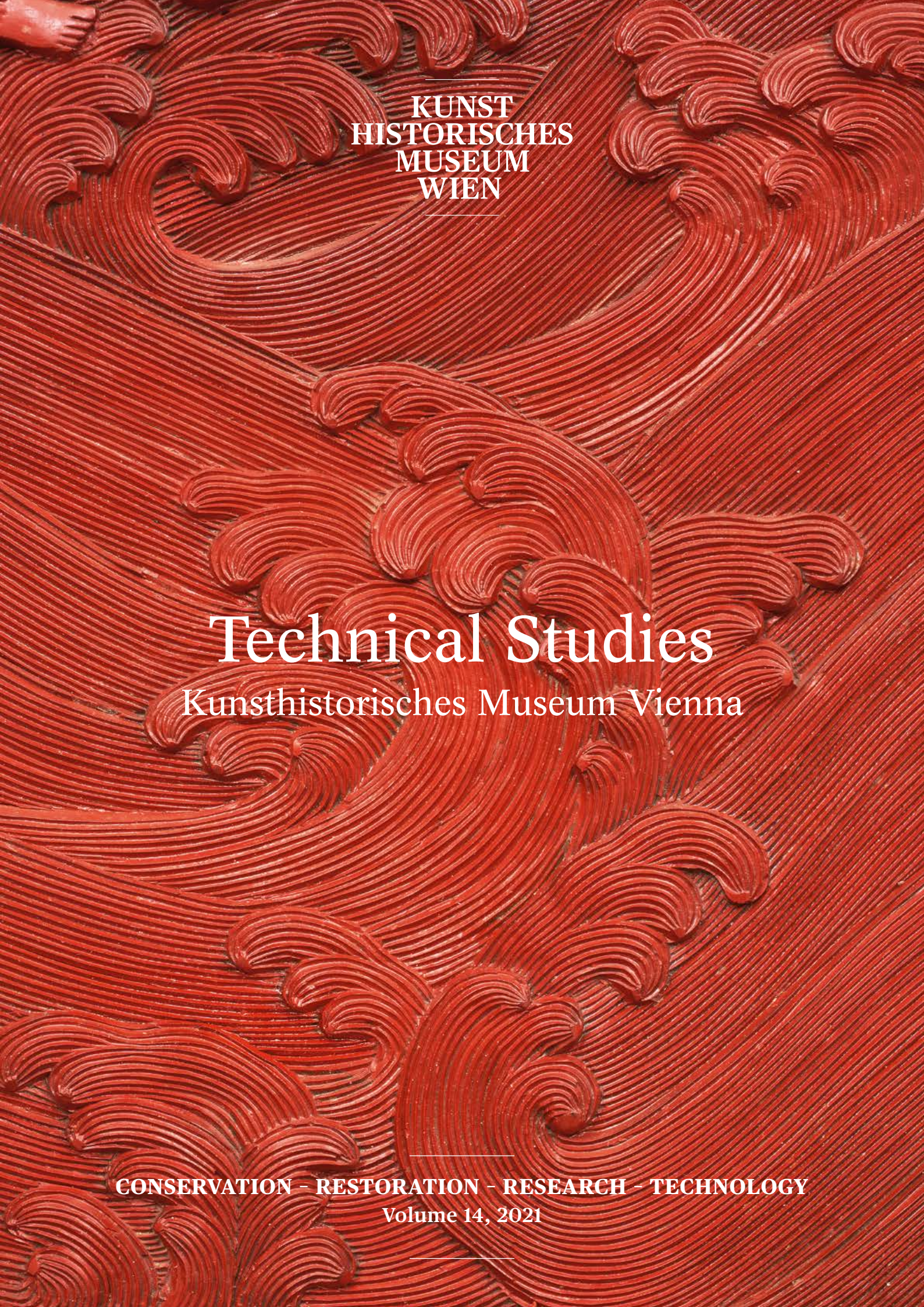

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Technical Studies

Kunsthistorisches Museum Vienna

CONSERVATION - RESTORATION - RESEARCH - TECHNOLOGY
Volume 14, 2021

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Editors:
Martina Griesser, Matthias Manzini, Elke Oberthaler

General Manager of Publications:
Franz Pichorner

Publication management:
Benjamin Mayr

Copy-editing:
Annette Van der Vyver

Proofreading:
Benjamin Mayr

Translations:
Matthew Hayes

Creative direction:
Stefan Zeisler

Graphic design:
Johanna Kopp

Typesetting:
Marianne Stålhös

Photography:
Thomas Ritter, Alexander Rosoli, Andreas Uldrich

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DIRECTOR'S FOREWORD

Sabine Haag,
General Director of the
KHM-Museumsverband

The KHM-Museumsverband (KHM association of museums) currently employs nearly one hundred scholars in its research areas: the thirteen collections of the Kunsthistorisches Museum including the Conservation Science Department, the collections of the Weltmuseum Wien and the Theatermuseum, and the related conservation departments. As museums by their nature are object centred, museum research necessarily applies style-critical methods and explores the significance of provenance, material, and technique. University research has increasingly developed generalist, cross-disciplinary studies from interdisciplinary institutes, which have sometimes displaced object-based research. For museums and to convey socially relevant aspects, these cross-sectional topics are certainly valid. For the museum's core competencies of 'preservation' and 'investigation', however, fundamental object-based study and comparatively focused specialization continue to be indispensable and expedient.

In this context, our own Conservation Science Department occupies a special position. It primarily carries out investigations on the holdings of the KHM-Museumsverband. These include the non-destructive analysis of two- and three-dimensional objects using x-ray fluorescence, microscopic examination directly on objects, analyses of complex organic binding media systems, national and international co-operations, preventive conservation, support of conservators with data to improve storage conditions, air pollutant measurements, assessing the impermeability of exhibition cases, etc.

The Conservation Science Department is a fundamental driver in the recently established Heritage Science research community, which seeks to improve and ensure the documentation, understanding, and preservation of cultural heritage through the trans-disciplinary networking of natural sciences, technology, and the humanities. Here we contribute at the European level to the sustainable creation and securing of expertise and the efficient transfer of knowledge.

Research in the museum usually occurs from within the individual collections and is thus closely connected with the availability of personnel and organisational resources. An FWF evaluation carried out in 2017 for the Kunsthistorisches Museum and 2018/19 for the Theatermuseum certified the institutions' generally excellent research accomplishments – even if it was noted, correctly, that the supporting infrastructure must continuously be improved to maintain our internationally recognized standards.

To me the continued, interdisciplinary, inter-departmental development of our research model is particularly important. In this context, the position created this year at the Kunsthistorisches Museum, Head of Collections and Research, will do important work. We are also developing a sustainable digital strategy, to which the current volume of the Technical Studies contributes: This is printed in a limited edition, with the focus this year on the digital version (available through our website), which also offers audio-visual files for the first time.

For the continued support and programming of the publication series I am deeply grateful to Martina Griesser, Elke Oberthaler, and Matthias Manzini; the latter ably completes the editorial team following the deserved retirement of our colleague Alfons Huber.

FOREWORD

Martina Griesser
Matthias Manzini
Elke Oberthaler

Practically all areas of our private and professional lives were upended during the past year – including the museum world.
After an initial, almost complete standstill of the cultural sector beginning in mid-March 2020 and three months of emergency operations within a program of drastically reduced work, activity behind the closed museum doors could recommence during the second half of 2020; conservation and research continued, if under more difficult conditions. Increased remote work, limited personnel numbers in at times extremely compact spaces occasioned by the pandemic, and many uncertainties and imponderables of programming did little to facilitate progress on the contributions to the *Technical Studies* – which require continued coordination between the authors and editors as well as other museum departments, including publications and visual media. The current volume appears more than a year later than originally planned. Fundamental questions also emerged as to the role of museums and the cultural industry more broadly. Not least, through the loss of (international) tourism and the mandated closures of cultural institutions, including the federal museums, the communication of research content was significantly transferred to the digital realm, which brings advantages but also disadvantages.
Even before the outbreak of the Coronavirus pandemic, a number of major changes were planned for the *Technical Studies* from volume fourteen. All volumes will now appear in both German and English, 'open access' in digital form on the KHM website and in a limited number of printed copies. Through the redesign of the website currently being implemented – this too has been delayed by the pandemic – it will not only be the publications themselves (previously only obtainable in bookstores) that will be available for free download in the future. Much more, an attempt will be made to add via a suitable platform, and thus make accessible to a wider public, the ever expanding and increasingly multimedia information that does not 'fit between the covers of a book'. Additional illustrations, high resolution photographs, images, audio and video material will thus considerably augment and enhance access to scholarly content, research results, and the current activities of the individual conservation laboratories and scholarly departments within the associated museums.
Likewise independent of the Coronavirus pandemic, a change has occurred in our editorial team: Matthias Manzini from the Imperial Carriage Museum succeeds our esteemed colleague Alfons Huber, who began his well-earned (and surely unretiring) retirement at the end of 2019. In Alfons Huber, the *Technical Studies* lose a co-founder and longtime comrade-in-arms who, even before the publication of the first volume in 2004, advocated that a great wish of many scholars in the associated museums be fulfilled: the combined presentation of conservation and restoration research and publications in serial form. It is not least thanks to his tireless efforts in finding and preparing interesting contributions that the *Technical Studies* have become a success story and are now established at the KHM as a scholarly periodical. At largely regular intervals, thirteen volumes with a total of eighty-four contributions have appeared thus far, offering in-depth insights from the perspective of conservators and curators into the study and preservation of artworks from the KHM-Museumsverband and also, occasionally, of external objects. We thank Alfons wholeheartedly for his valuable support and wish him the best for his future plans – which he will surely realize with the same enthusiasm that he brought to the *Technical Studies*. The collaboration on a personal level, in addition to the professional, also will be greatly missed.
At the same time, we are happy to welcome to the editorial team Matthias Manzini, who has been a conservator at the Imperial Carriage Museum since 2015 and is eminently qualified for the editorial supervision of

contributions to the *Technical Studies*, through both his professional expertise and from his interest in the scholarly presentation of conservation-restoration and technological concerns. The broad spectrum of professional areas represented at the KHM-Museumsverband is thus again to some extent mirrored in the editorial team.

