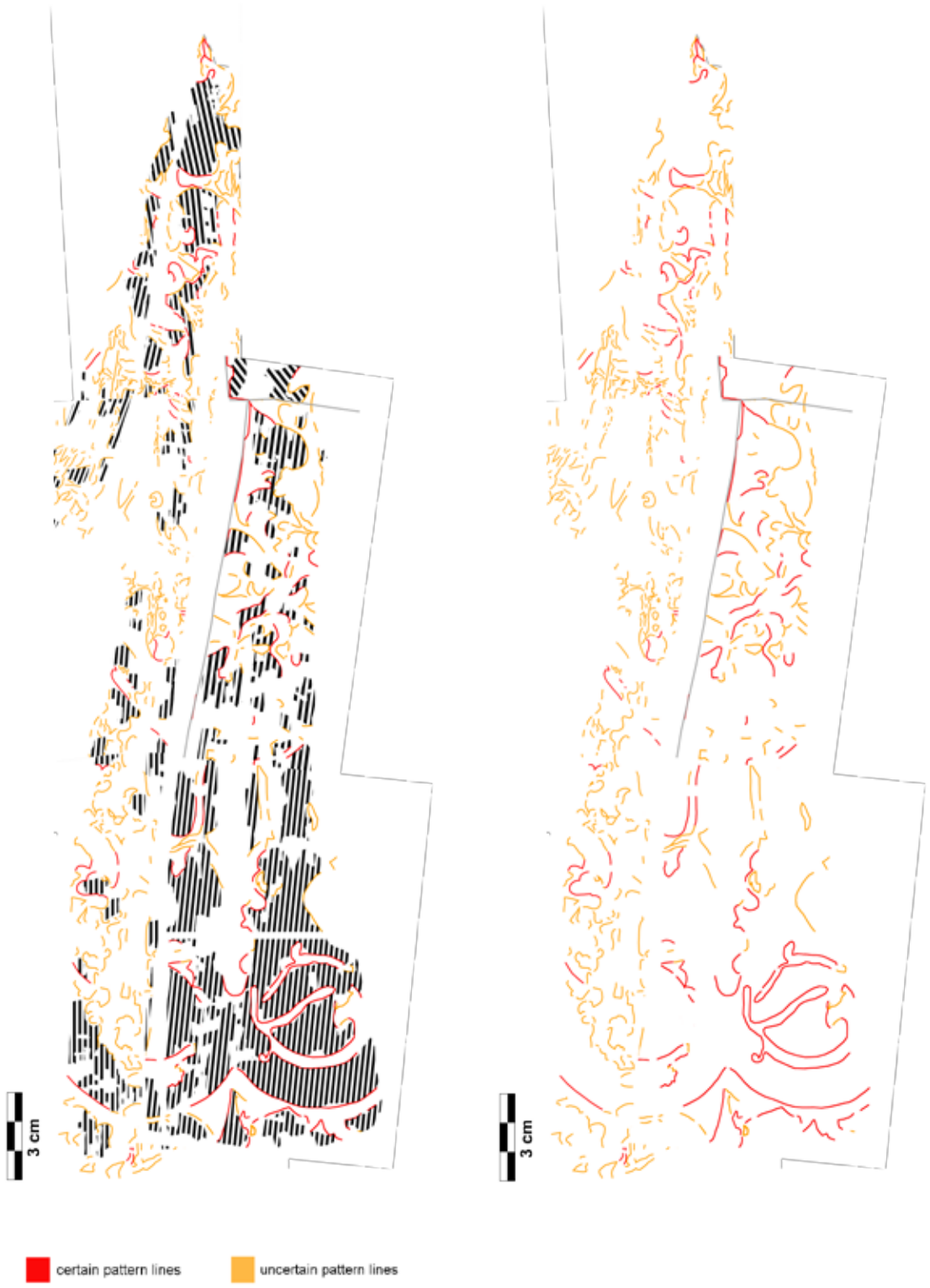
Mapping of special surface decoration and applied textile



Mapping of located metal foil

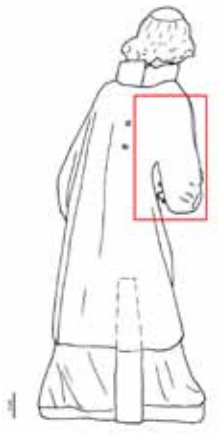


Reconstruction of observed pattern of the tin relief textile
(Montage of photographs # 02, 03, 06, 08, 09)

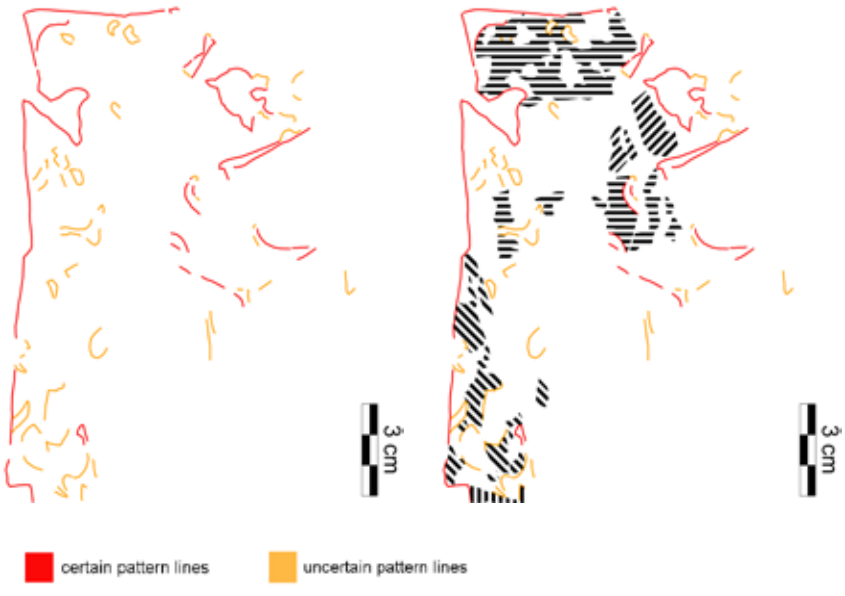


Reconstruction of observed pattern of the tin relief textile
(Montage of photographs # 02, 03, 06, 08, 09)

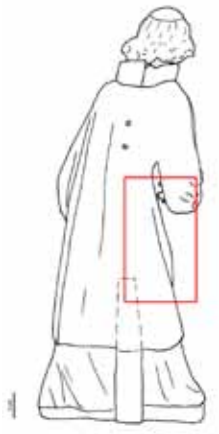
Reconstruction of the pattern of the applied relief textile



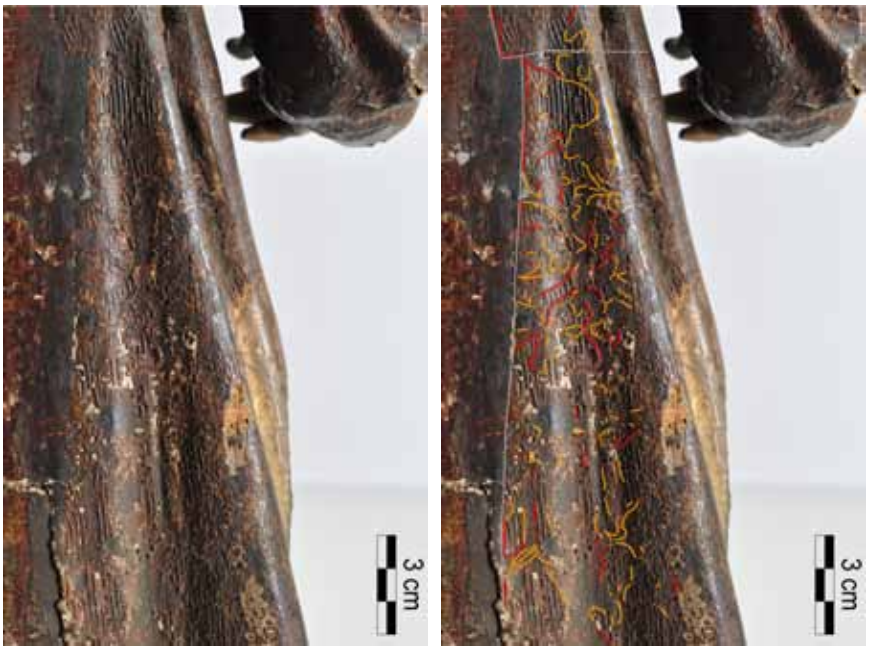
 # 01

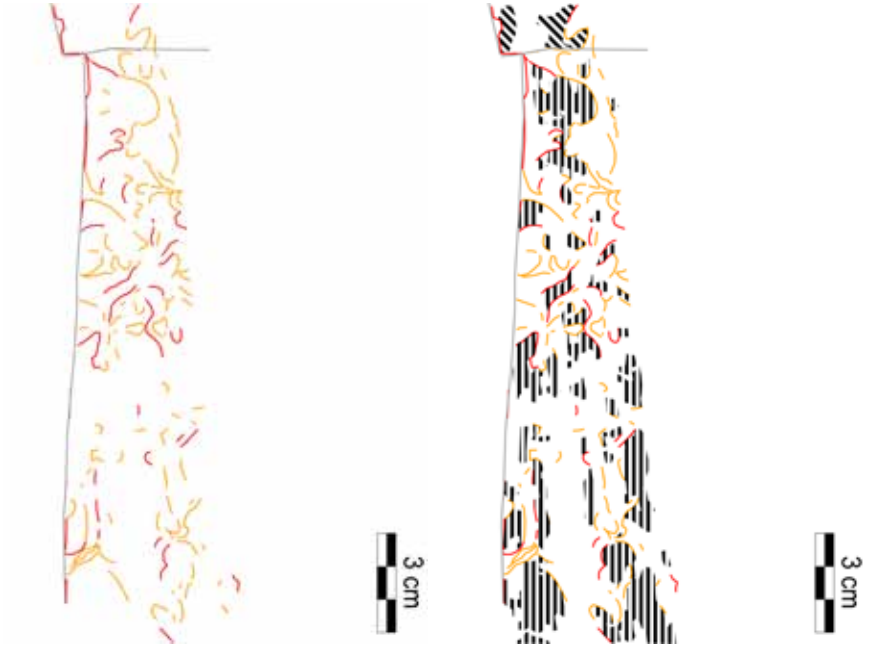


Reconstruction of the pattern of the applied relief textile



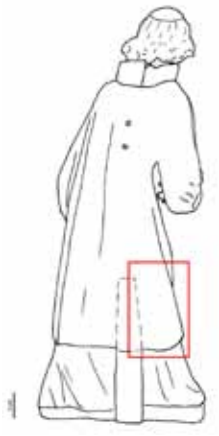
 # 02



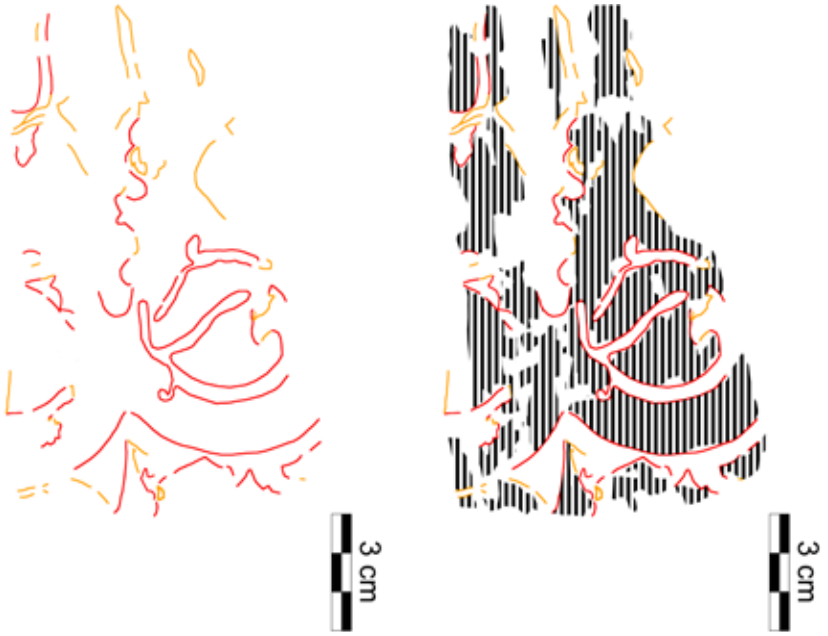


certain pattern lines uncertain pattern lines

Reconstruction of the pattern of the applied relief textile

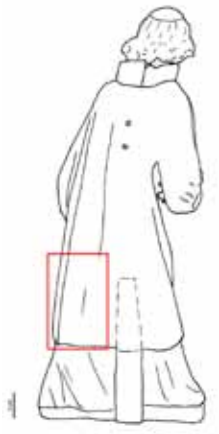


 # 03

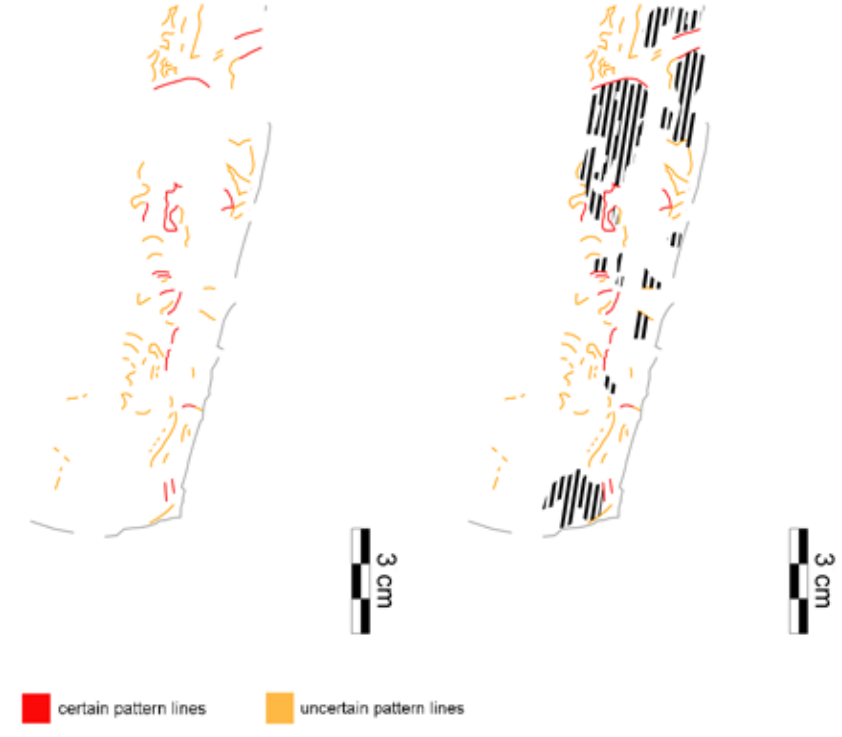


certain pattern lines uncertain pattern lines

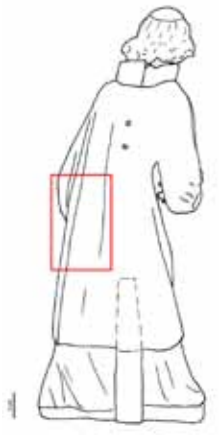
Reconstruction of the pattern of the applied relief textile



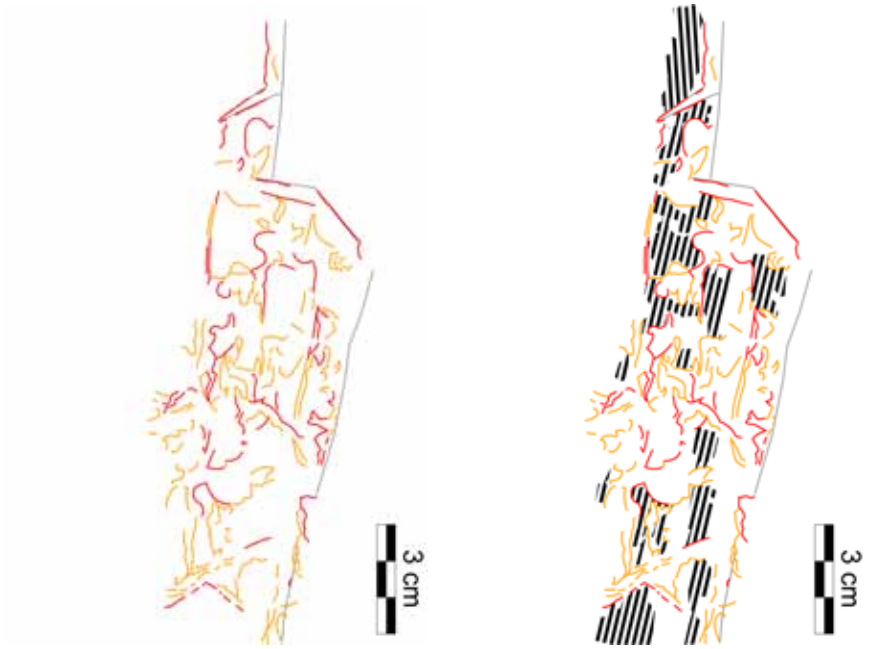
 # 04



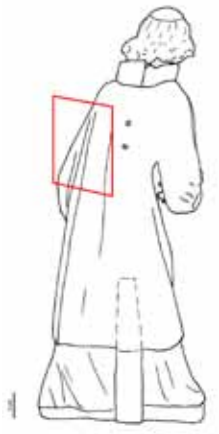
Reconstruction of the pattern of the applied relief textile