We are very pleased to again be able to present a wide-ranging cross-section of excellent research in the essays selected for the fourteenth volume of the *Technical Studies*. This time the arc of subjects spans from Egyptian mummy cartonnages from the tenth to eighth centuries BCE; to a monumental altar painting by Garofalo, *The Resurrection of Christ*, from the first quarter of the sixteenth century, which was hidden for decades in storage due to its poor condition; to one of the most important objects in the collection of the Weltmuseum Wien, the three part lacquer screen from the 1770s from the era of the Chinese emperor Qianlong; to the 1813 fortepiano by Nannette Streicher from the holdings of the Collection of Historic Musical Instruments. The latter contribution is also the first opportunity to offer expanded information relating to the *Technical Studies*, including a video and audio recording of a piano piece by Franz Schubert – minuet no. 2, C, from *Twenty Minuets for the Pianoforte* – which will be available online.

We thank the General Director, Sabine Haag, for her continuous support of the publication series. Our particular thanks go to the Publications Department, General Secretary Franz Pichorner, Benjamin Mayr, and Annette Van der Vyver, who accompanied the transformation of the *Technical Studies* through word and deed, as well as the Visual Media Department for digital image processing and layout.

We wish much inspiration and enjoyment in the study of the printed or the digital editions and in the exploration of the expanded multimedia content; we hope, with these additional materials, to gain new and hopefully regular readers.

Fig. 1: Cartonnage case of Ta-reti, inv. no. ÄS 8641, early 22nd dynasty, front.

Fig. 2: Cartonnage case of Pakharkhonsu, inv. no. ÄS 5155 b, early 25th dynasty, front.

Cartonnages from Mummies in the Egyptian and Near Eastern Collection of the Kunsthistorisches Museum Vienna

Elfriede Haslauer

1. ACQUISITION

In the Egyptian and Near Eastern Collection of the Kunsthistorisches Museum Vienna are five mummies in linen cartonnage cases, and another empty case. Their exteriors are each richly decorated with depictions and texts. The cartonnages can be dated to the Third Intermediate Period, from the late-tenth to the eighth centuries BCE. Five of these certainly come from Upper Egypt/Thebes, as the titles referenced on them relate to the Amun temple: Padiese, inv. no. ÄS 3940 b *(fig. 3)*, was gatekeeper of the Amun Temple, Pakharkhonsu, inv. no. ÄS 5155 b *(fig. 2)*, was barber of the Amun Temple. Ta-mit, inv. no. ÄS 3942 *(fig. 4)*, Ta-reti, inv. no. ÄS 8641 *(fig. 1)*, and Her, inv. no. ÄS 225 *(fig. 5)*, were singers of Amun. The cartonnage case of a woman, inv. no. ÄS 233 *(fig. 6)*, of whose name only the first part, 'Ta-', is preserved, can likewise be assigned to the findspot Thebes through the type of depictions.

Only on the cartonnage of Ta-reti is, for the name of her father Ankhpakhered, the title 'Gatekeeper of the Amun Temple' preserved. Her mother Neskhonsupakhered was likewise a singer of Amun. Within families of priests, descendants and relatives also stood in the service of temples, not only that of the god Amun, but also of Mut and Khonsu in Thebes. This becomes clear in the naming of children when a combination with the name of a deity is employed, as e.g. in the name Pakharkhonsu. The name of his father Djedmutiufankh contains the name of the goddess Mut, consort of Amun. Together with her child Khonsu, they formed the triad of Theban gods.

The acquisition of the cartonnages dates from the nineteenth century. In 1821, the unwrapped mummy of Her in its opened cartonnage *(see fig. 5)*, was consigned to the imperial collection as a gift from Carlo d'Ottavio Fontana, a merchant in Trieste.[1] The case of a woman whose name is partially

[1] Inv. no. ÄS 225 (inv. 1824: no. 545): corresponding mummy inv. no. ÄS 251 (inv. 1824: no. 520); L. 169 cm, W. 40 cm, W. head 25 cm, W. foot end 22 cm, D. foot end 29.5 cm; late 22nd to 23rd dynasty, ca. 800 BCE. Ex. cat. Wilfried Seipel (ed.), *Mumien aus dem Alten Ägypten. Zur Mumienforschung im Kunsthistorischen Museum*, Vienna (Kunsthistorisches Museum) 1998, 12; ex. cat. *Ägypten. Im Reich der Pharaonen*, Leoben (Kunsthalle) 2001, 99, cat. no. 73; Elfriede Haslauer, *Neuzeitlicher Schmuck an einer altägyptischen Mumie in der Ägyptischen Sammlung des Kunsthistorischen Museums Wien*, in: Monika R. M. Hasitzka – Johannes Diethart – Günther Dembski (eds.), *Das alte Ägypten und seine Nachbarn. Festschrift zum 65. Geburtstag von Helmut Satzinger*, Krems 2003, 69–76, pl. 29–38.

Fig. 3: Cartonnage case of Padiese, inv. no. ÄS 3940 b, front.

Fig. 4: Cartonnage case of Ta-mit, inv. no. ÄS 3942, blackened front.

Fig. 5: Cartonnage case of Her, inv. no. ÄS 225, front part.

Fig. 6: Cartonnage case of Ta-[…], inv. no. ÄS 233, front.

preserved *(see fig. 6)* is likewise already listed in the inventory from 1824.[2] The other cartonnages come from the Miramar collection, which was acquired by the Kunsthistorisches Museum in 1878.[3]

2. THE USE OF CARTONNAGE MUMMY CASES

With the start of the 22nd dynasty, under the reign of Osorkon I (924–899 BCE), a new burial practice emerged. Rather than in two or three nesting, mummy-shaped coffins, the mummy now lay in a cartonnage completely encasing the entire body.[4] These richly decorated cases replaced the painted inner coffins. The depictions of protective gods for the afterlife were thus directly in contact with the mummy.

In this period, the wooden mummy-shaped outer coffins only are painted on the exterior with the essential attributes: the face with the three-part strand wig, the jewelled collar, and a column in the centre of the lid with an offering formula and the title and name of the dead. On the inside of the coffin bottom, Ra-Horakhty or the goddess of the west are shown in mummy form as protective deities for the afterlife. On their discovery these simple coffins were considered uninteresting, and thus usually only the splendid cartonnage mummies were removed. Padiese in the Vienna collection, whose coffin is preserved, is an exception.[5]

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2 Inv. no. ÄS 233 (inv. 1824: no. 544): L. 154.5 cm, W. 38 cm, W. head 24 cm, W. foot end 21 cm, D. foot end 31 cm; late 22nd dynasty, 8th century BCE. Anton von Steinbüchel, *Beschreibung der k. k. Sammlung aegyptischer Alterthuemer*, Vienna 1826, 65; Anon., *Übersicht der kunsthistorischen Sammlungen*, Vienna 1927, 142, VI; ex. cat. Vienna 1998 (cit. n. 1), 32, 39 (Elfriede Haslauer and Karl Großschmidt); ex. cat. *Ägyptische Mumien. Unsterblichkeit im Land der Pharaonen*, Stuttgart (Landesmuseum Württemberg) 2007, 208 f., cat. no. 196; ex. cat. *Egypt, The Great Civilisation*, Seoul (National Museum of Korea) 2009, 178 f., cat. no. 131.

3 Inv. no. ÄS 3940 b Padiese: L. 181 cm, W. 44 cm, W. head 24 cm, W. foot end 20 cm, D. head 32 cm, D. foot end 29 cm; 22nd dynasty, reign of Osorkon I (924–899 BCE), ca. 900 BCE. Ex. cat. Vienna 1998 (cit. n. 1), 39 (Elfriede Haslauer and Karl Großschmidt), cover illus.; ex. cat. TBS Japan (ed.), *Egypt Collection Vienna*, Tokyo (Isetan Art Museum) 1999, 84 f., cat. no. 46; ex. cat. Seoul 2009 (cit. n. 2), 186, cat. no. 138.
Inv. no. ÄS 3942 Ta-mit: L. 170–171.5 cm, W. head 25 cm, W. chest 41.2 cm, W. foot end 18 cm, D. head 25.5 cm, D. chest 23.3 cm, D. foot end 31 cm; 22nd dynasty, reign of Osorkon I (924–899 BCE), ca. 900 BCE. Ex. cat. Vienna 1998 (cit. n. 1), 39 f. (Elfriede Haslauer and Karl Großschmidt); Elfriede Haslauer, *Die Kartonagehülle einer Mumie in der Ägyptischen Sammlung des Kunsthistorischen Museums Wien. Sichtbarmachen der durch Harze geschwärzten Darstellungen mittels Infrarotreflektografie*, in: Technologische Studien. Kunsthistorisches Museum Wien. Konservierung – Restaurierung – Forschung – Technologie 12, 2016, 124–141.
Inv. no. ÄS 8641 (inv. 1878: 3943) Ta-reti: L. 169.5 cm, W. 39.5 cm, D. 30 cm; late 22nd dynasty, ca. 2nd half of the 9th century BCE; the mummy was removed from this case. Ex. cat. Wilfried Seipel (ed.), *Ägypten. Götter, Gräber und die Kunst. 400 Jahre Jenseitsglaube*, Linz (Schlossmuseum) 1989, 299, cat. no. 471 (Elfriede Haslauer).
Inv. no. ÄS 5155 b Pakharkhonsu: L. 171 cm, W. 46.5 cm, W. head 34 cm, W. foot end 34 cm, D. head 30 cm, D. foot end 29 cm; late 22nd to 23rd dynasty, ca. 800 BCE. Simon Leo Reinisch, *Die aegyptischen Denkmaeler in Miramar*, Vienna 1865, 95–97, no. 7, pl. V, wooden coffin; the description refers to the cartonnage case of the mummy, however.

4 John H. Taylor, *The Development of Cartonnage Cases*, in: ex. cat. *Mummies & Magic. The Funerary Arts of Ancient Egypt*, Boston (Museum of Fine Arts) 1988, 166–168, here: 166.

5 Inv. no. ÄS 3940 a: conifer wood, L. 196 cm, W. 58 cm, D. 67 cm; the face with the wig and jewelled collar are covered with linen, smoothed with white stucco as a ground layer, and painted.

On the inside of the coffin bottom, Nut, the goddess of the sky, is represented *(fig. 7)*.
The cartonnage of Pakharkhonsu from the early 25th dynasty also had a mummy-shaped coffin, although only the coffin bottom was taken.[6] The large standing figure of Ra-Horakhty *(fig. 8)* adorns the floor, text columns and crouching protective gods armed with knives are found on the exterior walls. Richly painted coffins with mummies in cartonnage cases are rarely preserved, as e.g. the coffin and cartonnage of Tahai in Basel,[7] of Pasenenhor from Thebes in Trieste,[8] and of Pabastet in Hamburg.[9] The mummy of Penju from Akhmim in Hildesheim[10] lay in a richly coloured inner coffin, and this in a simple, dark-coloured outer coffin.[11]

3. GENERAL OBSERVATIONS ON THE PRODUCTION OF A FULL-BODY CASE FOR A MUMMY IN THE THIRD INTERMEDIATE PERIOD

If previously it was Egyptologists, who concerned themselves with the production of one-piece body coverings for mummies,[12] more recently it has been conservators who investigate this experimentally.[13] Materials that were available in ancient Egypt are used.

3.1 FORMING THE CARTONNAGE

For the construction of a mummy-shaped core, straw was bound with strings around a wooden post anchored to a base plate. Through the application of clay mixed with sand and straw chaff, the final form with head and foot ends was created.[14] The straw core of the mummy forms saves modelling material, reduces the weight, and later eases the removal from the finished cartonnage. Taylor considers a core made of reeds possible, as these were

6 Inv. no. ÄS 5155 a: sycamore wood, L. 201 cm, W. 71 cm, D. 30 cm.

7 Basel, Museum der Kulturen, inv. no. III 129. Ex. cat. *So lebten die alten Ägypter. Führer durch das Museum für Völkerkunde und Schweizerische Museum für Volkskunde Basel*, Basel (Museum für Völkerkunde) 1976, 25, 28, 32; Maya Müller, *Mumienhülle und Sarg der Tahai (Ägypten, 9./8. Jh. v. Chr.)*, Museum der Kulturen Basel, leaflet (4 pp.), June 1999.

8 Trieste, Civico Museo di Storia ed Arte, Collezione Egizia, inv. no. E 1. Franco Crevatin – Marzia Vidulli Torlo (eds.), *Collezione Egizia del Civico Museo di Storia ed Arte di Trieste*, Trieste 2013, 92–106, no. 4.4 (Susanna Moser and Silvano Iarini).

9 Hamburg, Museum am Rothenbaum, inv. nos. 4057 a and 4057 b. Christiane Altenmüller, *Außensarg und Mumienhülle des Pabastet im Museum für Völkerkunde Hamburg (inv. no. 4057 a und 4057 b)*, in: Mitteilungen aus dem Museum für Völkerkunde Hamburg, NF 30, 2000, 182–229.

10 Hildesheim, Pelizaeus-Museum, inv. no. 1902 c. Ex. cat. Arne Eggebrecht (ed.), *Suche nach Unsterblichkeit. Totenkult und Jenseitsglaube im Alten Ägypten*, Hildesheim (Roemer- und Pelizaeus-Museum) 1990, 62–65.

11 *Ibid*., 62, pl. 18; inner coffin: 78–80, pl. 26.

12 Taylor 1988 (cit. n. 4), 166 f.; Hartwig Altenmüller, *Die Mumie des Chonsu-maacheru*, in: Mitteilungen aus dem Museum für Völkerkunde Hamburg, NF 30, 2000, 28–30.

13 Anna Krekeler, Zur *Herstellungstechnik einteiliger ägyptischer Kartonagesärge aus der Zeit um 800–750 v. Chr*., in: Zeitschrift für Kunsttechnologie und Konservierung 21/1, 2007, 13–32; Annemarie Huhn, *Die Konservierung eines einteiligen ägyptischen Kartonagesarges um 945–900 v. Chr.*, in: Zeitschrift für Kunsttechnologie und Konservierung 23/2, 2009, 285–296, here: 285–288.

14 In ancient Egypt, air-dried bricks were made of clay mixed with straw chaff, also with sand. The tradition can still be found today in the country.

Fig. 7a: Cover of the coffin inv. no. ÄS 3940 a, exterior.

Fig. 7b: Coffin bottom inv. no. ÄS 3940 a, interior of the floor.

Fig. 8: Coffin bottom inv. no. ÄS 5155 a, interior of the floor.

always available in Egypt and are also more stable and longer than straw.[15] A ground of gypsum, animal glue, and sand was mixed to smooth the surface.[16] The material used for the reconstruction corresponds to findings on the insides of ancient Egyptian cartonnages where components of the form are still attached.[17] On the interior of the cartonnage of Her, Vienna inv. no. ÄS 225, mud, fine sand, and chaff still adhere *(fig. 9)*.

For the reconstruction of the cartonnage, a linen-cotton blend textile was used. Torn into pieces of varying size, it was fitted to the mummy form. The shaping of details in the face, wig, and feet was achieved through stretching and cutting the fabric. This was saturated with an adhesive of animal glue and gum arabic.[18] Repetition of this procedure resulted in multiple layers for the stability of the linen cartonnage. The vertical production left the foot end open.[19]

The cartonnage of a woman in Heidelberg[20] consists of up to seventeen layers of linen textile, for which old, used fabrics were also employed. The lowest layers from coarsely woven textiles give the thickness and stability of the cartonnage, fine fabrics above model details and are simultaneously the preparation for painting.[21]

Different phases of work can also be determined. For Ta-mit, Vienna inv. no. ÄS 3942, a clear division of the linen layers can be observed that suggests two phases of work at different times. For the lower innermost layer, the linen along the back slit is protruding and bent inward *(fig. 10)*. The subsequent layers cover the middle. This technique can perhaps be explained in that it made cutting open the cartonnage easier. The entire thickness need not be cut through, as the innermost layers were left open for the back slit. The cartonnage is 0.66 cm thick on the side, 0.6 cm at the crown of the head.

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15 John H. Taylor, *Mummy: the inside story*, London 2004, 42. Another reconstruction of the production of a cartonnage mummy case was proposed in Trieste, see Susanna Moser – Gian Luigi Nicola, *Sharing knowledge for restoring coffins: The case of the Civico Museo di Storia e Arte of Trieste*, in: Alessia Amenta – Hélène Guichard (eds.), *Proceedings First Vatican Coffin Conference, 19–22 June 2013*, Città del Vaticano 2017, vol. I, 317–326, here: 323 f., fig. 7, 1–11: The bandaged mummy was bound to a wooden post anchored vertically to the floor, over which the form was created from mud and straw. That mummies are heavy refutes this; additionally, the bandages would be dampened during the application of wet material during the long working process, from forming the cartonnage to painting (fig. 7, 1–7). Furthermore, the face with the strand wig could not be formed from cartonnage directly on the mummy. When the mummy with its cartonnage was freed from the post and the back slit tied and covered with a linen strip, form material would likewise remain within. This must thus still be present on removal of the mummy in the modern period. And, the linen on the mummy would have to show traces of this treatment. That the horizontal imprint of a cord is present on the inside of the cartonnage of Pasenenhor does not prove that the mummy was attached, rather that the form material was. On separation from the post, the mummy would tip due to its high centre of gravity, hence the lacing and further treatment of the back could not take place upright, as figs. 7, 8–11 depict. This is only possible in illustration.

16 Krekeler 2007 (cit. n. 13), 18 f., figs. 12–15.

17 *Ibid.*, 17; c.f. Anthony Adams, *The manufacture of ancient Egyptian cartonnage cases*, in: Smithsonian Journal of History 1/3, Fall 1966, 55–66, here: 58, 63. On the inside of the cartonnage of Khonspakhered, Graz, Universalmuseum Joanneum, Archaeology Museum Schloss Eggenberg, inv. no. 25000, grey Nile mud mixed with chaff is attached; see Elfriede Haslauer, *Aegyptiaca im Archäologiemuseum Schloss Eggenberg. Teil II: Die Mumie des Amun-Priesters Anch-pa-chrad in Kartonagehülle*, in: Schild von Steier 26, 2013/2014, 392–413, here: 405.

18 Krekeler 2007 (cit. n. 13), 20, fig. 17.

19 *Ibid.*, 17.

20 Heidelberg, Ruprecht-Karl-Universität, Collection of the Ägyptologisches Institut, inv. no. 1014.

21 Huhn 2009 (cit. n. 13), 285 f.

Fig. 9: Cartonnage of Her, inv. no. ÄS 225, back part with material attached to the interior at the head end.

Fig. 10: Inv. no. ÄS 3942, multiple layers of cartonnage, overlapping of the fabric at the crown of the head.

Fig. 11: Inv. no. ÄS 225, back part with separation of the cartonnage at the foot end.

At the open foot end of Pakharkhonsu, Vienna inv. no. ÄS 5155 b, the 0.4–0.65 cm thick cartonnage is separated in parts and consists of an inner and an outer layer. For the incompletely preserved foot end of Her, Vienna inv. no. ÄS 225, the separation is likewise visible *(fig. 11)*.