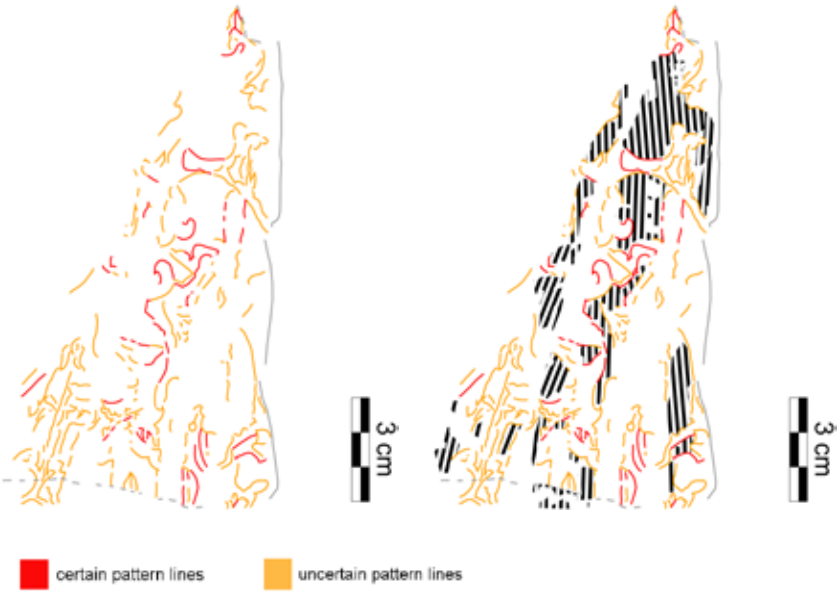
 # 05



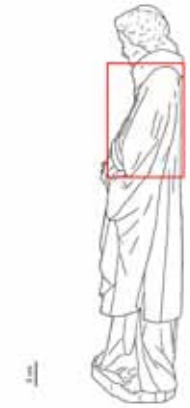
Reconstruction of the pattern of the applied relief textile



 # 06

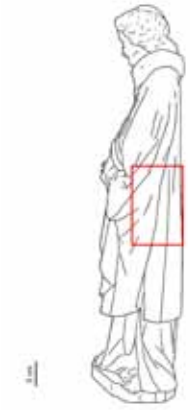


Reconstruction of the pattern of the applied relief textile

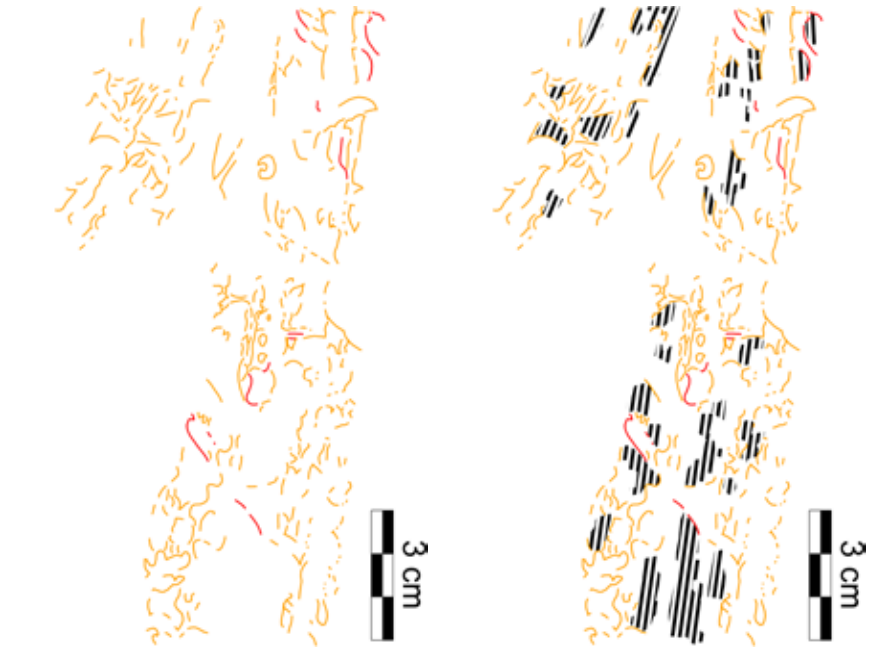


 # 07

Reconstruction of the pattern of the applied relief textile

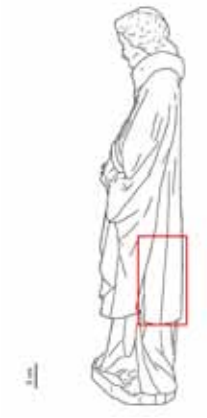


 # 08

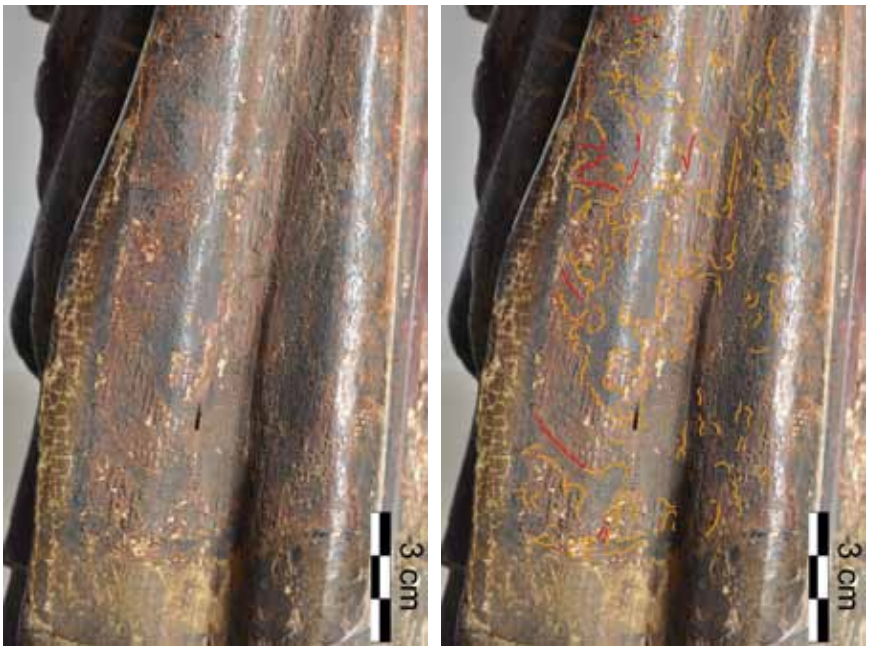


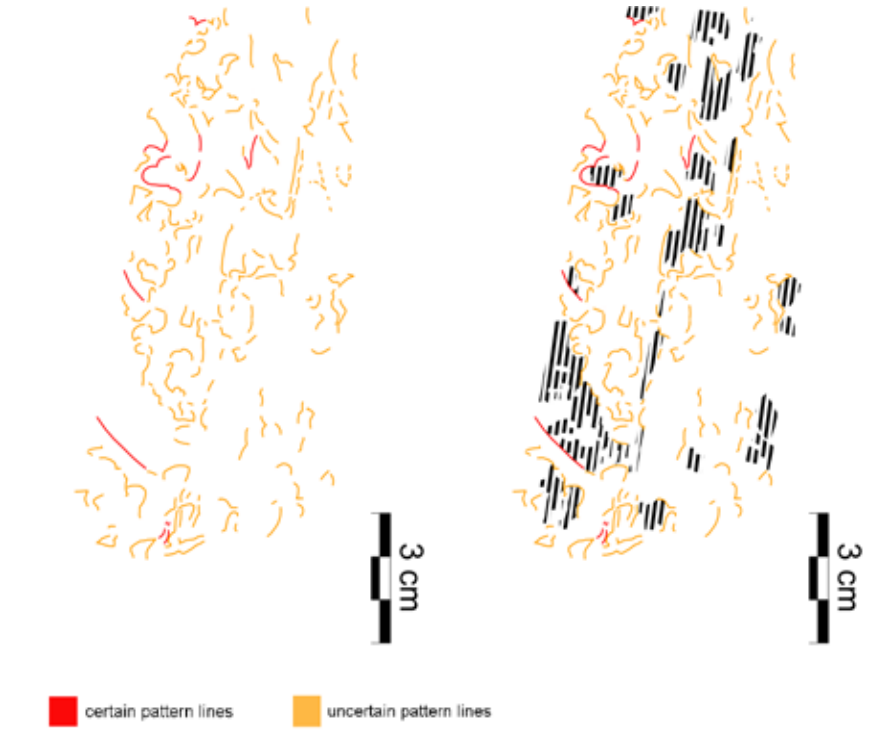
certain pattern lines uncertain pattern lines

Reconstruction of the pattern of the applied relief textile

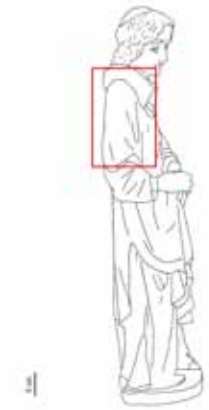


 # 09



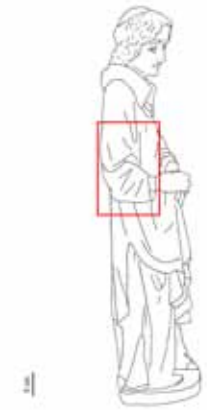


Reconstruction of the pattern of the applied relief textile

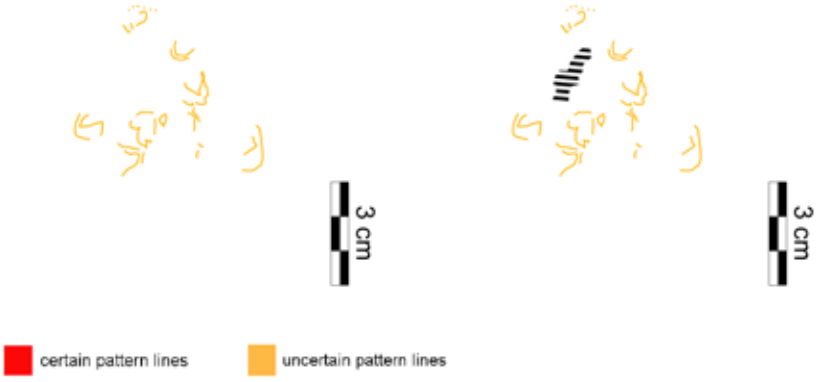


 # 10

Reconstruction of the pattern of the applied relief textile

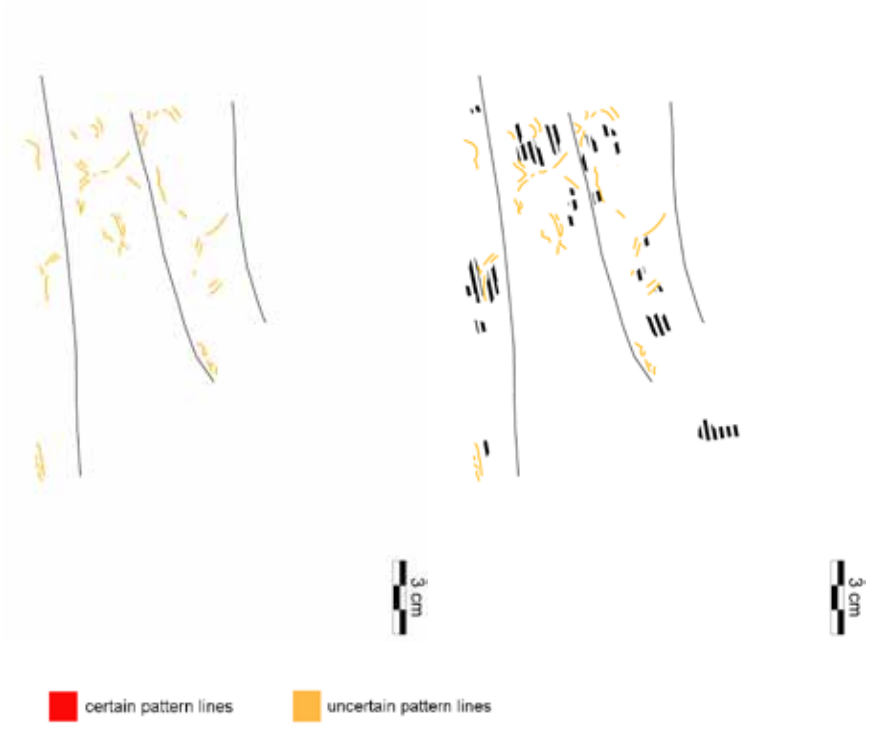


 # 11

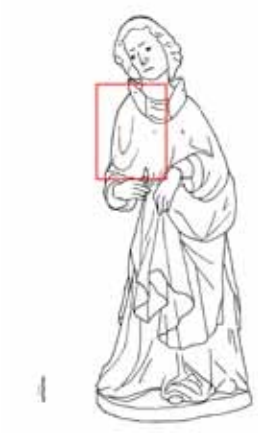


Reconstruction of the pattern of the applied relief textile

 # 12



Reconstruction of the pattern of the applied relief textile

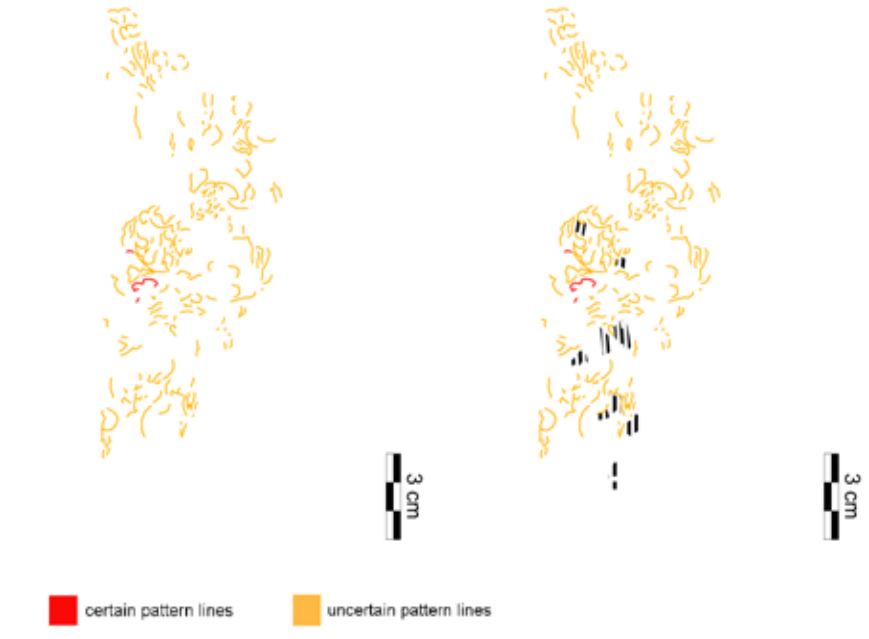


 # 13

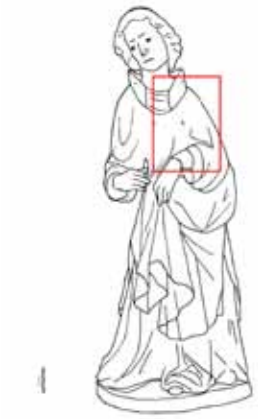
certain pattern lines uncertain pattern lines

Reconstruction of the pattern of the applied relief textile

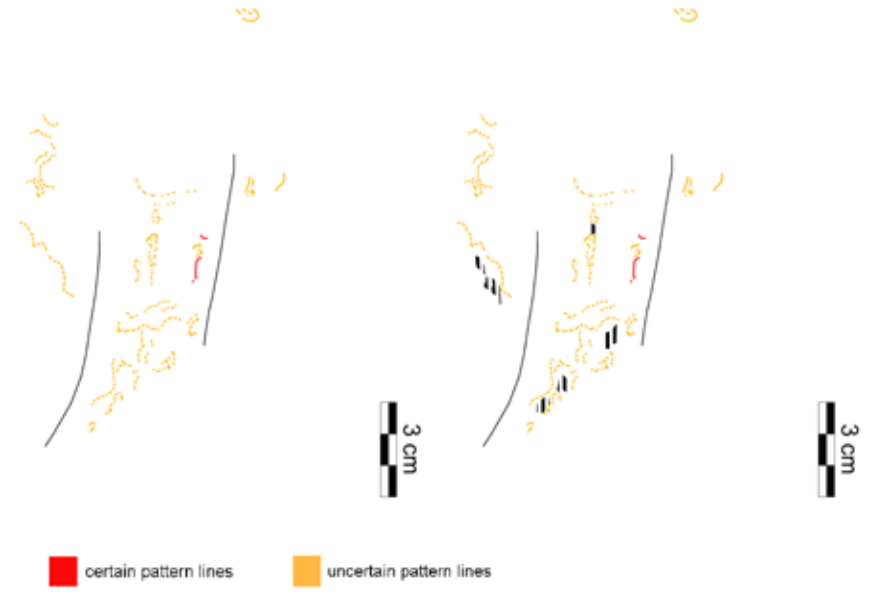
 # 14



Reconstruction of the pattern of the applied relief textile

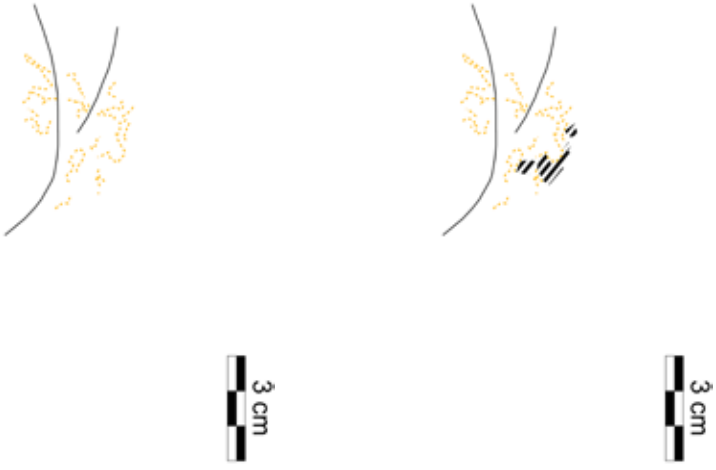


 # 15



Reconstruction of the pattern of the applied relief textile

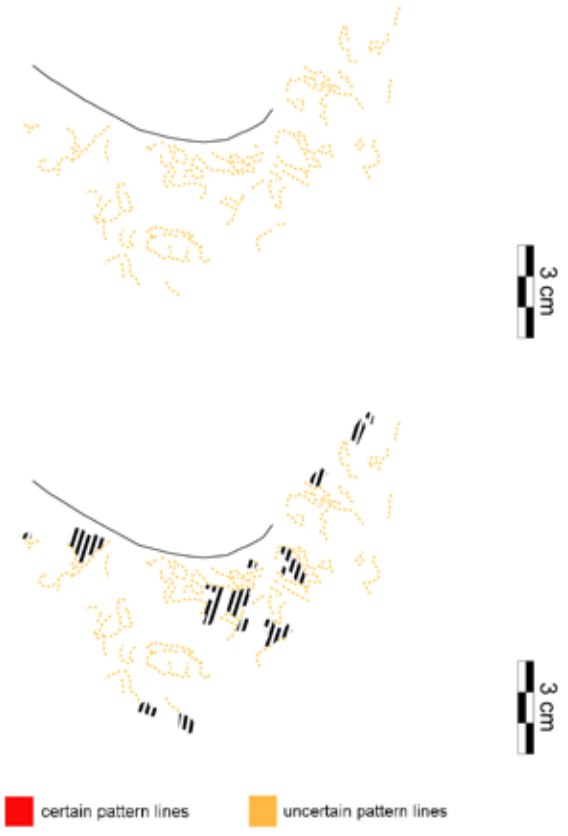
 # 16



certain pattern lines uncertain pattern lines

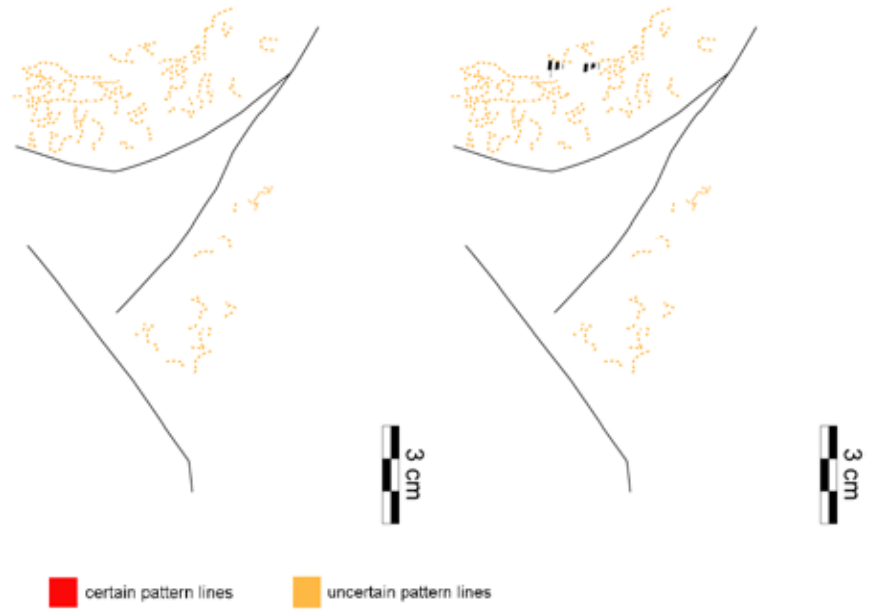
Reconstruction of the pattern of the applied relief textile