3.2 THE BACK SLIT

After drying, the middle line for the slit was marked on the back, the holes for later lacing were pierced on both sides and at the foot end using a pointed metal tool.[22] With a knife, the back was cut open and the cartonnage bent to remove it from the mould core. As the cartonnage was still relatively damp, the mould core could be removed from the back in pieces down to the inner straw. The supporting wooden post with the rest was then drawn out.[23]
For the reconstruction, initially only the upward-facing reverse of the horizontal cartonnage was prepared with a mixture of chalk and animal glue, which makes the cartonnage flexible for inserting the mummy.
To close the back slit, on both sides starting from the head a string was drawn through the punched holes in a running stich. A styrofoam mummy form was covered on the surface with paper and paste and inserted into the cartonnage case. The slit was then closed using string, drawn in a zigzag through the holes on both sides, and the base plate attached.[24]
After the ground layer was complete, painting took place. Linen strips were adhered over the lacing of the back slit and the edges of the foot end. On the Heidelberg cartonnage, the foot panel is not preserved, but four-sided holes on the front of the foot suggest the use of wooden nails.[25]

22 Krekeler 2007 (cit. n. 13), 25, figs. 29, 30.
23 *Ibid.*, 21 f., fig. 20.
24 *Ibid.*, 22–24, figs. 22, 25–27.
25 Huhn 2009 (cit. n. 13), 287.

Fig. 12: Inv. no. ÄS 3942, detail of the left eye.

4. ADDITIONAL OBSERVATIONS ON THE CONSTRUCTION

In the course of the restoration of the Vienna cartonnages,[26] various details on the production of this type of mummy case could be determined that are not mentioned in the earlier literature.

In order to preserve the form for further use, it would also be conceivable to remove the still flexible cartonnage from the upright form. Faces modelled in clay could be repaired if damaged and face masks made from wood substituted to allow a serial production of full-body cases. Taylor considers i.a. this type of production.[27]

This may have been the case for Ta-mit, Vienna inv. no. ÄS 3942, to achieve the fine facial features despite multiple layers of linen. The area of the eyes saw special treatment.[28] In the delicately formed face, the cartonnage of the eye area is particularly thin, in contrast to the multiple layers of cartonnage in the face, thus also around the eyes. For the insertion of the eyes and eyebrows from a different material, presumably glass, hollows were cut out following the contours.[29] In the current condition the rims of the eyes are partially torn, and the left eye also dented and deformed. This could have already occurred in antiquity during the insertion of the eye inlays, as the area below is hollow *(fig. 12)*. Fine linen was then presumably pressed into the eye sockets to support the eyes. The sharp contours of the rims of the eyes thus remained preserved. In the cavities, the eyeball and pupil/iris could be attached. The underlayer is coloured light blue. The flat hollows of the brows were filled with a blue paste.

[26] Conservation from 1998 by Irene Engelhardt, Vienna, Kunsthistorisches Museum, Conservation Department of the Egyptian and Near Eastern Collection.

[27] Taylor 1988 (cit. n. 4), 166.

[28] A possible method of production was reconstructed in consultation with the conservator Irene Engelhardt.

[29] Compare the cartonnage in Louvre N 2617; Frédéric Payraudeau, *Ioufâa, un gouverneur de Thèbes sous la XXIIe dynastie*, in: Bulletin de l'Institut Français d'Archéologie Orientale 105, 2005, 197–210, here: 210, fig. 3.C. There the eyes were likewise cut out of the cartonnage but are lost.

Fig. 13: Inv. no. ÄS 233, view from above of the crown of the head with secondary perforations from modern attachment.

4.1 THE BACK SLIT

The way in which the cartonnage is removed from the form and the mummy inserted thereafter depends on the type of back slit, how easily and how far this can be flexed open.

4.1.1 STARTING FROM THE BACK OF THE HEAD

This is the most commonly practiced type. On the Vienna cartonnages of Her, inv. no. ÄS 225, Ta-[…], inv. no. ÄS 233 *(fig. 13)*,[30] and Padiese, inv. no. ÄS 3940 b, the back slit begins at the back of the head at the level of the headband. For Padiese the knotted string forms a clearly raised area there. The same can be observed in London on the cartonnages of Djedameniufankh[31] and Peftauemawykhons,[32] likewise in the cartonnage of Pabastet in Hamburg.[33]

[30] The numerous holes at the crown of the head of ÄS 233 come from an attachment when the mummy was upright. A number of later holes are also present in the wooden foot panel.

[31] London, The British Museum, inv. no. EA 29577; Abeer H. Eladany, *A Study of a Selected Group of Third Intermediate Period Mummies in the British Museum*, dissertation University of Manchester 2011, 241, fig. 5.84; Carol Andrews, *Egyptian Mummies*, London 1984, 47, fig. 54.

[32] London, The British Museum, inv. no. EA 6681; Eladany 2011 (cit. n. 31), 405, detail of the crown of the head.

[33] Hamburg, Museum am Rothenbaum, inv. no. 4057 b; Altenmüller 2000 (cit. n. 9), 216, pl. 5.

When mummies were removed from their cases in the modern era, the lacing was usually cut open and the closure at the foot end removed. As in the course of centuries the cartonnage was totally hardened and thus fragile, it could occur that the slit tore at the top of the head. Cartonnages in Berlin[34] and Greenock[35] are examples of this.
To remove the mummy from its case without cutting open the lacing on the back, which was potentially covered by a strip of linen, the cartonnage was cut open around its length so that the front could be removed like the lid of a coffin. This is the case for Her, Vienna inv. no. ÄS 225 *(see fig. 5)*. The closure of the foot end was removed and is not preserved. The same occurred with the cartonnage of Isiuert in Como.[36] The cartonnage of Pasenenhor in Trieste[37] is also in two pieces, as the reverse was sawed along the lateral coloured strip to remove the mummy in the nineteenth century. The flat reverse is uniformly white.[38] The gap between the two parts is clearly visible in photographs.

4.1.2 BACK SLIT FROM THE CROWN OF THE HEAD

There are cartonnages for which the back slit already starts at the crown of the head. This can be in the rear area, as in the cartonnages of a priestess in London,[39] of the singer of Amun Kaipamaw in Zagreb,[40] and of a woman in Berlin.[41] The slit tore further and diagonally on removal of the mummy.[42] The case is similar for the cartonnage of Djedmutiusankh in Berlin.[43]

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34 Berlin, Egyptian Museum, inv. no. 8284 Neskhonspekhered; Renate Germer – Hannelore Kischkewitz – Meinhard Lüning, *Berliner Mumiengeschichten. Ergebnisse eines multidisziplinären Forschungsprojektes*, Regensburg 2009, 110 f., fig. 159 front view; the photo of the back shows that the cartonnage suffered tears and breaks, nothing remains of the lacing.

35 Greenock, McLean Museum and Art Gallery, inv. no. 1987.395; John H. Taylor, *Coffins as Evidence for a 'North-South-Divide' in the 22nd–25th Dynasties*, in: Gerard P. F. Broekman – Robert J. Demarée – Olaf E. Kaper (eds.), *The Libyan Period in Egypt. Historical and Cultural Studies into the 21st–24th Dynasties: Proceedings of a Conference at Leiden University*, 25–27 October 2007 (Egyptologische uitgaven XXIII), Leuven 2009, 375–415, here: 408, pl. VII; the lacing is completely removed, the slit opened to the forehead, the back of the head torn crosswise at the right.

36 Maria Cristina Guidotti – Enrica Leospo (eds.), *La Collezione Egizia del Civico Museo Archeologico di Como*, Como 1994, figs. I–IV; here the closure of the foot end is likewise missing.

37 Trieste, Civico Museo di Storia ed Arte, inv. no. E 1; Moser – Iarini 2013 (cit. n. 8), 101, 106, photo of the back; Moser – Nicola 2017 (cit. n. 15), 321, fig. 5.

38 Claudia Dolzani, *Sacofago Egiziano con mummia del Civico Museo di Storia Naturale di Trieste*, in: Atti del Museo Civico di Storia Naturale Trieste XXVI/7, 1969, N. 9, 249–275, here: 259, 261, fig. 11 front and back of the cartonnage; 263, fig. 13 left and right sides of the cartonnage.

39 London, The British Museum, inv. no. EA 25258; Eladany 2011 (cit. n. 31), 233, fig. 5.72; the perforations on both sides for the lacing also begin there.

40 Zagreb, Archaeological Museum, inv. no. 687; Igor Uranić, *Aegyptiaca Zagrebiensia. Egyptian Collection of the Archaeological Museum in Zagreb* (Catalogues and Monographs of the Archaeological Museum in Zagreb/Arheološki muzej u Zagrebu, vol. IV), Zagreb 2007, photos on pp. 20 and 98; the broad covering linen strip is visible, painted the same dark blue colour as the crown of the head.

41 Berlin, Egyptian Museum, inv. no. 31297; Germer – Kischkewitz – Lüning 2009 (cit. n. 34), 201, fig. 314 front view.

42 Assessment from photos in Berlin.

43 Berlin, Egyptian Museum, inv. no. 32; Germer – Kischkewitz – Lüning 2009 (cit. n. 34), 80, fig. 108 front view; assessment from personal inspection and photos in Berlin.

Fig. 14: Inv. no. ÄS 3942, detail of the crown of the head and beginning of the back slit.

For some cartonnages, the cut begins in the middle of the crown of the head, as for Tjayasetimu in London,[44] Nespakashuti in Athens,[45] and the Vienna cartonnages of Ta-mit, inv. no. ÄS 3942 *(fig. 14)*, Ta-reti, inv. no. ÄS 8641, and Pakharkhonsu, inv. no. ÄS 5155 b.
For Tahai in Basel, whose reverse is painted with figures,[46] the red-painted stripe of the back slit ends at the headband of lotus leaves. The holes for the lacing are regularly spaced to the crown of the head.
Photos of mummies in cartonnage cases that were made at their findspots clearly show the start of the slit at the crown of the head.[47]

44 London, The British Museum, inv. no. EA 20744; Eladany 2011 (cit. n. 31), 221, fig. 5.58; ex. cat. John H. Taylor – Daniel Antoine, *Ancient lives. New discoveries. Eight mummies, eight stories*, London (The British Museum) 2014, 125, fig. 125; inv. no. EA 22939; *ibid.*, 68 photograph and 70, fig. 57 CT scan.

45 Athens, National Archaeological Museum, inv. no. ANE 3412; Vassilis Chrysikopoulos, *Nespaqashouty, musicien égyptien de la Troisième Période intermédiaire (cartonnage ANE 3412)*, in: Sibylle Emerit (ed.), *Le statut du musicien dans la Méditerranée ancienne. Égypte, Mésopotamie, Grèce, Rome. Actes de la table ronde internationale tenue à Lyon, Maison, de l'Orient et de la Méditerranée (université Lumière Lyon 2) les 4 e 5 juillet 2008, Lyon* (Bibliothèque d'Étude, vol. 159/2013), Cairo 2013, 125–137, here: 134, fig. 1 front view; 137, fig. 4 back of the cartonnage. The holes for the lacing are spaced far apart, especially in the wig.

46 Müller 1999 (cit. n. 7), photograph of the back on the first page.

47 Taylor 2009 (cit. n. 35), 410, pl. IX.1; 411, pl. X.2, presumably found in Kafr Ammar.

Fig. 15: Cartonnage case in Berlin, Egyptian Museum, inv. no. 17074, detail of the head end with the back slit beginning above the forehead and lacing at the crown of the head.

4.1.3 ABOVE THE FOREHEAD

The cartonnage of Pabastet in Hamburg[48] is also painted on the reverse with registers of depictions. A wide zone in the middle is left free for the reverse slit. This is red with narrow yellow lateral stripes, extends over the entire crown of the head, and thereby interrupts the painting of the wig and headband. In areas of abrasion, the zigzag lacing can be recognized.[49]
On a cartonnage case from Meidum in New York,[50] a wide coloured stripe with a fine crack in the middle extends forward to the forehead. On a cartonnage case in Berlin, the back slit already starts above the forehead and the lacing at the crown *(fig. 15)*.[51] As this is torn, the slit has spread wide apart at the head.

[48] Hamburg, Museum am Rothenbaum, inv. no. 4057 b.
[49] After a photograph of the crown of the head provided by Renate Germer.
[50] New York, The Metropolitan Museum of Art, inv. no. 06.1232.1; Taylor 2009 (cit. n. 35), 409, pl. VIII.2.
[51] Berlin, Egyptian Museum, inv. no. 17074, unpublished, assessment of photographs in Berlin and personal inspection.

4.1.4 T-SHAPED CUT

The demonstration of a T-shaped cut is problematic. The extent to which this was already applied in antiquity is difficult to demonstrate due to a lack of adequate examples. In the modern period, a secondary perpendicular cut was sometimes made to the back of the head to remove the mummy from the case. One is certainly present on the cartonnage of a woman in Heidelberg.[52] The length of the perpendicular cut is 14 cm. This type has not been previously mentioned in the literature.[53] Pieces of the original string remain in the holes. To remove the mummy, the cut was extended in a semicircle on both sides.[54]
Whether the T-shaped cut on the cartonnage of the priest Ankhpakhrad in Graz[55] is also original can no longer be proven. The mummy remains in the cartonnage, but the back slit and perpendicular cut on the back of the head were covered with new strips of textile, probably during a restoration in the twentieth century. The cartonnage was damaged at the foot end – compressed through vertical exhibition over many decades.[56] The mummy thereby slid into the foot end, and its weight crushed the standing surface. It is assumed that the mummy was then removed, and that the perpendicular cut on the back of the head occurred for this purpose.[57]

4.1.5 SECONDARY T-CUT

A secondary T-cut was applied in the modern period to enable removal of the mummy from the case. This was the case for the priest Khonsumaakheru in Hamburg, whose mummy was removed in 1903.[58] From the protocol prepared at the time, it emerges that all old seams were opened – both those holding the foot plate and that along the reverse. The material of the case proved to be so hard and stiff, however, that it was not possible to bend the cartonnage open. Sideward cuts were thus made on the back of the head.[59] Similar can be asserted for the cartonnage of Nakhtbastetiru in Bologna.[60] Here too, the mummy was removed in the modern period, evidenced by a perpendicular cut on the back of the head reaching far toward the front.

52 Heidelberg University, Collection of the Institute of Egyptology, inv. no. 1014, presumably from Thebes, dated to the 22nd dynasty.
53 Huhn 2009 (cit. n. 13), 286, fig. 2; 287, fig. 8 detail.
54 *Ibid.*, 288, fig. 10; 289.
55 Graz, Universalmuseum Joanneum, Archaeology Museum Schloss Eggenberg, inv. no. 25200; Haslauer 2014 (cit. n. 17), 396, fig. 8; 405.
56 *Ibid.*, 408, n. 3 and 4; it was first installed in the study of Prokesch von Osten, from 1834 in the Joanneum.
57 The mummy was inserted as far as possible into the cartonnage, the foot end of the cartonnage repaired, the hollow area down to the mummy's feet filled with a cushion and, instead of the original cartonnage panel, a replacement panel affixed.
58 Hamburg, Museum am Rothenbaum, inv. no. C 3834; is not mentioned in the publication. Altenmüller 2000 (cit. n. 12), 28–30, reign of Osorkon I (924–899 BCE).
59 Copies of the protocol and a colour photograph of the back of the cartonnage were provided by Renate Germer.
60 Bologna, Museo Civico Archeologico, inv. no. KS 1972, 22nd–23rd dynasty, from Thebes; author's observation in the museum: a wide perpendicular cut at the back of the head, and information from Daniela Picchi. In the illustration in Sergio Pernigotti (ed.), *La Collezione Egiziana. Museo Civico Archeologico di Bologna*, Bologna 1994, 93, the opening can be seen on the side.

Fig. 16: Inv. no. ÄS 233, back of the cartonnage with lacing visible.

4.2 THE LACING OF THE BACK SLIT

4.2.1 VISIBLE

The lacing for Ta-[…], Vienna inv. no. ÄS 233, is only partially preserved. The strings, drawn on both sides with a spacing of ca. 4–5 cm, are generally not directly aligned *(fig. 16)*. The reverse of this cartonnage is white. Likewise uniformly white is the cartonnage of Pasenenhor in Trieste. Here too, traces of the lacing are preserved.[61]

If the reverse was painted with depictions, care was taken not to interrupt these with the lacing or the covering with a linen strip. A correspondingly wide strip was left free in the middle, which was usually painted red.[62] John H. Taylor indicated the magical significance of the colour red for defence against evil and protection of the mummy when the edges of coffin bottoms and lids are painted red.[63] The same is true for the opening on the back of the cartonnage.

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61 Trieste, Civico Museo di Storia ed Arte, inv. no. E 1; Dolzani 1969 (cit. n. 38), 259, 261, fig. 11; Moser – Iarini 2013 (cit. n. 8), 106.

62 Cartonnage of Tashebt from Thebes; Labib Habachi, *Clearance of the Tomb of Kheruef at Thebes (1957–1958)*, in: Annales du Service des Antiquités de l'Égypte 55, 1958, 325–350, pl. XVII a. Athens, National Museum, inv. no. ANE 3412 Nespaqashouty; Chrysikopoulos 2013 (cit. n. 45), 137, fig. 4; the spacing of the holes is far apart starting from the back of the head, the lacing is not original. Basel, Museum der Kulturen, inv. no. III 00129 a Tahai; Müller 1999 (cit. n. 7), 1. Darmstadt, Hessisches Landesmuseum, inv. no. A 2013:29; Annika Potzgalski, *Die leere Mumienkartonage einer Frau ohne Namensbezeichnung im Hessischen Landesmuseum Darmstadt*, in: Kunst in Hessen und am Mittelrhein, NF 8, 2015, 7–24, here: 8, fig. 2. Greenock, McLean Museum and Art Gallery, inv. no. 1987.395; Taylor 2009 (cit. n. 35), 408, pl. VII, 2. Hamburg, Museum am Rothenbaum, inv. no. 4057 b Pabastet; Altenmüller 2000 (cit. n. 9), 216, pl. 5. Havana, Museo Nacional, inv. no. 524; Jadviga Lipińska, *Monuments de l'Égypte ancienne au Palacio de Bellas Artes à La Havane et du Museo Bacardí à Santiago de Cuba* (Corpus Antiquitatum Aegyptiacarum, Cuba, vol. 1), Mainz 1982, 1,136 photo 7. London, The British Museum, inv. no. EA 29577 Djedameniufankh; Eladany 2011 (cit. n. 31), 241, fig. 5.8. London, The British Museum, inv. no. EA 20744 Tjayasetimu; ex. cat. London 2014 (cit. n. 44), 125, fig. 125.

63 Éva Liptay, *The ancient Egyptian coffin as sacred space: Changes of the sacred space during the Third Intermediate Period*, in: Alessia Amenta – Hélène Guichard (eds.), *Proceedings First Vatican Coffin Conference, 19–22 June 2013*, Città del Vaticano 2017, vol. I, 259–270, here: 268.

Fig. 17: Inv. no. ÄS 3940 b, back of the cartonnage with the lacing covered by a linen strip.

Fig. 18: Inv. no. ÄS 3942, view of the back. The lacing and covering strip are torn.