 # 17



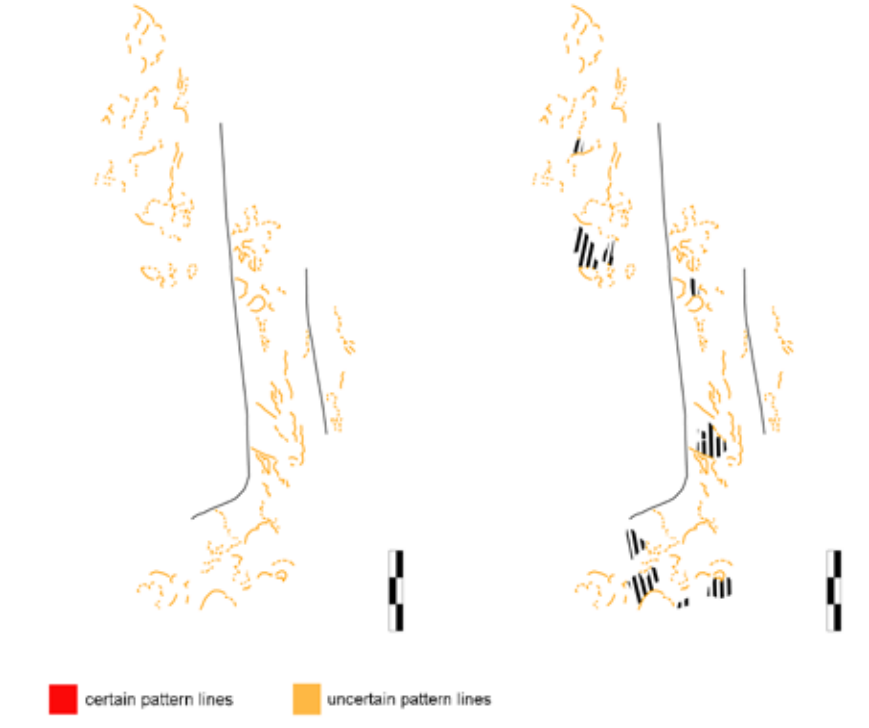
Reconstruction of the pattern of the applied relief textile

 # 18



Reconstruction of the pattern of the applied relief textile

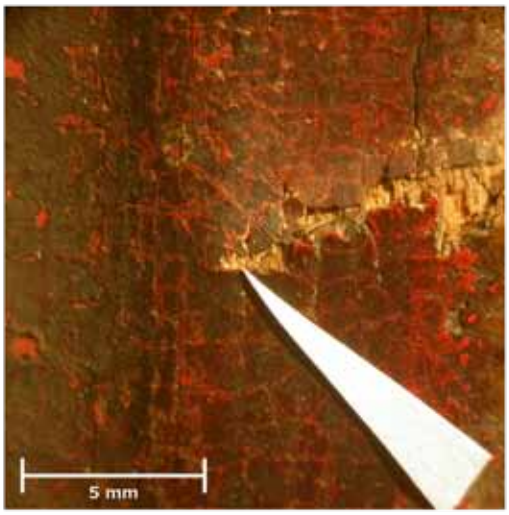
 # 19



Surface decoration samples

BC-50/30-CS-1 1/2

Sample description:	
Labelling:	BC-50/30-CS-1
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, left side at height of waist, red coloured area

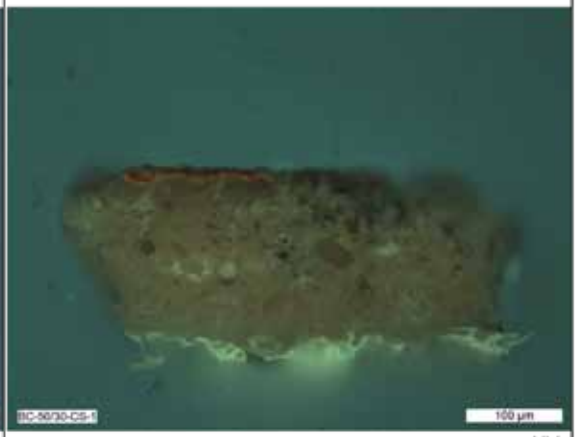


Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

VIS



UV

BC-50/30-CS-1 2/2

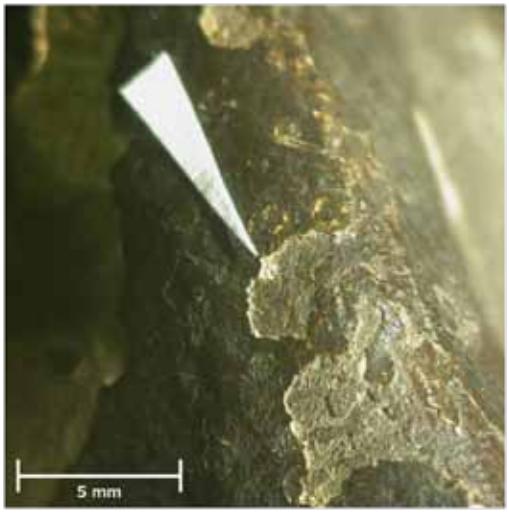
VIS UV

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Dark blackish layer; partially a thin dark interlayer	slightly fluorescent; interlayer shows no fluorescence	Soiling layer
...	Layer with bright orange to red colouration	bulk material of yellowish fluorescence; particles with deep red colouration	Paint layer
...	A bit darker and more transluscent layer	No fluorescence	Probably priming layer
...	Thick coarse-grained and white coloured layer, contains some huge particles	Overall no fluorescence (some fluorescent spots)	Ground, probably multilayered
lower most	Very thin translucent layer, no particles visible	Bright yellowish white fluorescence	Medium-rich layer, probably sealant

Surface decoration samples

BC-50/30-CS-2 1/2

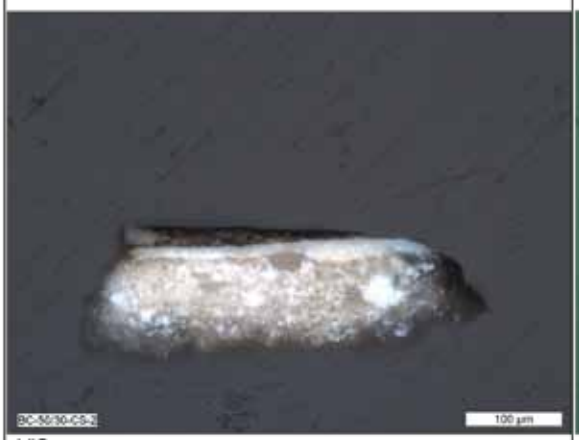
Sample description:	
Labelling:	BC-50/30-CS-2
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, fold on left side of undergarment



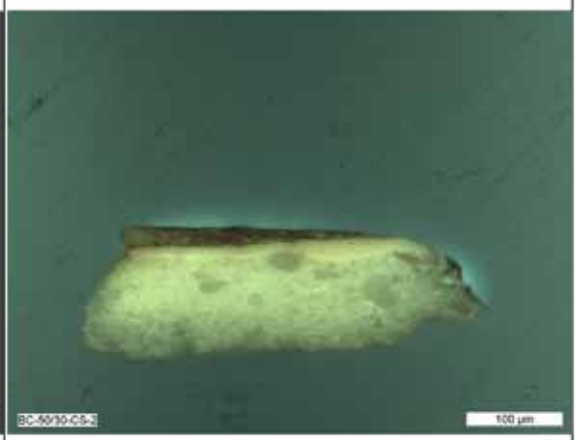
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

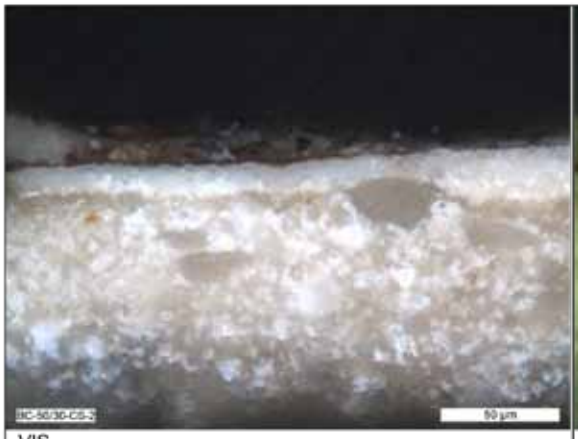


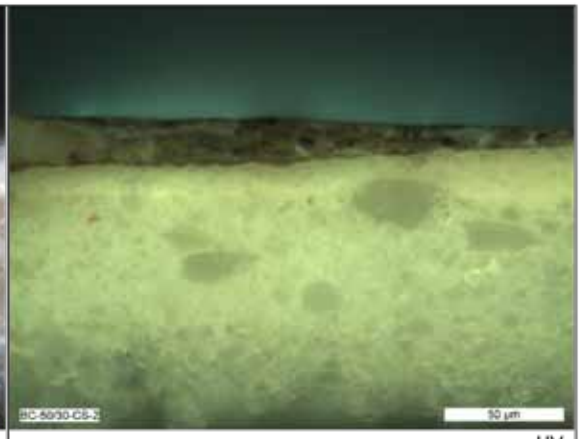
VIS



UV

BC-50/30-CS-2 2/2


VIS


UV

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Black coloured layer	Overall no fluorescence, some slightly fluorescent spots	Probably soiling layer, seems to be partially medium-rich
...	Inhomogeneous layer of greyish colouration with darker smaller particles and bigger lighter (nearly white) particles	No fluorescence	Paint layer
...	Very thin greyish seemingly slightly translucent layer	No fluorescence	Priming layer? Paint layer?
...	Thinner white coloured layer with smaller grains than layer below	Light yellowish white fluorescence	Paint layer or ground layer
lower most	Thick coarse-grained white coloured layer, with some huge particles	Light white fluorescence	Ground

Surface decoration samples

BC-50/30-CS-3 1/5

Sample description:	
Labelling:	BC-50/30-CS-3
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, left side of gown, height of the pattern lines of the applied relief textile

Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

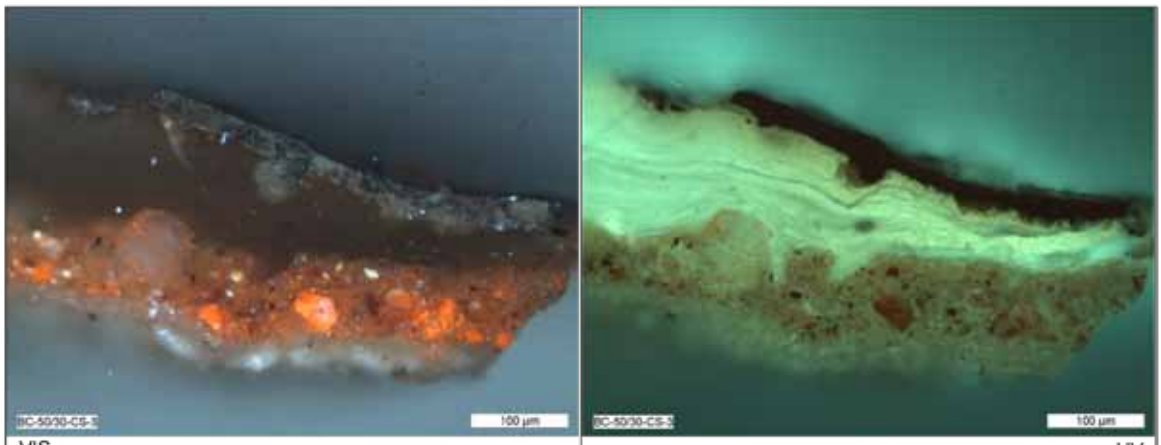
Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

VIS

UV

BC-50/30-CS-3 2/5



VIS UV

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Thin black layer	Light grey colouration	Soiling
...	Dense, dark grey metallic layer	Dark red colouration	Metal foil
...	Brown translucent layer, no particles visible	Bright white to yellow fluorescence	Medium-rich layer, probably wax (with or without admixtures of oil or resin); supposedly at least two layers
...	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with some fluorescent spots; particles have brownish orange colouration	Probably a coloured preparation layer
lower most	white coloured layer	Light grey colouration with light fluorescence spots	Ground

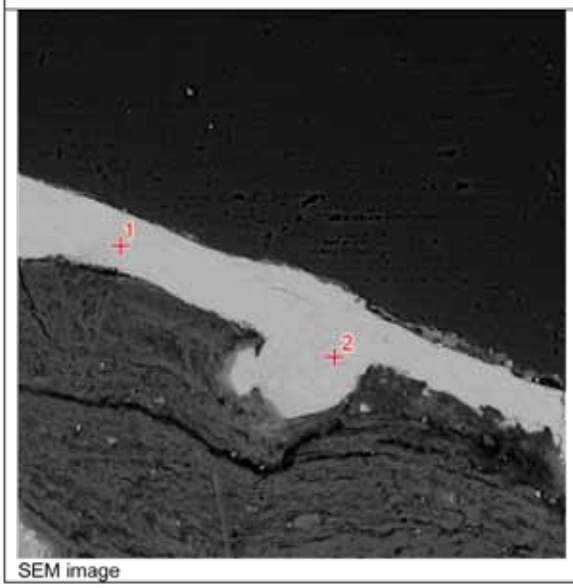
BC-50/30-CS-3 3/5

Analysis:	
Method of analysis:	SEM-EDX
Analysed by:	Dr. Dipl.-Rest. Cristina Thieme assisted by Barbara Jörg

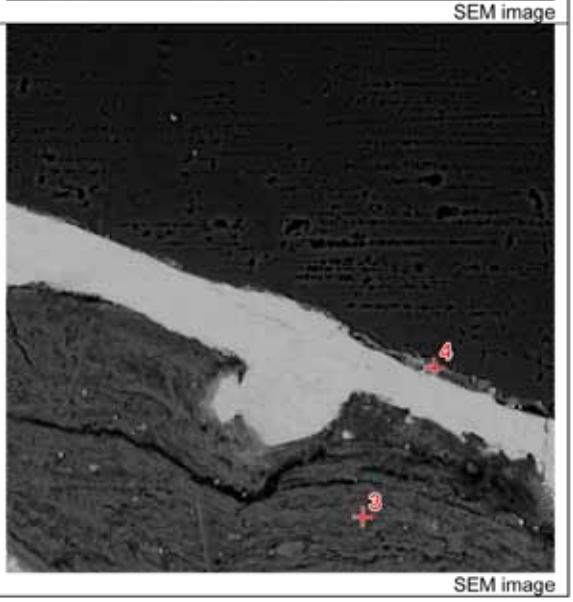
Images:

VIS

SEM image



SEM image

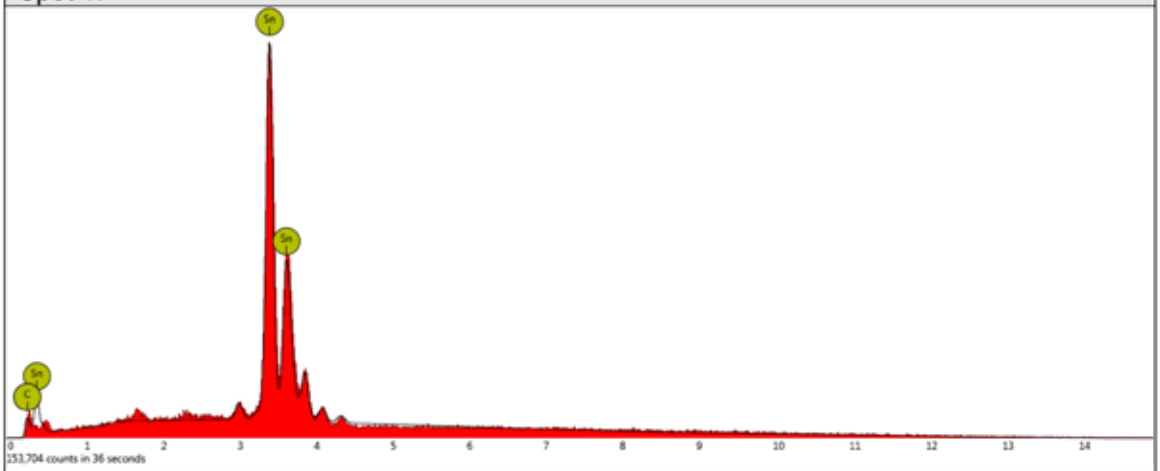


SEM image

BC-50/30-CS-3 4/5

Results:

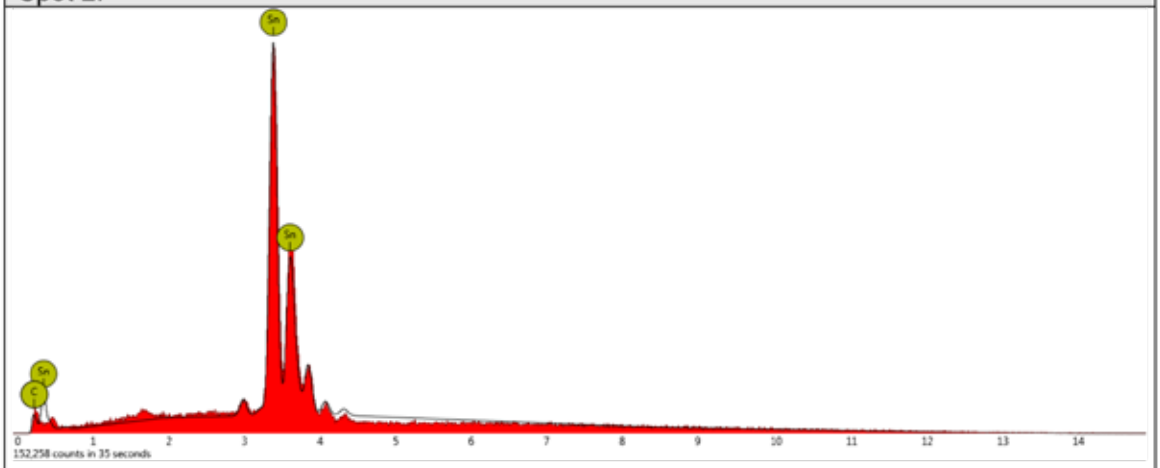
Spot 1:



	Weight percentage	Certainty
Sn	99.5 %	99.4 %
C	0.5 %	95.1 %

Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
50	Sn	Tin	Manual	99.5	0.6
6	C	Carbon	100.0	0.5	4.9

Spot 2:



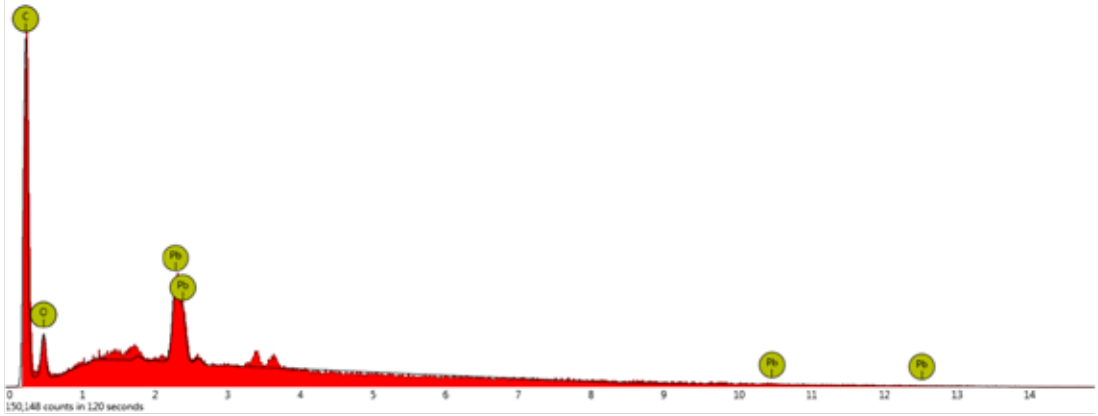
	Weight percentage	Certainty
Sn	99.5 %	99.4 %
C	0.5 %	95.0 %

Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
50	Sn	Tin	Manual	99.5	0.6
6	C	Carbon	100.0	0.5	5.0

BC-50/30-CS-3 5/5

Results:

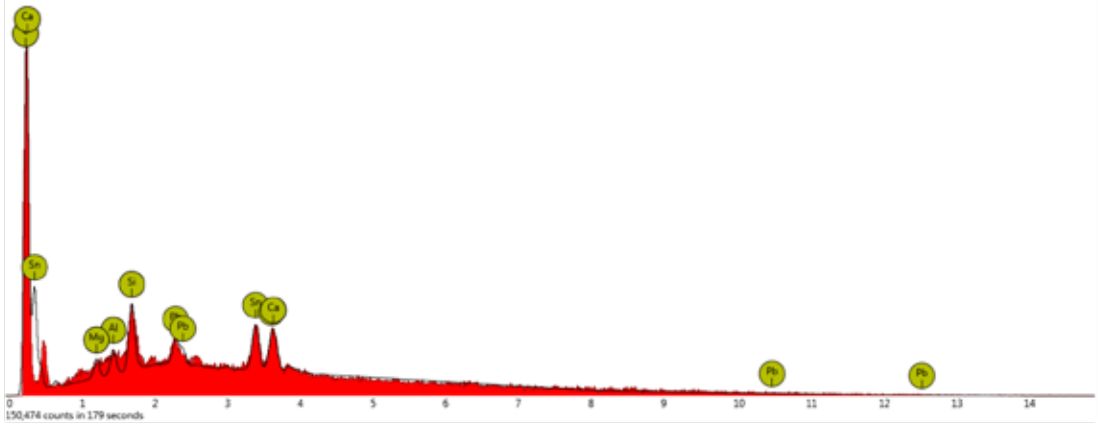
Spot 3:



	Weight percentage	Certainty
Pb	40.2 %	98.5 %
O	36.2 %	97.5 %
C	23.6 %	99.2 %

Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
82	Pb	Lead	100.0	40.2	1.5
8	O	Oxygen	100.0	36.2	2.5
6	C	Carbon	100.0	23.6	0.8

Spot 4:



	Weight percentage	Certainty
C	36.3 %	99.1 %
Sn	22.2 %	97.6 %
Pb	17.0 %	96.0 %
Si	9.5 %	97.9 %
Mg	5.4 %	95.0 %
Al	5.0 %	95.8 %
Ca	4.6 %	95.5 %

Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
6	C	Carbon	100.0	36.3	0.9
50	Sn	Tin	Manual	22.2	2.4
82	Pb	Lead	Manual	17.0	4.0
14	Si	Silicon	100.0	9.5	2.1
12	Mg	Magnesium	100.0	5.4	5.0
13	Al	Aluminium	100.0	5.0	4.2
20	Ca	Calcium	100.0	4.6	4.5

Surface decoration samples

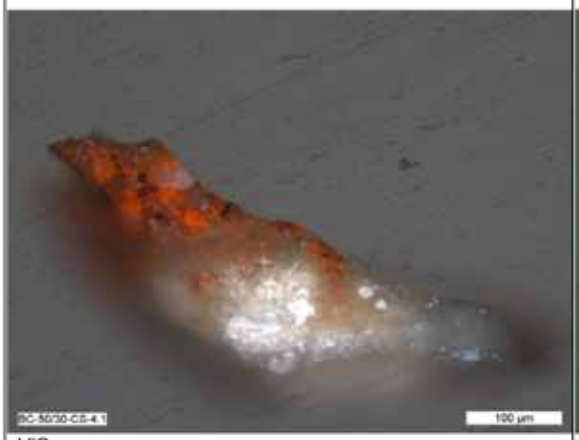
BC-50/30-CS-4.1 1/2

Sample description:	
Labelling:	BC-50/30-CS-4.1
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, left side of gown, area of applied relief textile with no pattern lines

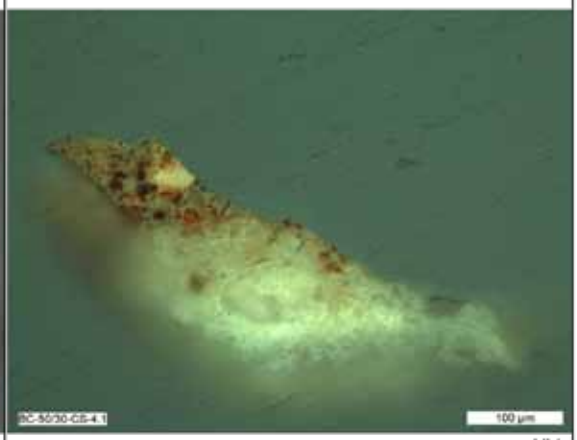
Notes:	Initial sample broken into 3 pieces during sampling (4.1 ; 4.2; 4.3)
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:



VIS



UV

BC-50/30-CS-4.1 2/2

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with some fluorescent spots; particles have brownish orange colouration	Probably coloured preparation layer
lower most	white coloured layer, coarse-grained with big particles	Light grey colouration with light fluorescence	Ground

Surface decoration samples

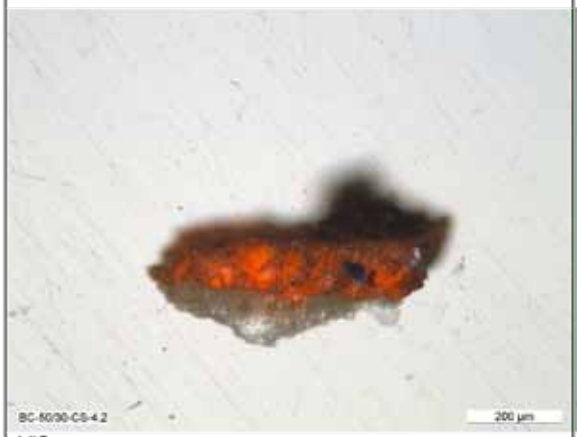
BC-50/30-CS-4.2 1/2

Sample description:	
Labelling:	BC-50/30-CS-4.2
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, left side of gown, area of applied relief textile with no pattern lines

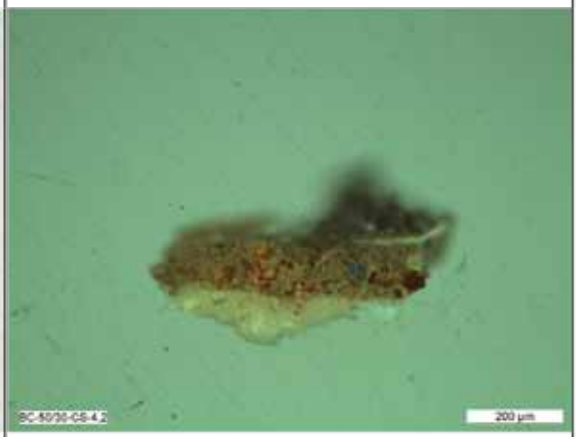
Notes:	Initial sample broken into 3 pieces during sampling (4.1 ; 4.2; 4.3)
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

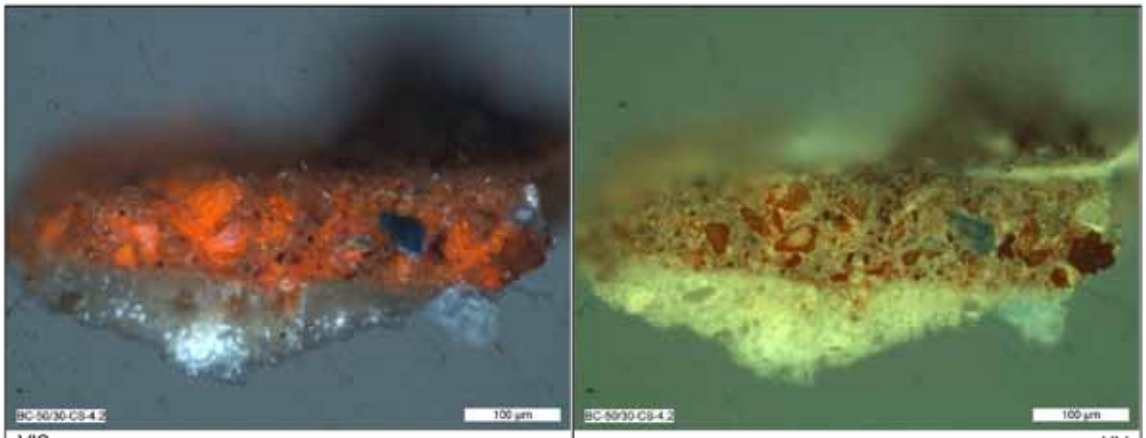


VIS



UV

BC-50/30-CS-4.2 2/2



VIS UV

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Inhomogeneous dark brown to black coloured layer, contains few red particles	Grey colouration	Soiling
...	Thin greyish brown coloured layer, no particles visible	Yellowish white fluorescence	Medium-rich layer, relief mass, probably wax (with or without admixtures of oil or resin)
...	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with fluorescent areas; particles have brownish orange colouration	Probably coloured preparation layer
lower most	white coloured layer	Yellowish white fluorescence	Ground

Surface decoration samples

BC-50/30-CS-4.3 1/2

Sample description:	
Labelling:	BC-50/30-CS-4.3
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, left side of gown, area of applied relief textile with no pattern lines

Notes:	Initial sample broken into 3 pieces during sampling (4.1 ; 4.2; 4.3)
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

VIS

UV

BC-50/30-CS-4.3 2/2

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Inhomogeneous dark grey to black coloured layer, partially slightly translucent	Light grey translucent colouration	Soiling
lower most	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with fluorescent areas; particles have brownish orange colouration	Probably coloured preparation layer

Surface decoration samples

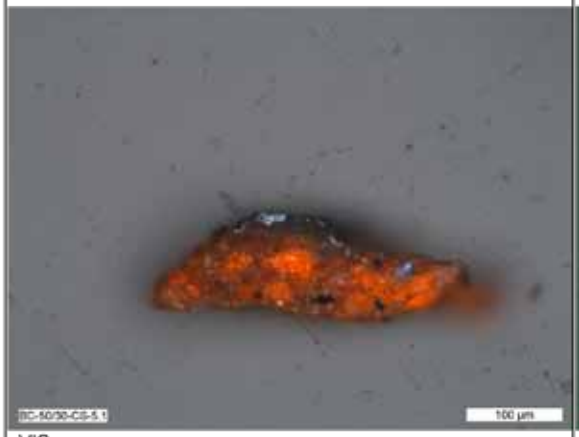
BC-50/30-CS-5.1 1/2

Sample description:	
Labelling:	BC-50/30-CS-5.1
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, left side of gown, area of applied relief textile with no pattern lines

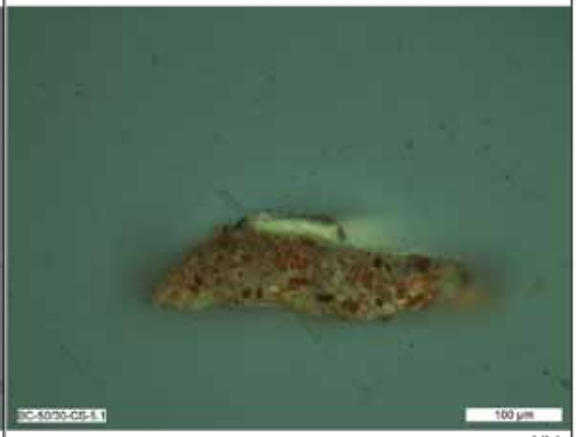
Notes:	Initial sample broken into 2 pieces during sampling (5.1 ; 5.2)
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:



VIS



UV

BC-50/30-CS-5.1 2/2

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Inhomogeneous dark grey to black coloured layer	Grey colouration	Soiling
...	Thin greyish brown coloured layer, no particles visible	Yellowish white fluorescence	Medium-rich layer, relief mass, probably wax (with or without admixtures of oil or resin)
lower most	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with some fluorescent spots; particles have brownish orange colouration	Probably coloured preparation layer

Surface decoration samples

BC-50/30-CS-5.2 1/2

Sample description:	
Labelling:	BC-50/30-CS-5.2
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, left side of gown, area of applied relief textile with no pattern lines

Notes:	Initial sample broken into 2 pieces during sampling (5.1 ; 5.2)
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

VIS

UV

BC-50/30-CS-5.2 2/2

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with some fluorescent spots; particles have brownish orange colouration	Probably coloured preparation layer
lower most	white coloured layer, coarse-grained with big particles	Light yellowish white fluorescence	Ground

Surface decoration samples

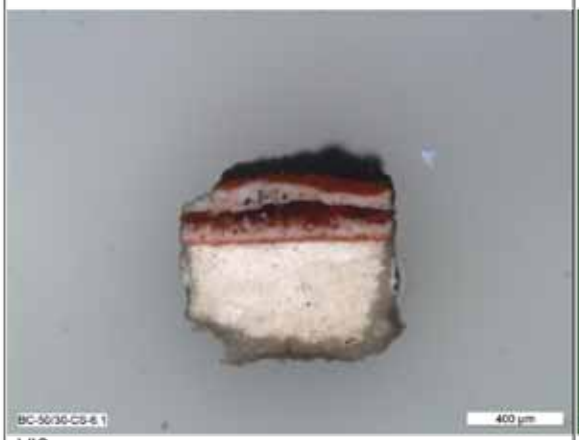
BC-50/30-CS-6.1 1/4

Sample description:	
Labelling:	BC-50/30-CS-6.1
Sampled by:	Barbara Jörg
Sampling location:	Front of sculpture, right side of face near hair line, flesh coloured area with blood

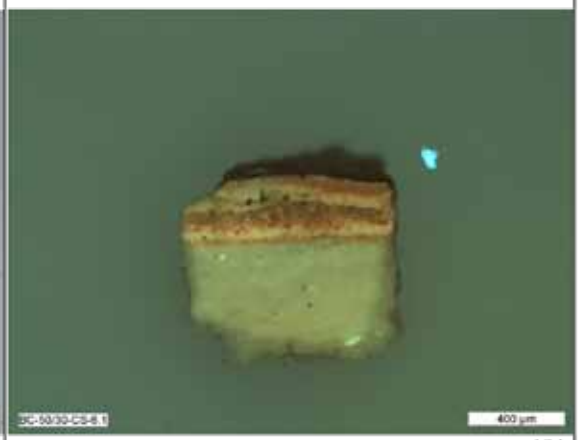
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:



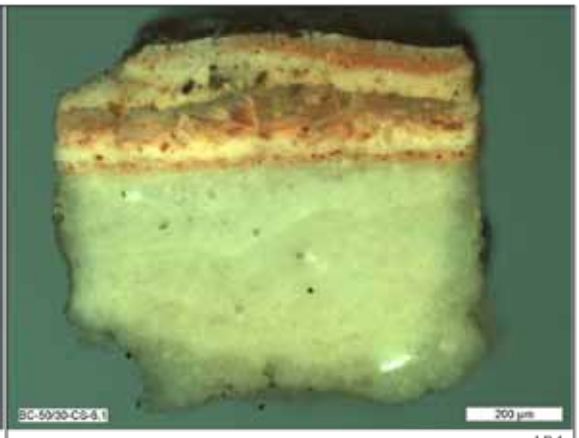
VIS



UV

BC-50/30-CS-6.1 2/4

VIS



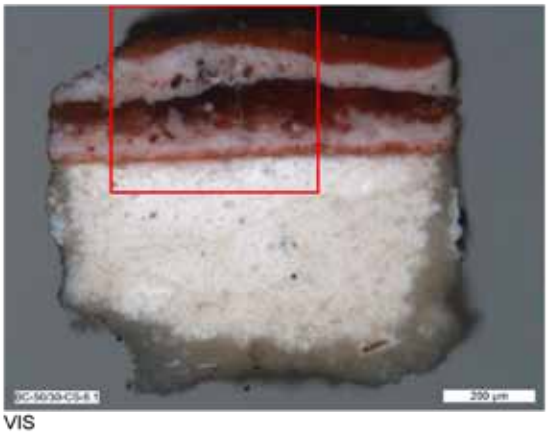
UV

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Inhomogeneous dark blackish layer	Grey to black colouration, no fluorescence	Soiling
...	Red coloured layer with small red opaque particles	Light orange to white fluorescence, particles have dark red colouration	Paint layer (blood), probably overpainting
...	white, slightly pinkish coloured layer enclosing small red particles	Yellowish white fluorescence	Paint layer (flesh colour), probably overpainting
...	Thick slightly translucent deep and dark red coloured layer containing big particle	Partially grey colouration with marginal fluorescence, partially light orange fluorescence, particles have light orange to red fluorescence	Paint layer (blood)
...	White slightly pinkish layer with big particles	Yellowish white fluorescence	Paint layer (flesh colour)
...	Thin layer of light red colouration with deep red coloured particles	Light orange fluorescence with red coloured particles	Paint layer
...	Very thin and a bit translucent layer of brownish grey colouration	slightly fluorescent	Probably priming
lower most	Thick white coloured layer, quite coarse-grained	Light white fluorescence	Ground, presumably multi-layered (at least 2 layers)

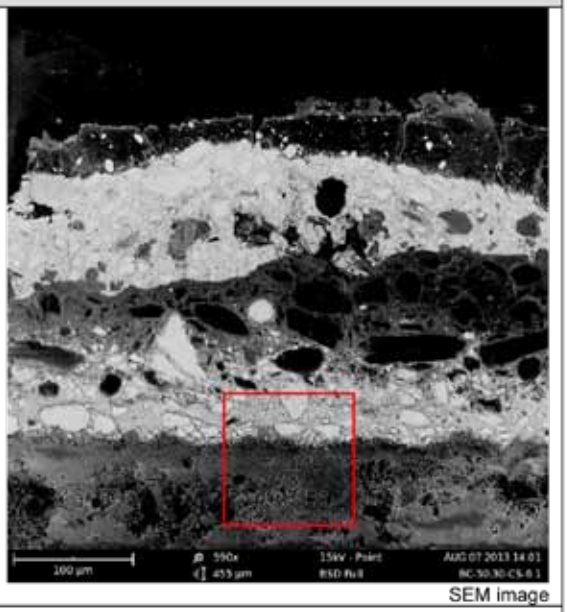
BC-50/30-CS-6.1 3/4

Analysis:	
Method of analysis:	SEM-EDX
Analysed by:	Dr. Dipl.-Rest. Cristina Thieme assisted by Barbara Jörg

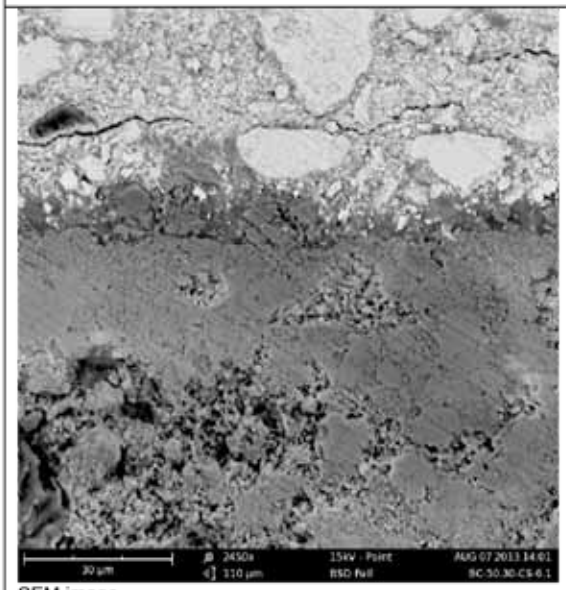
Images:



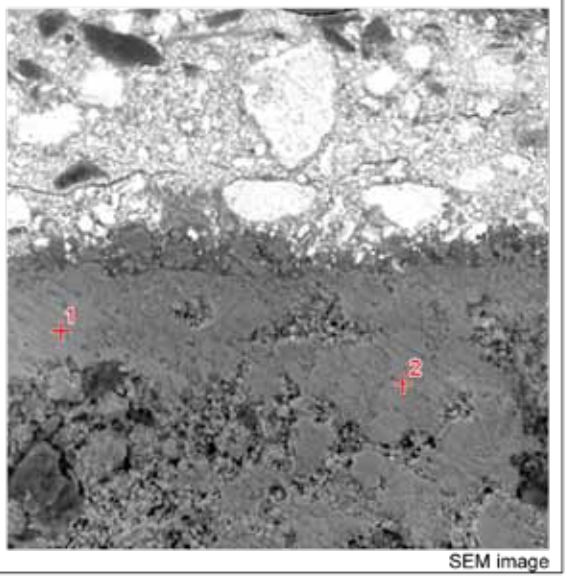
VIS



SEM image



SEM image

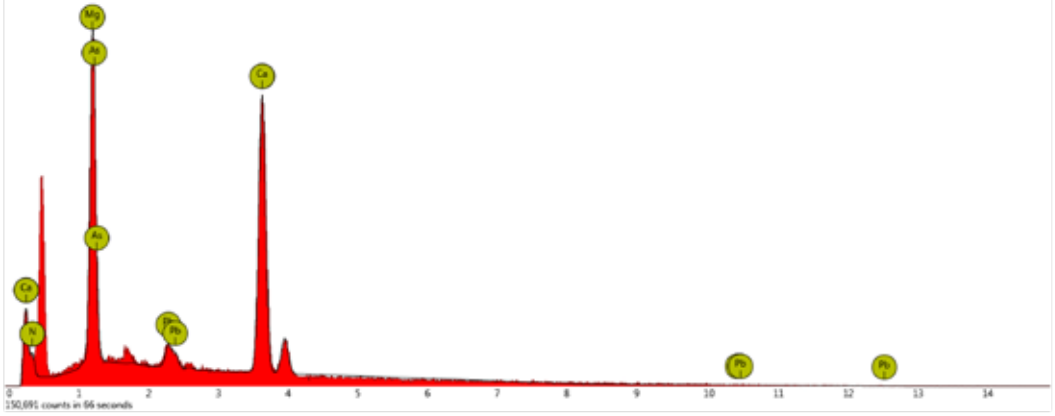


SEM image

BC-50/30-CS-6.1 4/4

Results:

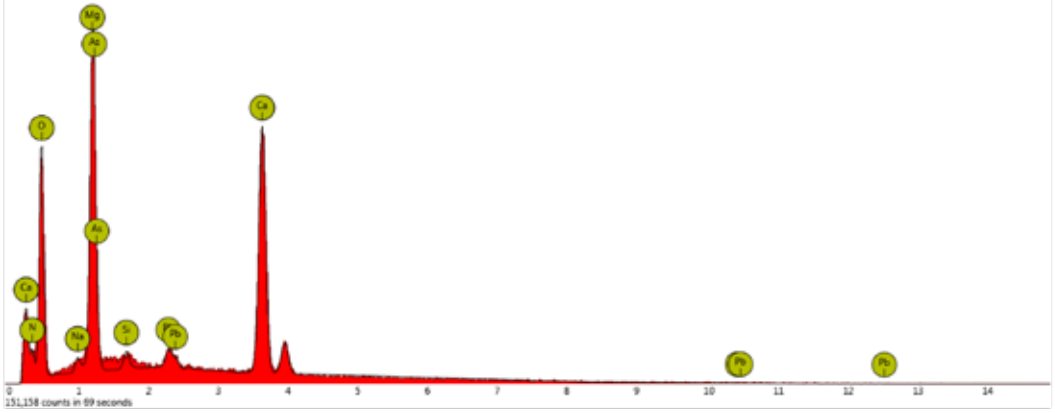
Spot 1:



	Weight percentage	Certainty
Mg	34.1 %	99.2 %
Ca	28.9 %	99.3 %
N	15.0 %	96.5 %
As	11.9 %	96.8 %
Pb	10.1 %	96.5 %

Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
12	Mg	Magnesium	100.0	34.1	0.8
20	Ca	Calcium	100.0	28.9	0.7
7	N	Nitrogen	100.0	15.0	3.5
33	As	Arsenic	100.0	11.9	3.2
82	Pb	Lead	100.0	10.1	3.5

Spot 2:



	Weight percentage	Certainty
O	48.6 %	99.1 %
Mg	20.1 %	99.2 %
Ca	11.5 %	99.3 %
As	9.1 %	97.6 %
N	4.6 %	96.9 %
Pb	3.5 %	96.2 %
Na	1.8 %	95.1 %
Si	0.9 %	95.7 %

Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
8	O	Oxygen	Manual	48.6	0.9
12	Mg	Magnesium	100.0	20.1	0.8
20	Ca	Calcium	100.0	11.5	0.7
33	As	Arsenic	100.0	9.1	2.4
7	N	Nitrogen	100.0	4.6	3.1
82	Pb	Lead	100.0	3.5	3.8
11	Na	Sodium	100.0	1.8	4.9
14	Si	Silicon	100.0	0.9	4.3

Surface decoration samples

BC-50/30-CS-6.2 1/2

Sample description:	
Labelling:	BC-50/30-CS-6.2
Sampled by:	Barbara Jörg
Sampling location:	Front of sculpture, right side of face near hair line, flesh coloured area with blood

Notes:	Upper paint layers that came off during sampling of 6.1
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

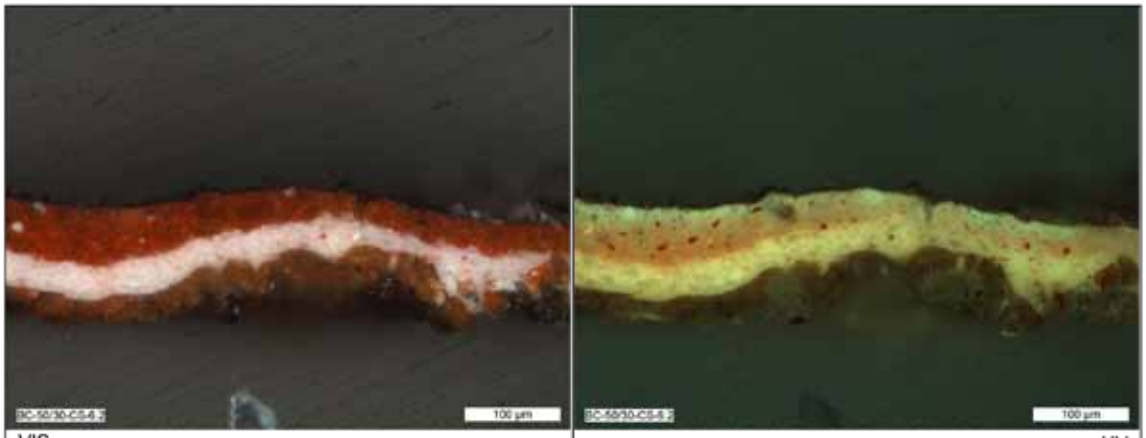
Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

VIS

UV

BC-50/30-CS-6.2 2/2



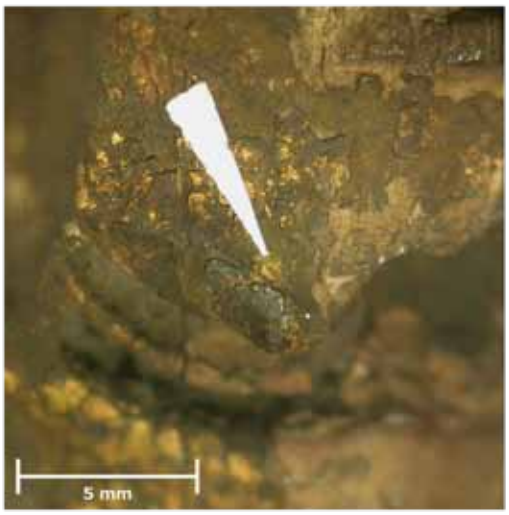
VIS UV

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Inhomogeneous dark blackish layer	Grey colouration, no fluorescence	Soiling
...	Red coloured layer with small red opaque particles	Light orange to white fluorescence, particles have dark red colouration	Paint layer (blood)
...	white, slightly pinkish coloured layer enclosing small red particles	Yellowish white fluorescence	Paint layer (flesh colour)
lower most	Slightly translucent layer of orange to brown colouration, contains small orange to red coloured particles	Grey to brown colouration, no fluorescence, particles have red colouration	Paint layer (blood)

Surface decoration samples

BC-50/30-CS-7 1/2

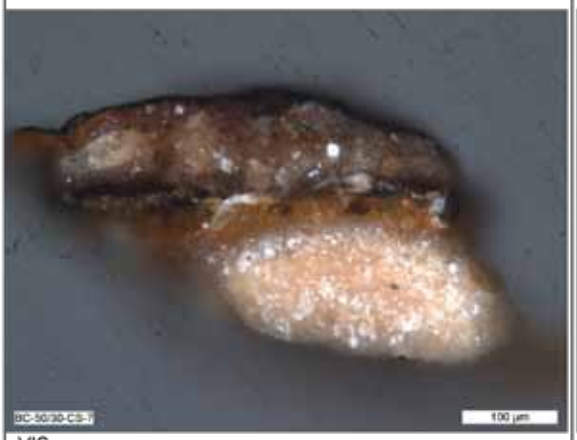
Sample description:	
Labelling:	BC-50/30-CS-7
Sampled by:	Barbara Jörg
Usage:	Cross-section
Sampling location:	Hair on lower right side of the head



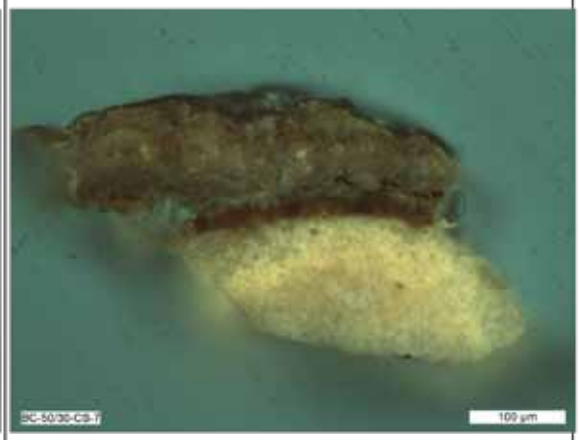
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

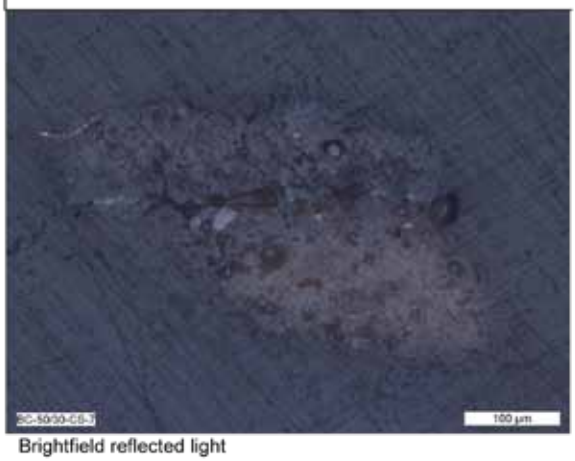


VIS



UV

BC-50/30-CS-7 2/2



Brightfield reflected light

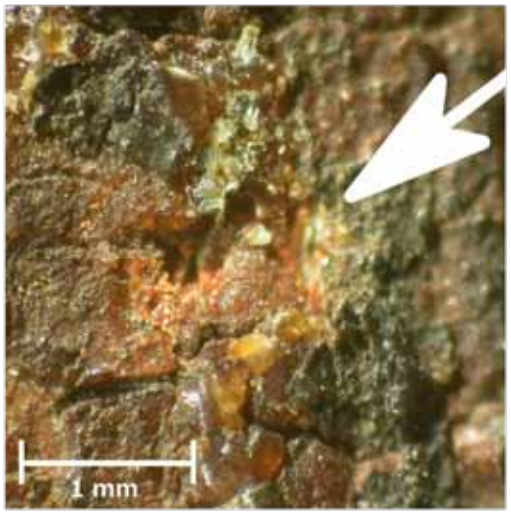
Results:

Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	blackish colouration	No fluorescent, but a slightly fluorescent in some areas	Soiling, probably multi-layered
...	Gold leaf	-	Gilding
...	Orange to red coloured layer	Greyish brown colouration	Most likely gilding ground
...	White to brown coloured package, probably multi-layered	Grey colouration with some slightly fluorescent spots	?
...	Gold coloured leaf	-	gilding
...	Orange coloured layer	Brown colouration	Probably gilding ground
lower most	white coloured layer	Yellow fluorescence	Ground

Surface decoration samples

BC-50/30-CS-8.1 1/2

Sample description:	
Labelling:	BC-50/30-CS-8.1
Sampled by:	Barbara Jörg
Usage:	Cross-section
Sampling location:	Back of sculpture, left side at height of waist, red coloured area



Notes:	Sample is broken during sampling (BC-50/30-CS-8.1, BC-50/30-CS-8.2)
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