4.2.2 COVERED WITH STUCCO

If the reverse was also painted in the centre, as for the cartonnage of Panesy in Leiden,[64] with an Osiris pillar over the entire length as for Nebnetjeru in Philadelphia[65] and Khonsumaakheru in Hamburg[66], then the holes for the lacing were pierced very close together and close to the edge, and covered with stucco after the lacing to form a continuous painting surface. This part of the painting, however, was damaged in the modern period during the removal of the mummy. The same can also be observed on the cartonnage of a woman in Heidelberg.[67]

The lacing of the back slit with its covering of stucco and painting is very well preserved on the cartonnage case of Isiuret in Como.[68] In 1887, this case was cut open along the side text columns to get to the mummy. The reverse is dominated by Osiris as a *djed*-pillar.

64 Leiden, Rijksmuseum van Oudheden, inv. no. L.XII.3 (M 36); John H. Taylor, *Theban coffins from the Twenty-second to the Twenty-sixth Dynasty: dating and synthesis of development*, in: Nigel Strudwick – John H. Taylor (eds.), T*he Theban Necropolis. Past, Present and Future*, London 2003, fig. 51.

65 Philadelphia, University of Pennsylvania, Museum of Archaeology and Anthropology, inv. no. E 14344 b, c; Taylor 2003 (cit. n. 64), fig. 50.

66 Hamburg, Museum am Rothenbaum, inv. no. C 3834; Altenmüller 2000 (cit. n. 12), 59, pl. 4 back view.

67 Heidelberg University, Collection of the Institute of Egyptology, inv. no. 1014; ex. cat. Stuttgart 2007 (cit. n. 2), 215; Huhn 2009 (cit. n. 13), 285 f., fig. 2, the cartonnage case was cut open at the sides.

68 Como, Civico Museo Archeologico, inv. no. ED 1; Guidotti – Leospo 1994 (cit. n. 36), 7 f., fig.: the two halves of the cartonnage with the unwrapped mummy in the back half are in a vitrine; colour plates I–IV.

Fig. 19: Inv. no. ÄS 5155 b, back. The head end with remains of the lacing and covering strip.

4.2.3 COVERING WITH A LINEN STRIP

On the cartonnage of Padiese, Vienna inv. no. ÄS 3940 b, the lacing of the back slit is completely preserved. The distance between the holes on both sides is 10–11 cm. The beginning of the connecting string is knotted at the back of the head. The reverse is uniformly white and separated on the sides from the front depictions by a coloured band. The lacing was covered with a 16 cm wide strip of densely woven linen and coated with a thin layer of stucco to match the white paint of the cartonnage. At the foot end, the lateral border stripes were also covered. This covering strip is torn and lifting in multiple places *(fig. 17)*.

For Ta-mit, Vienna inv. no. ÄS 3942, the lacing and thereby also the linen strip adhered above is torn *(fig. 18)*. The back slit is somewhat open, especially at the head, as the slit was only threaded from the back of the head *(see figs. 10 and 14)*.[69] During the burial ritual, resin was poured over the cartonnage, and the liquid collected on the back to a thick crust.[70] Through blackening, the linen strip can only clearly be seen on the rear crown of the head. It is 4.5 cm wide.

Of the zigzag lacing of Pakharkhonsu, Vienna inv. no. ÄS 5155 b, only traces at the head and foot ends are preserved. It extends from the back of the head, beginning at the flat crown *(fig. 19)*. A few fragments of the linen strip glued over the lacing are adhered. The strip was 8 cm wide – i.e. so narrow that it did not encroach on the painting of representative fields on the reverse. This

[69] The tear – it is not a straight cut – presumably first occurred at the top of the head as the back slit ripped open. As the body of the bandaged mummy completely filled the cartonnage, it is possible that the back of the case split from repeated handling.

[70] Haslauer 2016 (cit. n. 3), 124, fig. 1; 127, fig. 3.

Fig. 20: Inv. no. ÄS 5155 b, reverse with open back slit.

Fig. 21: Inv. no. ÄS 8641, reverse, covering of the back slit.

middle part of the back was white. As the lacing and thus also the linen strip is torn, the back slit has opened *(fig. 20)*.
The lacing of Her, Vienna inv. no. ÄS 225, is no longer completely preserved in its lower part. The spacing of the holes is 5 cm; at the head end the covering linen strip, 9 cm wide, is still preserved.
On Ta-reti, Vienna inv. no. ÄS 8641, the original closure of the back is not preserved as the mummy was removed from the cartonnage. The back slit was afterward laced again and covered with a wide strip of textile. It was very broadly overpainted, whereby parts of the depictions in the lower half were rendered totally unrecognizable *(fig. 21)*. In the area of the legs, the later lacing is also torn.

Fig. 22: Inv. no. ÄS 225, foot end with string and covering strip preserved.

5. THE CLOSING PANEL AT THE FOOT END

The closing panel can be made of various materials and connected to the foot end of the cartonnage in different ways.

5.1 CUT FROM WOOD

5.1.1 CONNECTED TO THE CARTONNAGE

On the cartonnage of Her, Vienna inv. no. ÄS 225, the closing panel is not preserved, but conclusions can be drawn from the remaining traces. Along the edge of the foot end, in large running stitches, a thick string (twisted from numerous linen threads) is drawn. There is additionally one hole on each side, perhaps to secure the plank in position for lacing. Apparently, the closing wooden panel was connected by a string threaded in a zigzag through both the cartonnage and the wooden plank, similar to the lacing of the back slit. On the preserved sides of the cartonnage, strings are present below the linen strip adhered above, which was glued over the edge *(fig. 22)*. This type of attachment is documented on the cartonnage of Nesperennub in London.[71] Such was also reconstructed for Neskhonsupakhered

[71] London, The British Museum, inv. no. EA 30720; Salima Ikram – Aidan Dodson, *The Mummy in Ancient Egypt. Equipping the Dead for Eternity*, London 1998, 176, fig. 211.

in Dresden. There the foot panel is lost, but remains of the original string from attaching the foot panel are present on the cartonnage.[72]
At the edges of the foot end of the cartonnage case of Isiuret in Como, regularly spaced holes are present, in a number of which loops of string from securing the foot panel still cling.[73]
The foot plate of Tahai in Basel was likewise connected by lacing, evidenced by the numerous holes along the edge of the foot end of the cartonnage – now however no longer in their original form.[74]
Similar can be found on the cartonnage of Nakhtbastetiru in Bologna.[75] The foot end was closed and tied to a new wooden panel – not in an ancient Egyptian manner, but rather with vertical connections. The numerous holes at the foot end of the cartonnage, however, come from the original lacing.
The closing plate of the cartonnage of Pasenenhor in Trieste was likewise tied on. On both sides, five holes are visible, and six on the front. The original closing panel was lost, presumably in the course of opening the cartonnage.[76]

5.1.2 SECURED WITH WOODEN PEGS, NOT COVERED

The most common type of closure is that employing a wooden panel cut to fit and secured with wooden nails, which are driven through pre-punched holes above the edge of the cartonnage, diagonally or horizontally into the panel.[77]
One example of this is the cartonnage of Ta-[…], Vienna inv. no. ÄS 233. Here dowels are placed from the toes, the heels, and the two sides *(see figs. 6 and 16)*, the tapered ends of which are visible in the bottom panel. Sawmarks are recognizable on the panel. This was coated with an extremely thin stucco layer and painted a pale yellow *(fig. 23)*. The edges were not covered with a linen strip. The foot panel of the cartonnage of Penju in Hildesheim, painted with the Apis bull, is secured in the same way.[78]
Sometimes, the panel is only attached to the cartonnage with wooden nails on two sides. Two wooden pegs are inserted through both the toe and heel ends of the cartonnage, diagonally through the wooden board, as in the cartonnage of Tjayasetimu in London.[79] The fastening at the front and back is also preserved for the cartonnage of Panesy in Leiden. There, two dowel holes are visible at the front.[80]

72 Krekeler 2007 (cit. n. 13), 26.
73 Como, Civico Museo Archeologico, inv. no. ED 1; Guidotti – Leospo 1994 (cit. n. 36), pl. IV 10–13; that the foot panel is missing is not mentioned.
74 Basel, Museum der Kulturen, inv. no. III 129; ex. cat. Basel 1976 (cit. n. 7), 28, fig. 9 a, b, c.
75 Bologna, Museo Civico Archeologico, inv. no. KS 1972, 22nd–23rd dynasty, information from Daniela Picchi.
76 Trieste, Civico Museo di Storia ed Arte, inv. no. E1; Moser – Iarini 2013 (cit. n. 8), 106.
77 Krekeler 2007 (cit. n. 13), 26.
78 Ex. cat. Hildesheim 1990 (cit. n. 10), 62 f., pl. 18 (Rainer Hannig).
79 London, The British Museum, inv. no. EA 20744; Ikram – Dodson 1998 (cit. n. 71), 176, fig. 210.
80 Leiden, Rijksmuseum van Oudheden, inv. no. L.XII.3 (M 36); Maarten J. Raven, *De dodencultus van het Oude Egypte*, Amsterdam 1992, 52, no. 19.

Fig. 23: Inv. no. ÄS 233, view of the foot plate, attached with eight pegs.

Fig. 24: Inv. no. ÄS 5155 b, right side of the foot end with a dowel hole preserved.

Further examples are the mummy cases of Ankhpefhor in Boston[81] and the cartonnage of Nespanetjerenre in the Brooklyn Museum[82], each with one dowel hole in both the front and back. For Djedameniufankh in London, the wooden pegs are inserted horizontally through the cartonnage into the side edge of the board.[83]

5.1.3 THE EDGES COVERED WITH LINEN STRIPS[84]

On the cartonnage case of Pakharkhonsu, Vienna inv. no. ÄS 5155 b, the front of the foot end is missing and thus also the closing plate. From the existing diagonal holes, two on the back *(see fig. 20)* and one on each side by the heels *(fig. 24)*, one can conclude that this wooden plate was also secured all around, presumably with eight wooden nails. The distance to the lower edge of the cartonnage is 1.8 cm. A folded, 5 cm wide linen strip was glued over the edges, traces of which still adhere. The seam and attachment were thus covered and given additional strength.

81 Boston, Museum of Fine Arts, Hay Collection, Gift of C. Granville Way, inv. no. 1872 (72.4837); Taylor 1988 (cit. n. 4), 170 f., no. 122, a dowel hole is clearly visible at the front of the foot end.

82 New York, Brooklyn Museum, Charles Edwin Wilbour Fund, inv. no. 361265; Richard A. Fazzini et al. (eds.), *Ancient Egyptian Art in the Brooklyn Museum*, New York 1989, no. 67.

83 London, The British Museum, inv. no. EA 29577; Eladany 2011 (cit. n. 31), 239, fig. 5.79.

84 Krekeler 2007 (cit. n. 13), 26.

Fig. 25: Inv. no ÄS 8641, wood foot panel, coated with stucco and painted with ochre colours.

Likewise for Ta-reti, Vienna inv. no. ÄS 8641: the board is covered with stucco on the exterior side. It was attached to the cartonnage from both sides with diagonally set wooden dowels. A strip of linen is glued to the edges on all sides *(fig. 25)*. Thereafter, everything was overpainted an ochre colour, as was the ground layer of the pedestal. The attachment and the lacing and covering of the back slit are later, however, as the mummy was removed.

5.1.4 JOINING WITH STUCCO[85]

The wooden panel on Padiese, Vienna inv. no. ÄS 3940 b, is covered on the exterior with thin linen, over which an irregularly thick stucco layer was applied. The attachment was achieved through two diagonally set wooden nails from both respective sides *(fig. 26)*. The distance to the lower edge of the cartonnage is 2 cm. The edges are spackled with plaster to the cartonnage.

[85] *Ibid.*, 26.

Fig. 26: Inv. no. ÄS 3940 b, foot end of the cartonnage, right side with the attachment of the wood panel with wooden nails.

Remains of a join using gesso are preserved on the foot panel of the cartonnage coffin of Ken-hor in Berlin.[86] This cartonnage is fashioned as the lid and bottom of the coffin, which were connected with wooden nails. The foot end is closed with a wooden plate, the outside of which is painted with the Apis bull and inscription.[87]

5.1.5 WITHOUT FIXED CONNECTION

Closure without a fixed connection to the cartonnage case is also possible. The wooden panel was thereby only wedged into place. On an example in Berlin, inv. no. ÄM 17074,[88] no traces of securing can be seen on either the cartonnage or the foot panel.
For Ta-mit, Vienna inv. no. ÄS 3942, the foot end is closed with a wooden panel, the exterior of which is covered with two layers of linen and a thin stucco layer. The attachment is not evident, as the edges to the cartonnage are thickly pasted over with linen strips. The covering is broken through at

[86] Berlin, Egyptian Museum, inv. no. 8500; Germer – Kischkewitz – Lüning 2009 (cit. n. 34), 129, fig. 184.
[87] *Ibid*., 128 f., fig. 123.
[88] Berlin, Egyptian Museum, unpublished; viewed in storage.

the toe end and right side, however. There are no dowels or dowel holes in the wood, although at least one perforation is evident at the edge of the cartonnage. Possibly the holes were intended for an attachment using dowels, but then not used. The foot panel was only joined with the cartonnage through the linen strips glued in multiple layers over the edges *(fig. 27)*. The linen strip on the back slit extends 5 cm up the foot plate.

5.2 FROM LINEN CARTONNAGE

There are examples of panels for closing the foot end made from linen cartonnage. The foot panel of the cartonnage of the priest Ankhpakhrad in Graz consisted of cartonnage that is prepared inside and outside with a white ground.[89] On the heel side, the end piece from the coarse fabric of the original linen strip of the back slit is extant *(fig. 28)*.
From a cartonnage case in Berlin is a closing plate made from cartonnage, coated on both sides with a thin stucco layer, which on one side in the middle bears a black ink notation in hieroglyphics with the indication 'inner, inside'.[90] This panel was either used later or added secondarily for greater stability. It consists of two cartonnage layers. In that used as the inside, there are small holes 2 cm apart along the edge. A thin string running over these perforations is held to the underside by small loops of string in the holes, apparently in this way sewn to an additional linen layer. Further layers of linen were adhered thereafter. Later larger holes, ca. 10 cm apart and three each on the long sides, extend through all of the layers.
In a detached closing panel in Berlin with a thin stucco layer on both sides and holes along the edge, two loops of string remain from the usual zigzag connection with the cartonnage.[91] Along the edge, remains of mud are preserved over the lacing, which were to cover both the lacing and the edges to the foot end of the cartonnage case.

5.3 FROM LEATHER

A closing panel made from leather was found in Thebes, in the Hatschepsut temple of Deir el-Bahari. It was connected all around, a number of string remains are still present. The leather is stuccoed on both sides, and additionally adhered with linen on the exterior.[92]

89 Graz, Universalmuseum Joanneum, Archaeology Museum Schloss Eggenberg, inv. no. 25200; Haslauer 2014 (cit. n. 17), 392, 405. During an early restoration of the cartonnage and particularly of the crushed foot end, the cartonnage panel, broken in four parts, was placed at the foot end of the mummy and the foot end closed with a fitted soft fibreboard plate.

90 Berlin, Egyptian Museum, inv. no. ÄM 31297; unpublished; viewed in storage.

91 Berlin, Egyptian Museum, inv. no. Z 4825, spacing of the holes ca. 3.5 cm.

92 Mirosław Barwik, *New data concerning the Third Intermediate Period cemetery in the Hatshepsut temple at Deir el-Bahari*, in: Nigel Strudwick – John H. Taylor (eds.), *The Theban Necropolis. Past, Present and Future*, London 2003, 122–130, here: 126 and pl. 90.

Fig. 27: Inv. no. ÄS 3942, diagonal view of the foot end, wood panel with linen strip attached along the edge.

Fig. 28: Cartonnage of Ankhpakhrad in Graz, Universalmuseum Joanneum, Archaeology Museum Schloss Eggenberg, inv. no. 25200, lashed foot panel of linen cartonnage.

6. FABRICATION IN ADVANCE

In general, the cases are larger and especially longer than the mummies. This can be seen through x-radiography. The head lies not in the head area of the case but usually lower, even considerably so.[93] The feet stand at the foot end, caused in part through the transport and vertical positioning of the mummy. During the burial ritual, mummies were stood upright to perform the opening of the mouth ritual on them.[94]

This also means that the mummy with its bandages is somewhat thinner, as it can only slide due to its slightly conical body form, proving that the cartonnage cannot have been formed on the prepared mummy. After the closing of the back and the foot end, the painting was completed in these areas.

[93] E.g. the cartonnage case of a woman, 2nd half of the 22nd to 23rd dynasty (850–750 BCE); Baltimore, Walters Art Museum, inv. no. 79.1, ex New York, The Metropolitan Museum of Art; Regine Schulz – Matthias Seidel, *Egyptian Art. The Walters Art Museum*, Baltimore 2009, 103, no. 41. London, The British Museum, inv. no. EA 20744; Eladany 2011 (cit. n. 31), 434; Warren R. Dawson – Peter H. K. Gray, *Catalogue of Egyptian Antiquities in the British Museum I. Mummies and Human Remains*, London 1968, frontispiece b. 35. *Ibid*., inv. no. EA 22393; Eladany 2011 (cit. n. 31), 298, fig. 7.12. *Ibid*., inv. no. EA 22939; Eladany 2011 (cit. n. 31), 446; ex. cat. London 2014 (cit. n. 44), 70, fig. 57 CT scan; 72, fig. 60. Vienna, Kunsthistorisches Museum, inv. no. ÄS 3942; Haslauer 2016 (cit. n. 3), 140, fig. 18.

[94] Taylor 2003 (cit. n. 64), 104 f.

The cartonnage case of a grown woman was even used for the mummy of a girl.[95] The difference in length between cartonnage and mummy in London is ca. 25 cm. A similar situation was found in Brooklyn. The body rests in the lower half of the case, the empty space above is filled with linen.[96]
The cartonnage case could also be too small, that is, too narrow for the mummy. On the case of a woman in Berlin,[97] the back slit is wide apart from about the middle of the body to the foot end. Possibly, the mummy was taken out of the cartonnage in Egypt by antiquities dealers looking for amulets and papyri and then could not be returned to its original place.[98] The foot panel was later subsequently secured with a linen strip.
In another instance, the cartonnage was too short. The mummy of Padiamenet in London was considerably longer than the case, hence the feet extended beyond the foot end and were thickly padded there with linen to extend the cartonnage.[99]
As the cartonnage was still elastic at the time the mummy was inserted, it is also conceivable that it was not necessary to destroy the mummy form each time to remove the opened cartonnage. The similarity in the dimensions of length and width for identical origins is notable. In preserving the form, one could work more efficiently and also achieve uniformity of appearance, using it for all mummies that would fit inside with their bandages.
Fabrication in advance is also confirmed in that fields for later inscription were left empty. This can be recognized in the differing types of script.[100] Blank spaces could be left where the name and title of the deceased were to be.[101] On the cartonnage of a woman in Darmstadt, no column for the name was even provided.[102]

95 London, The British Museum, inv. no. EA 20744; ex. cat. London 2014 (cit. n. 44), 114, fig. 107 CT scan; 116, fig. 109.
96 New York, Brooklyn Museum, inv. no. 34.1223; Mildred M. Pace, *Wrapped for Eternity. The Story of the Egyptian Mummy*, New York 1974, 112.
97 Berlin, Egyptian Museum, inv. no. 40, 22nd dynasty; Germer – Kischkewitz – Lüning 2009 (cit. n. 34), 36, figs. 31, 32, 33.
98 *Ibid.*, 38.
99 London, The British Museum, inv. no. EA 6682; Eladany 2011 (cit. n. 31), 418; ex. cat. London 2014 (cit. n. 44), 94, fig. 85 CT scan; 96, figs. 87, 99; 109, fig. 104.
100 Altenmüller 2000 (cit. n. 12), 30.
101 Berlin, Egyptian Museum, inv. no. 40; Germer – Kischkewitz – Lüning 2009 (cit. n. 34), 36, after the title 'lady of the house', the name is missing.
102 Darmstadt, Hessisches Landesmuseum, inv. no. A 2013:29; Potzgalski 2015 (cit. n. 62), 16.