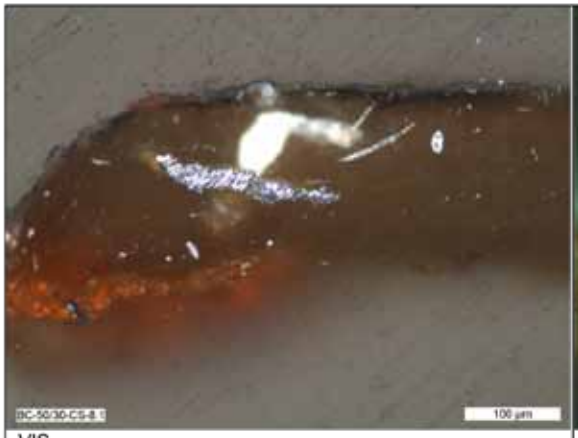
Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

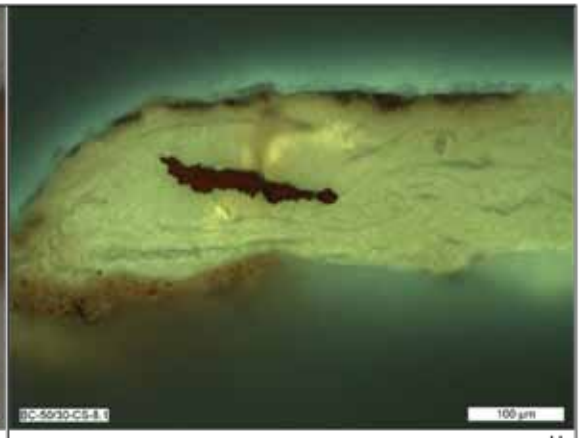
VIS

UV

BC-50/30-CS-8.1 2/2



VIS



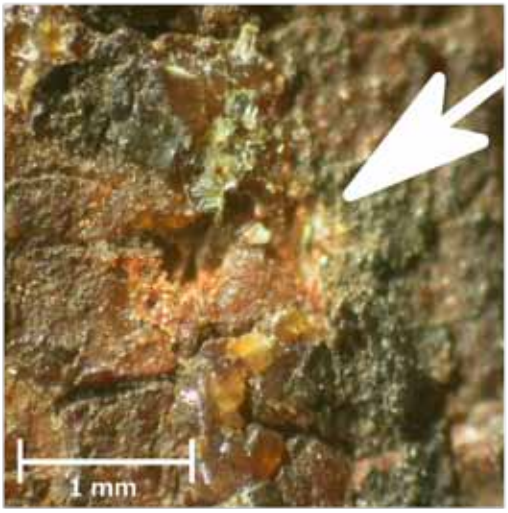
U

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Thin inhomogeneous dark grey to black coloured layer	Dark grey colouration	Soiling
...	Thin greyish brown coloured layer, no particles visible. Dense interlayer of silver colouration	Bright yellowish white fluorescence, metal foil shows red colouration	Medium-rich layer, relief mass, probably wax (with or without admixtures of oil or resin). Metal foil (probably tin)
lower most	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with some fluorescent spots; particles have brownish orange colouration	Probably coloured preparation layer

Surface decoration samples

BC-50/30-CS-8.2 1/2

Sample description:	
Labelling:	BC-50/30-CS-8.2
Sampled by:	Barbara Jörg
Usage:	Cross-section
Sampling location:	Back of sculpture, left side at height of waist, red coloured area

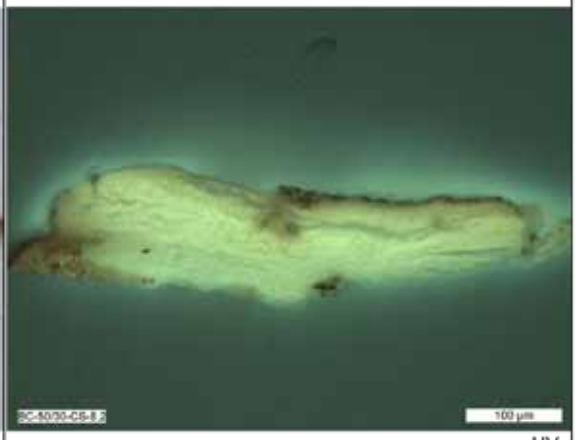


Notes:	Sample is broken during sampling (BC-50/30-CS-8.1, BC-50/30-CS-8.2)
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

VIS



UV

BC-50/30-CS-8.2 2/2

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Thin inhomogeneous dark grey to black coloured layer	Dark grey colouration	Soiling
...	Thin greyish brown coloured layer, no particles visible.	Bright yellowish white fluorescence	Medium-rich layer, relief mass, probably wax (with or without admixtures of oil or resin), probably multi-layered
lower most	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with some fluorescent spots; particles have brownish orange colouration	Probably coloured preparation layer

Surface decoration samples

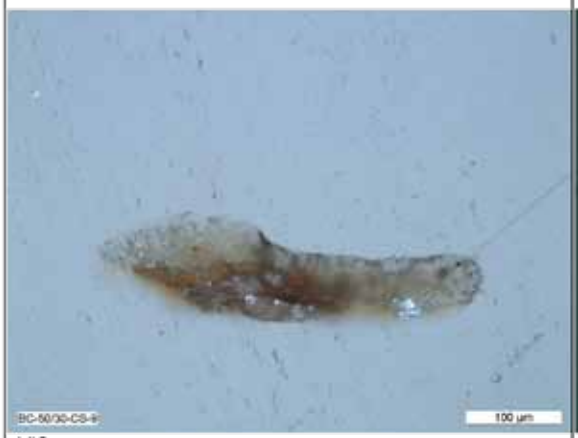
BC-50/30-CS-9 1/2

Sample description:	
Labelling:	BC-50/30-CS-9
Sampled by:	Barbara Jörg
Usage:	Cross-section
Sampling location:	Back of sculpture, left side at height of waist, red coloured area

Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

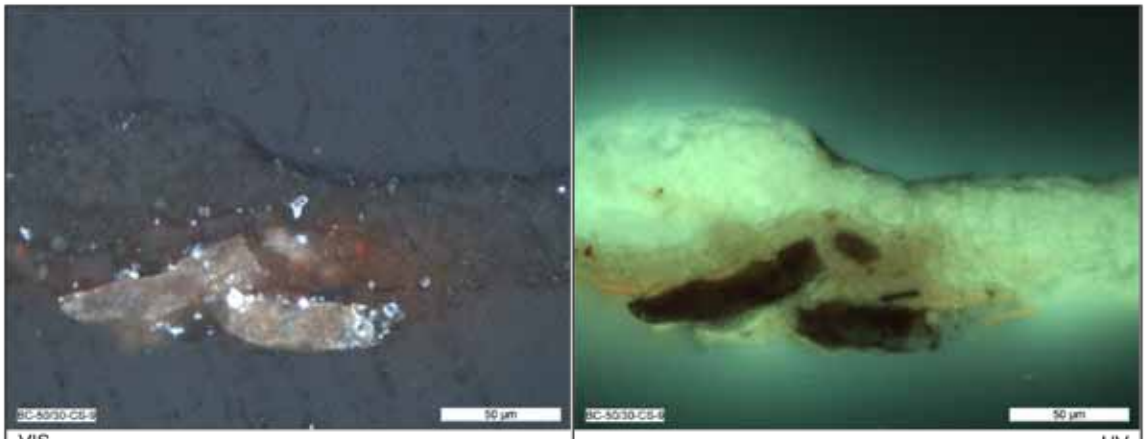
Photomicrographs:



VIS

UV

BC-50/30-CS-9 2/2



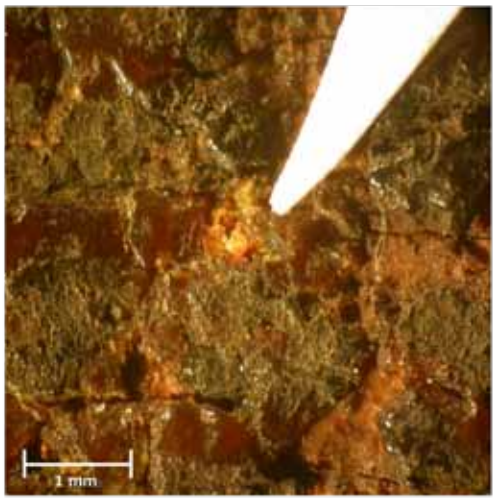
VIS UV

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Thin dark coloured layer	Grey, dark appearance	soiling
...	Thick brown coloured layer, no particles visible	Bright yellow to white fluorescence	relief mass probably consisting of a wax (with or without admixtures or resin/oil)
...	Brownish coloured translucent layer	Light brown colouration, slightly fluorescent	Another layer of glaze?
...	Thin red coloured translucent layer	Orange fluorescence	Red glaze
...	Thick dense silver coloured layer	Red colouration	Metal foil (probably tin)
lower most	Thin translucent brown coloured layer, no particles visible	Bright yellow to white fluorescence	relief mass probably consisting of a wax (with or without admixtures or resin/oil)

Surface decoration samples

BC-50/30-CS-10 1/4

Sample description:	
Labelling:	BC-50/30-CS-10
Sampled by:	Barbara Jörg
Usage:	Cross-section
Sampling location:	Back of sculpture, left side of gown, on the right side of the armpit

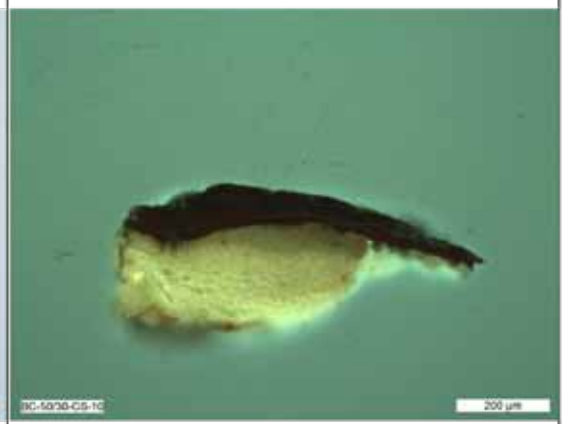


Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS, UV, Brightfield reflected light)
Analysed by:	Barbara Jörg

Photomicrographs:

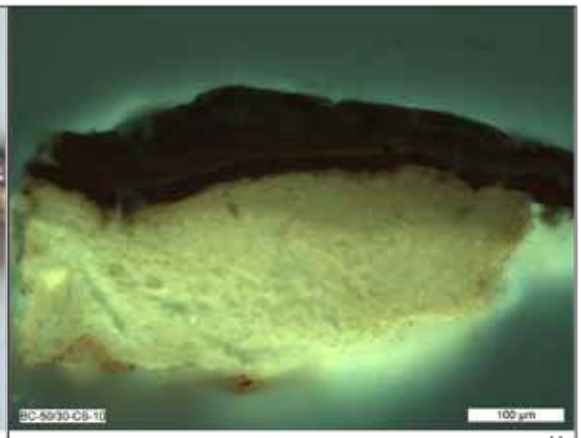
VIS



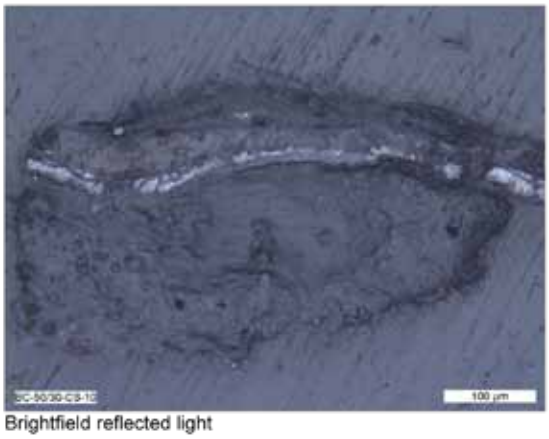
UV

BC-50/30-CS-10 2/4

VIS



U



Brightfield reflected light

Results:

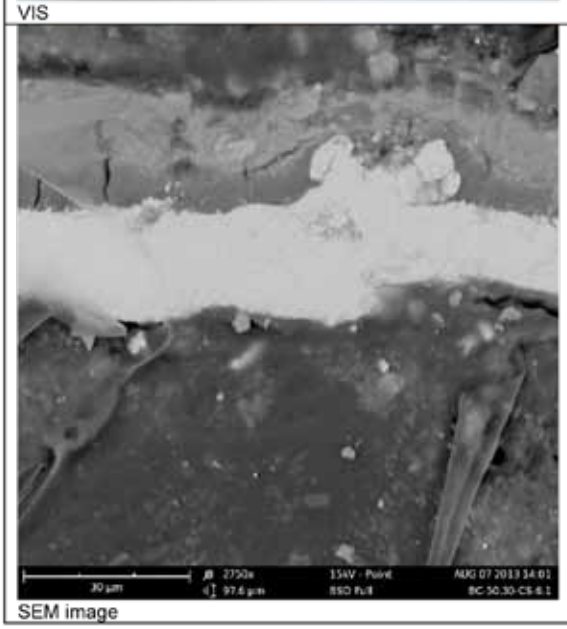
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	dark black layer that contains also some small red particles	No fluorescence	Probably Soiling (multilayered?)
...	Spots of golden coloured metal foil	-	Probably gilding
..	Dark coloured layer, slightly translucent	No fluorescence	Probably adhesive for gilding
...	opaque and light ochre coloured layer	No fluorescence, brown colouration	Probably gilding ground
	Thin red coloured translucent layer	Slightly fluorescent	Red glaze
...	Dense and silver coloured layer	Dark red colouration	Metal foil (probably tin)
...	Thick brown coloured translucent layer, no particles visible	Bright yellow to white fluorescence	Medium-rich layer, relief mass, probably wax (with or without admixtures of oil or resin)
lower most	Brownish orange coloured layer, mixed-grained with bright orange particles	Light grey colouration with some fluorescent spots; particles have brownish orange colouration	Probably coloured preparation layer

BC-50/30-CS-10 3/4

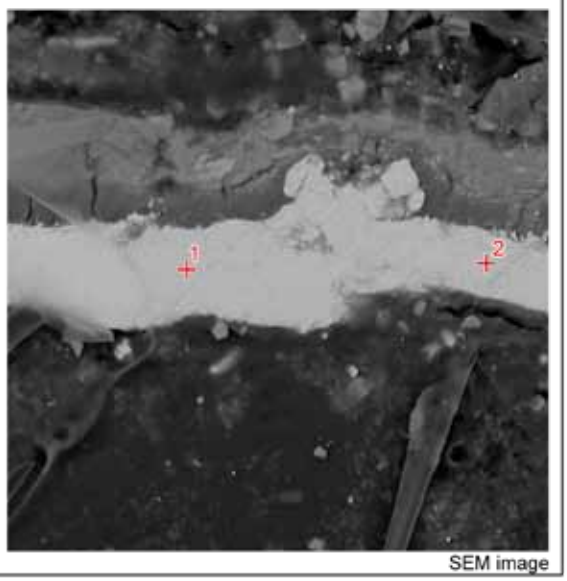
Analysis:	
Method of analysis:	SEM-EDX
Analysed by:	Dr. Dipl.-Rest. Cristina Thieme assisted by Barbara Jörg

Images:

VIS



SEM image

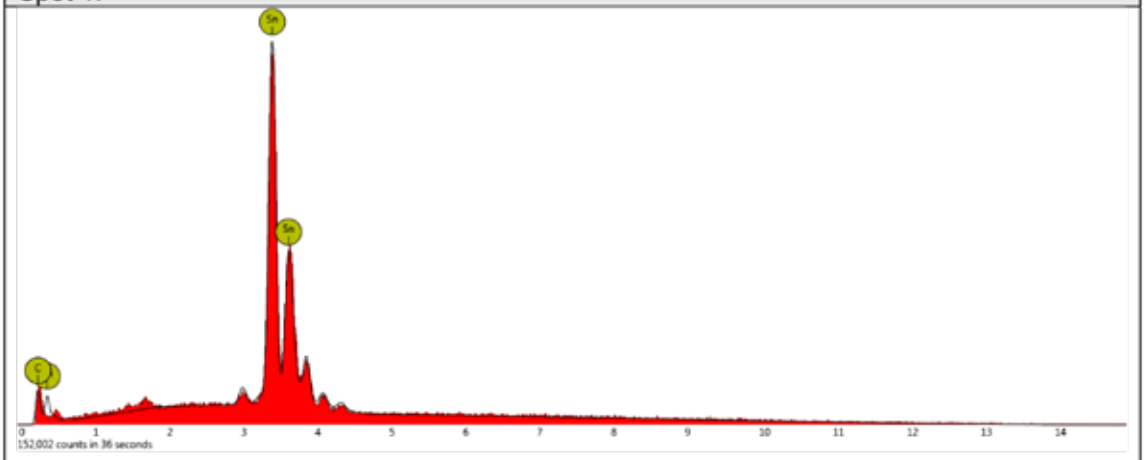


SEM image

BC-50/30-CS-10 4/4

Results:

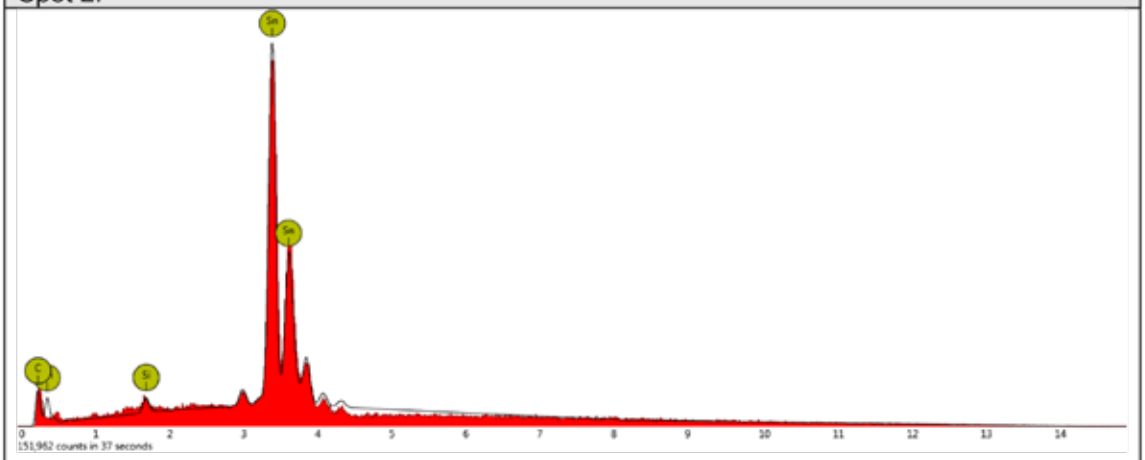
Spot 1:



	Weight percentage	Certainty
Sn	99.0 %	99.4 %
C	1.0 %	97.0 %

Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
50	Sn	Tin	Manual	99.0	0.6
6	C	Carbon	100.0	1.0	3.0

Spot 2:



	Weight percentage	Certainty
Sn	96.7 %	99.3 %
Si	2.1 %	95.0 %
C	1.2 %	97.1 %

Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
50	Sn	Tin	Manual	96.7	0.7
14	Si	Silicon	100.0	2.1	5.0
6	C	Carbon	100.0	1.2	2.9

Surface decoration samples

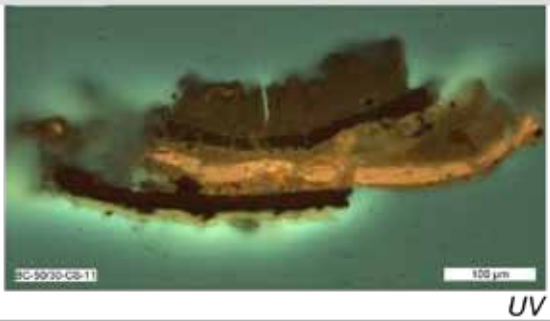
BC-50/30-CS-11 1/2

Sample description:	
Labelling:	BC-50/30-CS-11
Sampled by:	Barbara Jörg
Usage:	Cross-section
Sampling location:	Back of sculpture, left side of gown, armpit, applied relief textile

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

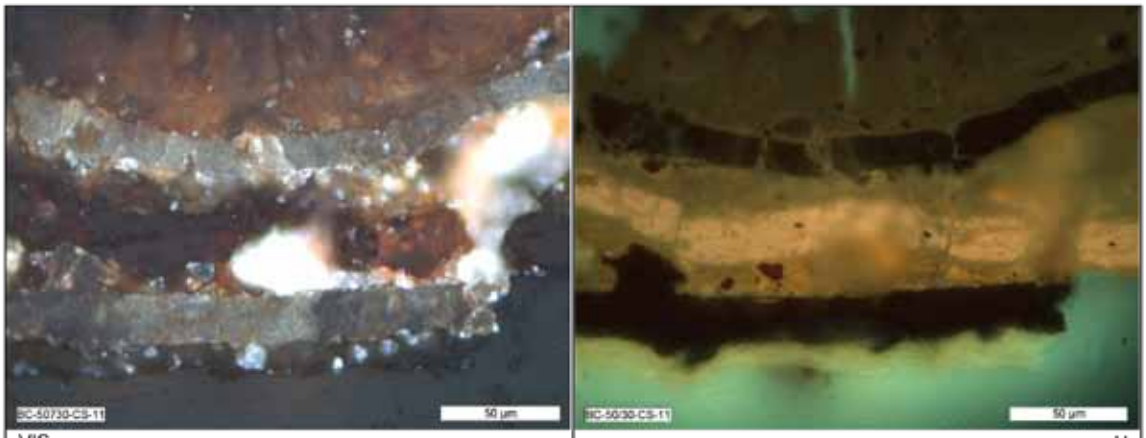
Photomicrographs:

VIS



UV

BC-50/30-CS-11 2/2



VIS U

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Thick, brownish coloured layer		??
...	Dense silver coloured layer	Dark red colouration	Metal foil
...	Ochre coloured layer	Dull orange fluorescence	??
...	Red coloured translucent layer, thickness of metal foil underneath	Bright, pale orange fluorescence	Red glaze
...	Red to brown coloured translucent layer	Orange fluorescence including red fluorescent particles	(part of) Glaze
...	Dense silver coloured layer	Dark red colouration	Metal foil
lower most	Brown translucent layer, no particles visible	Yellowish fluorescence	Medium-rich layer, probably wax (with or without admixtures of oil or resin)

Surface decoration samples

BC-50/30-CS-12 1/2

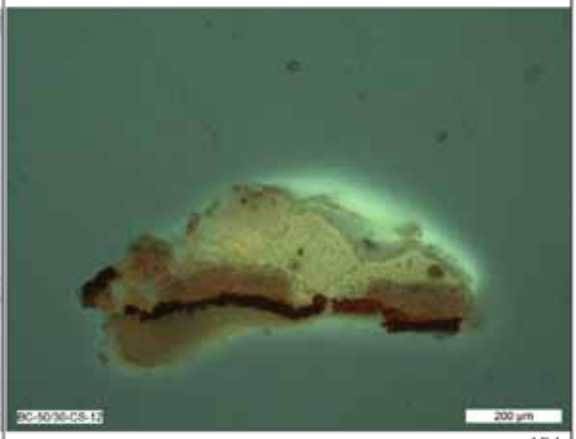
Sample description:	
Labelling:	BC-50/30-CS-12
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, left side of gown, armpit, applied relief textile

Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

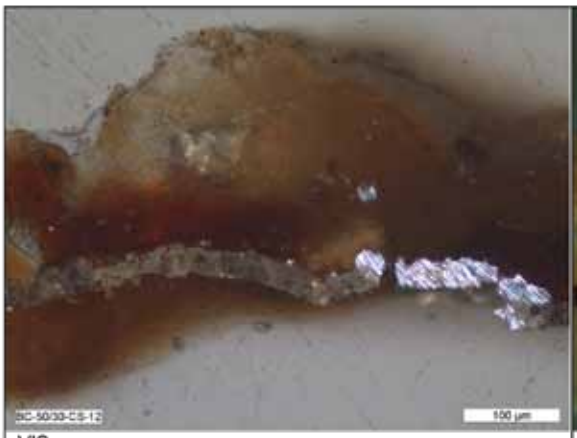
Photomicrographs:

VIS

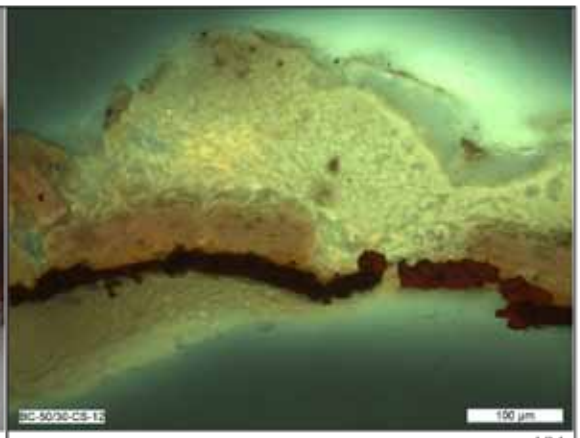


UV

BC-50/30-CS-12 2/2



VIS



UV

Results:			
Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Thin grey coloured layer	No fluorescence	Soiling
	Transparent and nearly colourless	No fluorescence	?
...	Thick brown translucent layer	Bright yellow fluorescence	Medium-rich layer, probably wax (with or without admixtures of oil or resin); not authentic as it is lying in the cracks of the layer below
...	Red coloured translucent layer, no particles visible	pale red to pale purple fluorescent	Glaze
...	Red coloured translucent layer, no particles visible, thinner as layer above	Orange fluorescence	Glaze
...	Dense silver coloured layer	Dark red colouration	Metal foil
lower most	Brown translucent layer, no particles visible	Yellowish fluorescence	Medium-rich layer, probably wax (with or without admixtures of oil or resin)

Surface decoration samples

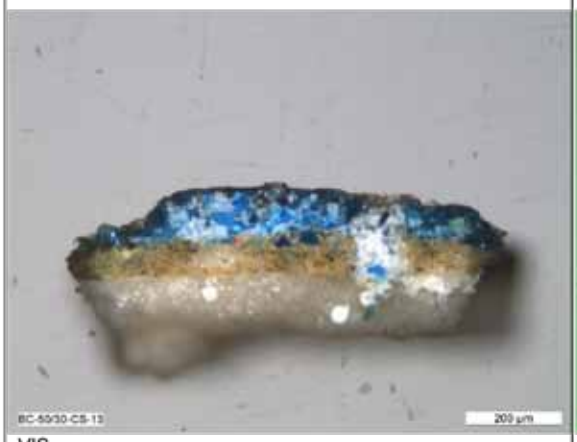
BC-50/30-CS-13 1/2

Sample description:	
Labelling:	BC-50/30-CS-13
Sampled by:	Barbara Jörg (surface/stray find)
Usage:	Cross-section
Sampling location:	Front of sculpture, fold on left side of gown, reverse side of the gown

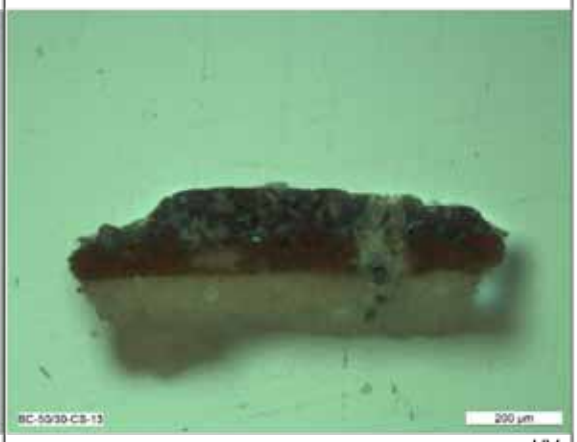
Usage:	Cross-section
Embedding medium:	Technovit 2000 LC

Analysis:	
Methods of analysis:	Microscopic examination with reflected light (VIS and UV)
Analysed by:	Barbara Jörg

Photomicrographs:

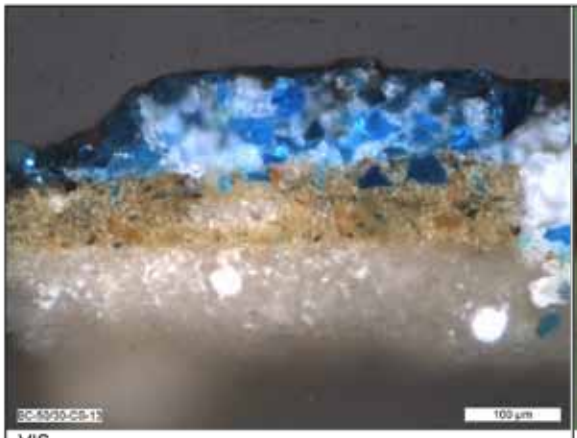


VIS

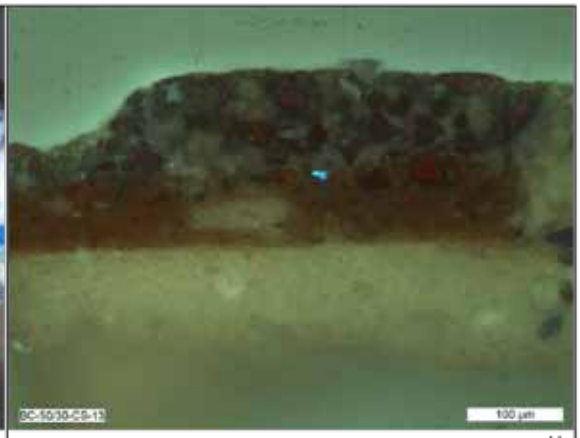


UV

BC-50/30-CS-13 2/2



VIS



U

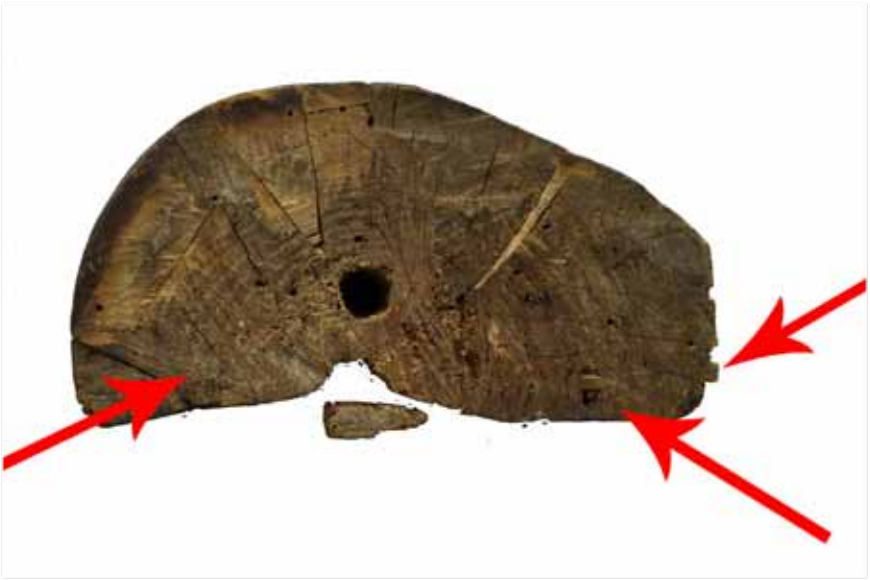
Results:

Layer	*Description*	*Fluorescence under UV light*	*Interpretation*
top	Mixed-grained layer varying in regards to the intensity of the blue colouration of the particles	Some blue particles are showing a red colouration	Paint layer
...	pigmented layer of yellow brown colouration with blue pigment particle	Orange colouration	Paint layer?
lower most	white coloured layer, with coarse-grained particles	Slightly yellowish fluorescence	ground

Wood identification

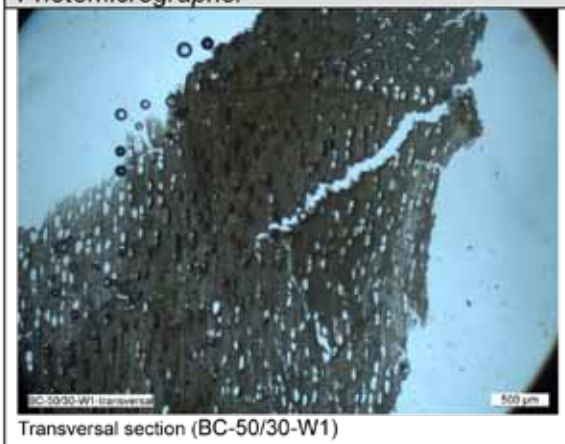
BC-50/30-W1, BC-50/30-W2, BC-50/30-W3 1/2

Sample description:	
Labelling:	BC-50/30-W1, BC-50/30-W2, BC-50/30-W3
Sampled by:	Barbara Jörg
Sampling locations:	Three spots at bottom of base

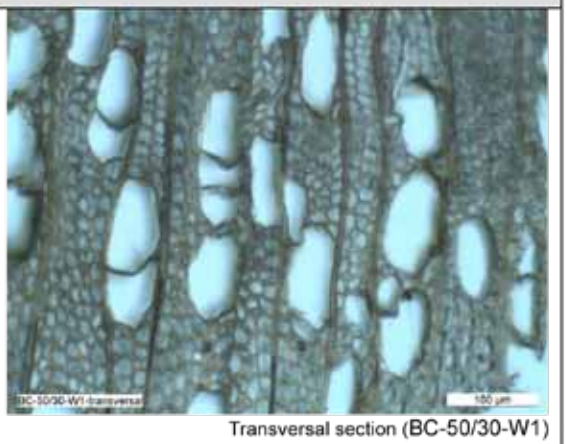


Analysis:	
Methods of analysis:	Microscopic wood anatomy
Analysed by:	Barbara Jörg

Photomicrographs:



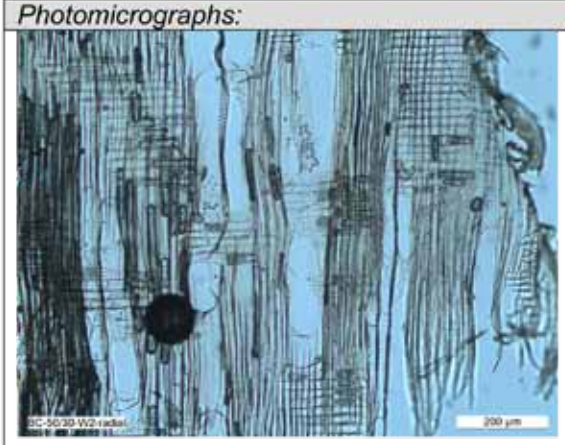
Transversal section (BC-50/30-W1)



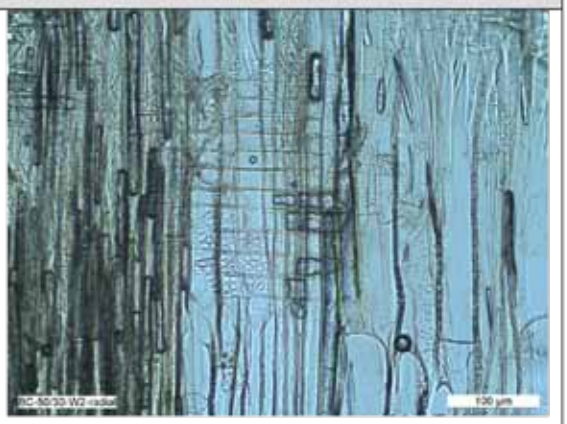
Transversal section (BC-50/30-W1)

BC-50/30-W1, BC-50/30-W2, BC-50/30-W3	2/2

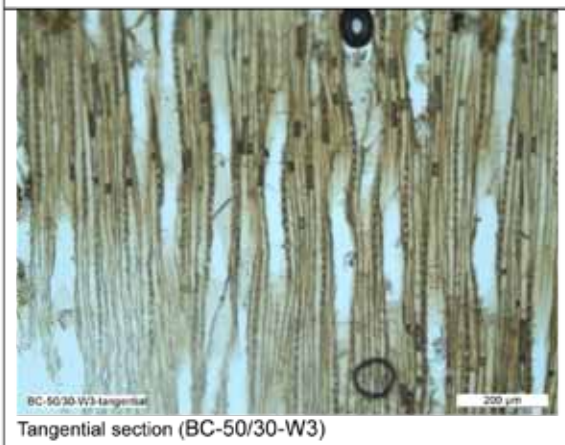
Photomicrographs:



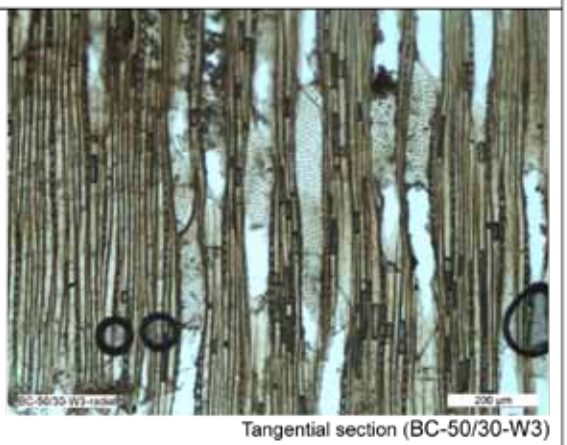
Radial section (BC-50/30-W2)



Radial section (BC-50/30-W2)



Tangential section (BC-50/30-W3)



Tangential section (BC-50/30-W3)

Analysis:	
Transversal section	1) Diffuse-porous 2) many solitary pores or in small groups of 2 to 3 3) uniseriate ray width
Radial section	1) homogeneous ray type 2) simple ray-vessel pits 3) simple perforation plates 4) Libriform fibres present
Tangential section	1) uniseriate ray width

Result:
ssp. populus

Optical microscopy on natural fibre

BC-50/30-F1 1/2

Sample description:	
Labelling:	BC-50/30-F1
Sampled by:	Barbara Jörg
Sampling location:	Back of collar at damaged area

Usage:	Fiber analysis
Embedding medium:	Meltmount ™ 1,662

Analysis:	
Methods of analysis:	Microscopic fibre identification
Analysed by:	Barbara Jörg

Photomicrographs:

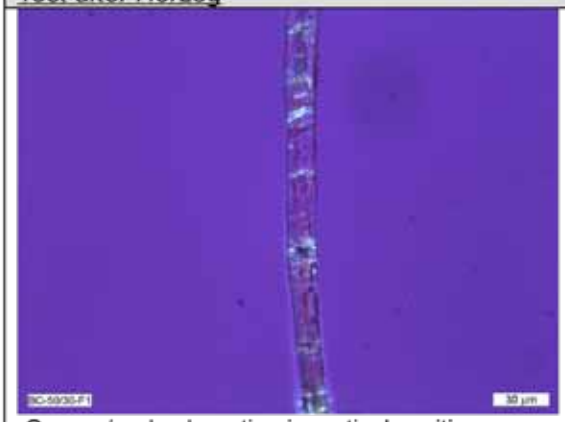
VIS

VIS

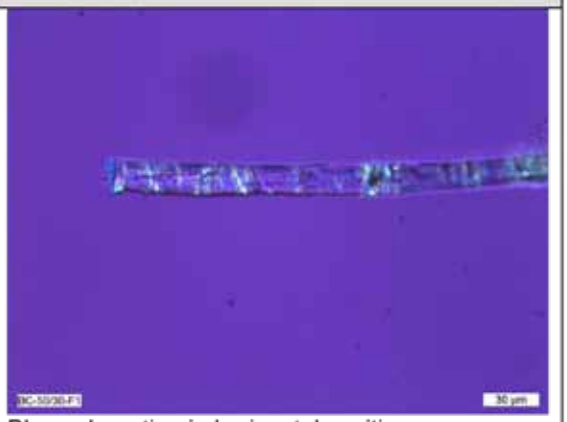
BC-50/30-F1 2/2

Results:			
Description	*Diagonal lines, knots, offset, small lumen*	*Index of refraction related to embedding medium*	*n < 1,662*
Extinction under cross-polarized light	*Extinction in orthogonal position*	*Optical positive Optical negative*	*Optical positive*

Test after Herzog



Orange/ red colouration in vertical position



Blue colouration in horizontal position

Conclusion

Flax

Optical microscopy on natural fibre

BC-50/30-F2 1/2

Sample description:	
Labelling:	BC-50/30-F2
Sampled by:	Barbara Jörg
Sampling location:	Back of sculpture, rim of dalmatic

Usage:	Fibre analysis
Embedding medium:	Meltmount ™1,662

Analysis:	
Methods of analysis:	Microscopic fibre identification
Analysed by:	Barbara Jörg

Photomicrographs:

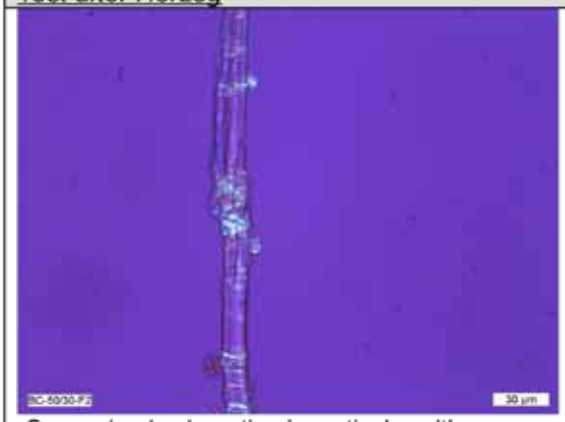
VIS

VIS

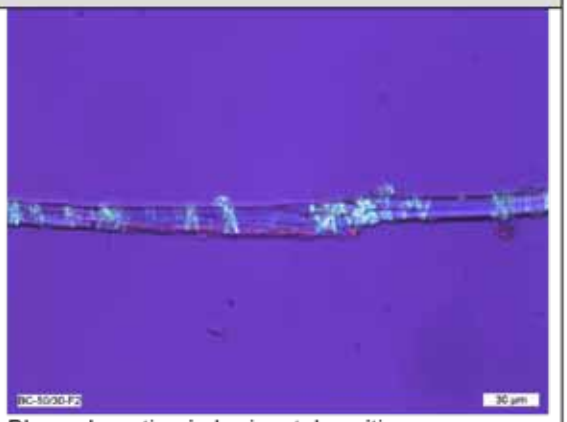
BC-50/30-F2 2/2

Results:			
Description	*Diagonal lines, knots, offset, small lumen*	*Index of refraction related to embedding medium*	*n < 1,662*
Extinction under cross-polarized light	*Extinction in orthogonal position*	*Optical positive Optical negative*	*Optical positive*

Test after Herzog



Orange/ red colouration in vertical position



Blue colouration in horizontal position

Conclusion

Flax

Optical microscopy on natural fibre

BC-50/30-F3 1/2

Sample description:	
Labelling:	BC-50/30-F3
Sampled by:	Barbara Jörg
Sampling location:	Back of collar at damaged area, horizontal thread

Usage:	Fibre analysis
Embedding medium:	Meltmount ™ 1,662

Analysis:	
Methods of analysis:	Microscopic fibre identification
Analysed by:	Barbara Jörg

Photomicrographs:

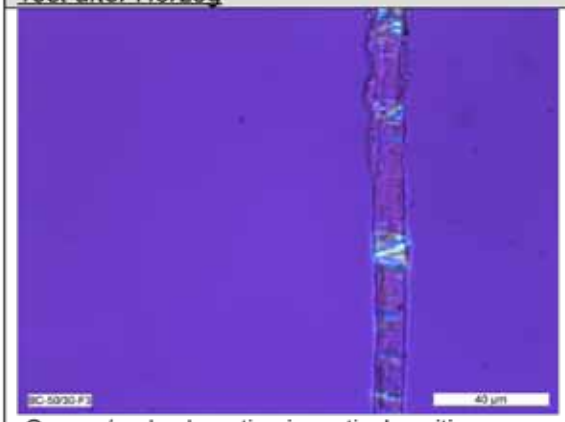
VIS

VIS

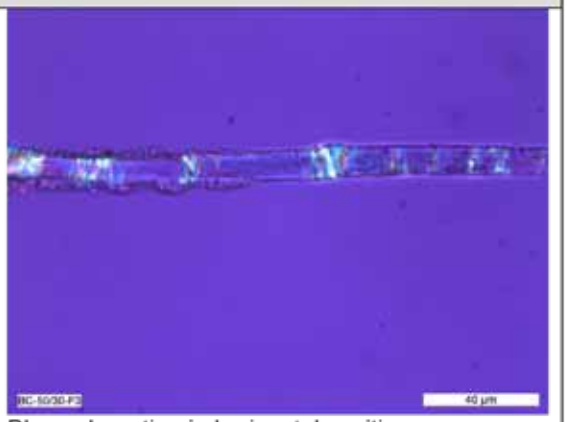
BC-50/30-F3 2/2

Results:			
Description	*Diagonal lines, knots, offset, small lumen*	*Index of refraction related to embedding medium*	*n < 1,662*
Extinction under cross-polarized light	*Extinction in orthogonal position*	*Optical positive Optical negative*	*Optical positive*

Test after Herzog



Orange/ red colouration in vertical position



Blue colouration in horizontal position

Conclusion

Flax

Optical microscopy on natural fibre

BC-50/30-F4 1/2

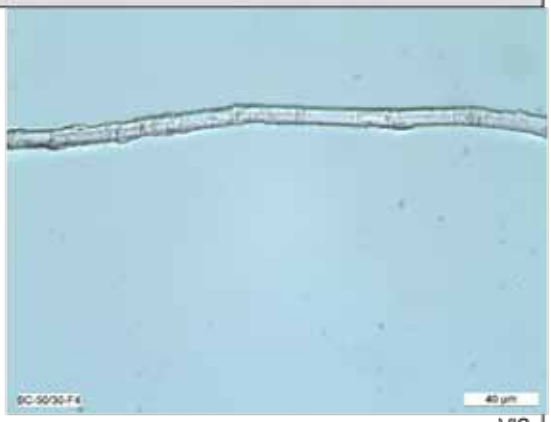
Sample description:	
Labelling:	BC-50/30-F4
Sampled by:	Barbara Jörg
Sampling location:	Back of collar at damaged area, vertical thread

Usage:	Fibre analysis
Embedding medium:	Meltmount ™ 1,662

Analysis:	
Methods of analysis:	Microscopic fibre identification
Analysed by:	Barbara Jörg

Photomicrographs:

VIS

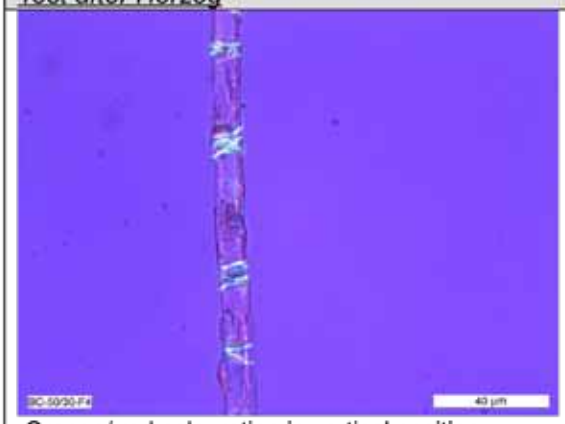


VIS

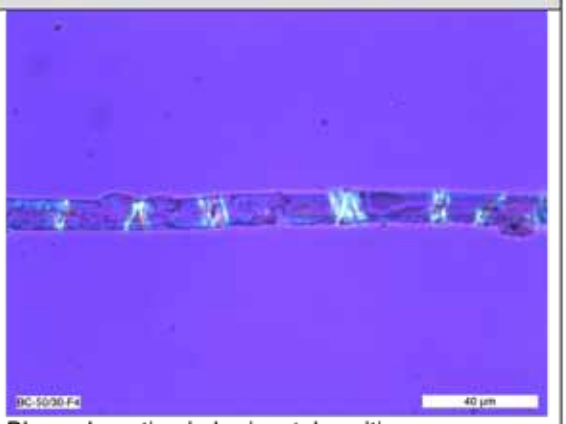
BC-50/30-F4 2/2

Results:			
Description	*Diagonal lines, knots, offset, small lumen*	*Index of refraction related to embedding medium*	*n < 1,662*
Extinction under cross-polarized light	*Extinction in orthogonal position*	*Optical positive Optical negative*	*Optical positive*

Test after Herzog



Orange/ red colouration in vertical position



Blue colouration in horizontal position

Conclusion

Flax

# of Testmixture	volume per cent solvent 1	volume per cent solvent 2	Teas parameter		
			fd	fp	fh
Test mixture I – Cyclohexane / Toluene					
01	100	00	94	2	4
02	50	50	87	5	8
03	00	100	80	7	13
Test mixture II – Toluene / Ethanol					
04	75	25	69	10	21
05	66	33	65	11	24
06	50	50	58	13	29
07	33	66	51	14	35
08	25	75	47	15	38
09	00	100	36	18	46
Test mixture III – Ethanol / Water					
10	75	25	32	20	48
11	50	50	27	23	50
12	00	100	18	28	54
Test mixture IV – Toluene / Acetone					
13	75	25	72	13	15
14	66	33	69	15	16
15	50	50	64	19	17
16	33	66	58	24	18
17	25	75	55	26	19
18	00	100	47	32	21
Test mixture V – Cyclohexane / Ethyl acetate					
19	50	50	73	10	17
20	33	66	65	13	22
21	00	100	51	18	31
Test mixture VI – Acentone / Ethanol					
22	75	25	44	29	27
23	50	50	42	25	33
24	25	75	39	22	39

Table 01: Test solvents employed in the cleaning tests by Pitesch [PIETSCH 2005, p. 156]

	fd	fp	fh
Toluene / Ethanol 60 : 40	62.4	11.4	26.2
Xylene / Acetone 30 : 70	57.8	23.9	18.3
Xylene / Ethanol 60 : 40	64.2	10.2	25.6

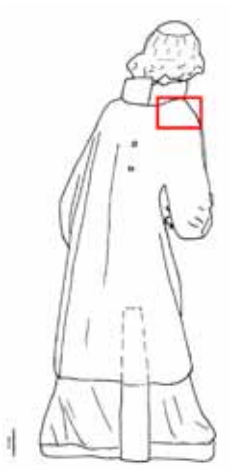
Table 02: Test solvents employed in the cleaning tests mixed by the author

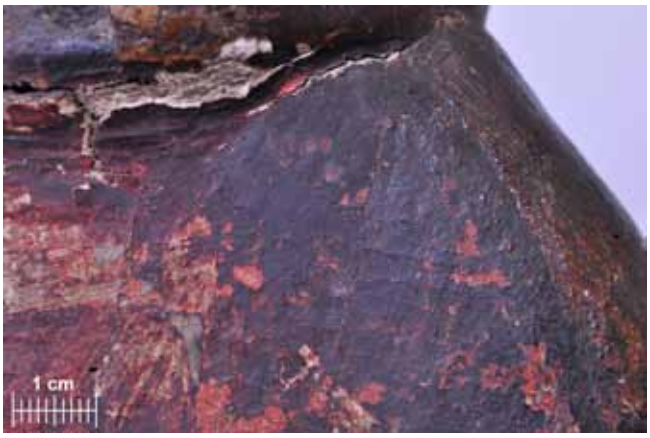
# of Testmixture	solvent or solvent mixture	ratio of ingredients	fd value	fp value
Surface cleaning				
01	i-Octane	pure	≈ 100	/
02	Diisopropylether	pure	/	/
03	White Spirit	aromatic content 16%	90	4
04	p-Xylene	pure	83	5
05	**p-Xylene / trichloroethane**	50 : 50	75,5	11
Resinous solvents				
06	i-Octane / i-Propanol	50 : 50	70,5	9
07	Toluene / i-Propanol	50 : 50	60,5	12,5
08	i-Octane / Ether / Ethanol	80 : 10 : 20	85,3	5,3
09	i-Octane / Ether / Ethanol	55 : 15 : 30	75,8	8,9
10	Ethyl acetate / Methyl ethyl ketone	50 : 50	52	21
11	i-Propanol / Methyl isobutyl ketone	50 : 50	49	19
Oil solvents				
12	**Dichlorethane / Methanol**	50 : 50	48,5	20,5
13	**Toluene / Dimethyl formamide**	75 : 25	70,3	13,2
14	**Trichloroethane / Diacetone alcohol**	75 : 25	64	20
15	**Trichloroethane / Dimethyl formamide**	50 : 50	55,5	25,5
16	**Ethyl acetate / Dimethyl formamide**	50 : 50	46	25
17	**i-Propanol / Ammonia / water**	90 : 10 : 10	/	/
18	**i-Propanol / Ammonia / water**	50 : 25 : 25	/	/
Protein solvents				
19	**Methylene chloride / Ethyl formate / Formic acid**	50 : 50 : 2	/	/
Carbohydrate solvents				
20	Toluene / i-Propanol / water	50 : 65 :15	53	14
21	Methyl ethyl ketone	25 : 75	27	27
22	**Ethyl acetate / Tetrahydrofuran / water**	5 : 35 : 45	35	24
23	**Acetic acid / water**	5 : 95	/	/

*__Bold__ solvents are critical from a conservation and/or safety related point of view.

Table 03: Test solvent mixtures provided by Masschelein-Kleiner [Pietsch 2005, p. 160]

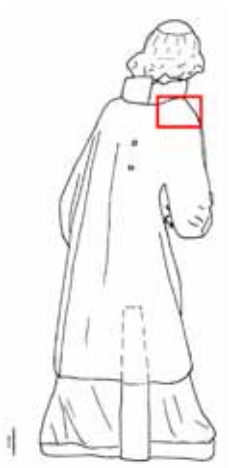
Cleaning test area No. 01 – Back of shoulder, red coloured area (dalmatic), #01





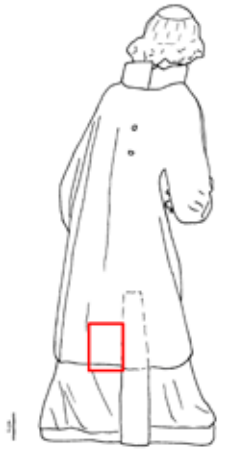
Tested area after cleaning tests

Cleaning test area No. 01 – Back of shoulder, red coloured area (dalmatic), #02



Tested area after cleaning tests

Cleaning test area No. 02 – Back of sculpture, red coloured area (dalmatic)



Tested area after cleaning tests

Cleaning test area No. 03 – Back of sculpture, gilded rim (dalmatic)

Tested area after cleaning tests

Cleaning test area No. 04 – Back of sculpture, undergarment (alb)

Tested area after cleaning tests

Cleaning test area No. 05 – Back of sculpture, undergarment (alb)

Tested area after cleaning tests

Cleaning test area No. 06 – Back of sculpture, undergarment (alb)

Tested area after cleaning tests