SUMMARY

From the beginning of the 22nd dynasty, mummies were wrapped in a linen cartonnage that was painted like an inner sarcophagus. The outer sarcophagus continued to be constructed from wood but was only simply painted: with the face and large wig, the jewelled collar, and a vertical text column with the name of the deceased.

Although there are several publications on the production of these cartonnages and even on their replication over a mould core using materials available in ancient Egypt, additional details could be observed from the six mummy cases in the Egyptian and Near Eastern Collection of the Kunsthistorisches Museum Vienna, which in comparison with similar objects from other collections revealed variations especially in the back slit and the closure of the foot end. For the latter, different materials and variations of attachment were employed.

ZUSAMMENFASSUNG

Mit dem Beginn der 22. Dynastie wurden Mumien mit einer Leinen-Kartonage umhüllt, die wie ein Innensarg bemalt wurde. Der Außensarg war weiterhin aus Holz konstruiert, jedoch nur einfach bemalt: mit dem Gesicht mit der großen Perücke, dem Schmuckkragen und einer vertikalen Schriftkolumne mit dem Namen des/der Verstorbenen.

Zur Herstellung dieser Kartonagen gibt es zwar verschiedene Publikationen und sogar den Nachbau über einem Formkern unter Verwendung von Materialien, die auch im Alten Ägypten vorhanden waren, doch können an den sechs Mumienhüllen der Ägyptisch-Orientalischen Sammlung des Kunsthistorischen Museums Wien zusätzliche Details festgestellt werden, die im Vergleich mit derartigen Objekten aus anderen Sammlungen Variationen vor allem beim Rückenschlitz und dem Verschluss des Fußendes ergeben. Für letzteren wurden verschiedene Materialien verwendet, so wie auch die Befestigung unterschiedlich war.

Fig. 1: Benvenuto Tisi, called Garofalo, *Resurrection of Christ*. 1520. Oil on poplar, 315 × 181.5 cm. Vienna, Kunsthistorisches Museum, Picture Gallery, inv. no. 9551. After conservation treatment.

Garofalo's *Resurrection of Christ* Altarpiece (1520)

Provenance – Painting Technique – Technical Observations – Conservation

Francesca Del Torre Scheuch, Ingrid Hopfner, and Sabine Stanek

1. INTRODUCTION

The *Resurrection of Christ* by Benvenuto Tisi, called Garofalo (1481–1559), *(fig. 1)*[1] is one of the last major works acquired by the Kunsthistorisches Museum; this was realized in 1962 thanks to collaboration between the Federal Monuments Office (*Bundesdenkmalamt*) and the Picture Gallery. Even at the moment of its acquisition, however, the condition of the monumental panel was problematic. Despite two conservation initiatives in the Paintings Conservation Department of the Picture Gallery during the 1960s and 1970s, in 1976 installation of the painting in the primary gallery was considered impossible and it was finally put into storage. The move of the storage facility in 2011 offered an opportunity to return the panel to Paintings Conservation for investigation. Following detailed study of the condition and scientific investigations, the Picture Galley management and the conservators advocated an intervention. This proved to be a challenging, labour intensive, and extensive treatment occupying a period of two and a half years. To ensure the stability of the panel as well as an aesthetically appropriate presentation of the painting, a new frame was also designed and constructed in the Paintings Conservation carpentry workshop, in a close collaboration between art historians, conservators, and carpenters. In autumn 2015, the altarpiece could again, for the first time in more than forty years, be exhibited in Gallery III of the Picture Gallery.

[1] The first mention of the work is by Giorgio Vasari: see *Le vite de' più eccellenti pittori, scultori ed architettori* [Florence 1568], ed. Gaetano Milanesi, Florence 1881, vol. 6, 457–469, esp. 466. See also Klaus Demus, *Kunsthistorisches Museum Wien. Verzeichnis der Gemälde*, Vienna 1973; Anna Maria Fioravanti Baraldi, *Benvenuto Tisi da Garofalo: aggiunte al catalogo delle opere*, in: Musei Ferraresi 9–10 (1979–1980), 129–139; Id., *Il Garofalo. Benvenuto Tisi Pittore (1476–1779). Catalogo generale*, Rimini 1993. Alessandra Pattanaro has devoted numerous important essays to Garofalo, listed in her article *Tisi Benvenuto, detto Garofalo*, in: *Dizionario Biografico degli Italiani*, vol. 95 (2019), 727–732. See also Laura Malagutti, *La Resurrezione di Garofalo a Vienna per la chiesa arcipretale di Bondeno*, Thesis, Scuola di specializzazione in beni storico-artistici, Università degli Studi di Firenze 2013/14. The library of the Picture Gallery of the Kunsthistorisches Museum holds a copy of this work.

2. PATRON AND PROVENANCE

Signed and dated 1520 *(fig. 2)*, this monumental altarpiece is one of the most representative works by the Ferrarese painter Benvenuto Tisi, called Garofalo. It was commissioned by Girolamo Sacrati for the archprelatic church in Bondeno, near Ferrara.

Sacrati was a member of one of the most important Ferrarese families, one closely connected with the house of Este. Little is known of his career at the court of Pope Julius II in Rome. We know, however, that he occupied the office of protonotary apostolic. According to Vasari, it was Sacrati who, as a lover and patron of the arts, brought Garofalo to Rome. The painter travelled to the Eternal City in 1512, where he quickly joined the circle of Raphael. Vasari reports that Garofalo befriended the painter, who supported and promoted him. The intensive activity as a draftsman and the study of works by Michelangelo and Raphael in Rome influenced and shaped his style.[2] As recent research has suggested, Garofalo was perhaps in Rome again around 1517–1519. The stylistic features of the works created in these years, in any case, show that he was artistically up to date: he was familiar with the development of Raphael's frescoes in the Stanze, and the Farnesina and Vatican loggias. He was also able to see one of Raphael's cartoons for the Stanza of the Fire in the Borgo at Alfonso's court in Ferrara.[3]

In September 1520, Sacrati was named archpriest of Bondeno. He engaged his protégé Garofalo in the redecoration of the church. It can be assumed, however, that the commission for the *Resurrection of Christ* had already been given by the beginning of the year, as it is unlikely that such a large panel was completed in only four months.

The painting shares its fate with that of the *Saint Sebastian with Saint Roch and Saint Demetrius* by Giovanni Battista Benvenuti, called L'Ortolano, now in the National Gallery in London.[4] The two pictures adorned the altars on either side of the main altar:[5] Garafolo's *Resurrection of Christ* on the right, in the Chapel of the Holy Sacrament, the panel by L'Ortolano on the left.[6] There they remained until, around the middle of the nineteenth century, they were sold to private individuals to finance the church's urgently needed renovation – on the condition that they remain in the city of Ferrara (a requirement that was not fulfilled).[7] The originals were replaced by copies by Alfonso Alessandro Candi.[8]

2 Vasari 1881 (cit. n. 1), 457–469.

3 Alessandra Pattanaro, *La maturità del Garofalo. Annotazioni ad un libro recente*, in: Prospettiva 79, 1995, 39–53; *Id., Garofalo: il terzo decennio e la difficile cronologia di un nuovo disegno*, in: *De Lapidibus sententiae. Scritti di Storia dell'arte per Giovanni Lorenzoni*, Padua 2002, 295–305, here: 296; Pattanaro 2019 (cit. n. 1), 729.

4 Inv. no. NG 669, wood transferred to canvas, 230.4 × 154.9 cm.

5 Luigi Napoleone Cittadella, *Bondeno e la sua chiesa arcipretale. Cenno storico e descrittivo*, Ferrara 1856, 33 f.

6 See the graphic reconstruction in Malagutti 2013/14 (cit. n. 1), figs. 3–7.

7 See Cittadella 1856 (cit. n. 5), 33 f.; Cammillo Laderchi, *La pittura ferrarese*, in: Antonio Frizzi, *Memorie per la storia di Ferrara*, vol. 5, Ferrara 1848, Appendix: *Ferrara; Id., La pittura ferrarese. Memorie del Conte Cammillo Laderchi*, Ferrara 1856. Both altarpieces were still in the city around 1856. The date of sale can only be reconstructed through mentions of the painting's location in the literature.

8 Cittadella 1856 (cit. n. 5), 34. Candi's copy, signed and dated 1852, is located in the Archbishop's Palace in Ferrara. See Malagutti 2013/14 (cit. n. 1), 2, n. 10.

Fig. 2: Signature and date: 'BENVENVTO · GAROFALLO · F / ·M·D·XX'.

Around 1848, both paintings were owned by the antiques dealer Ubaldo Ghersi.[9] Ortolano's picture left the city a few years later.[10]
The further history of our painting is unclear.[11] At an unknown point, it entered the collection of the Bourbon-Parma family. In 1962, its then owner, Alice Bourbon-Parma, decided to sell the panel, and an export license was sought from the Federal Monuments Office in Vienna. There, the outstanding quality and exceptional significance of the picture for Austria were determined and its provenance recognized. After a negative verdict was issued on 17 October 1962, purchase by the Republic was recommended and completed within a few weeks by the director of the Kunsthistorisches Museum's Picture Gallery, Vinzenz Oberhammer, with the approval of the Financial Procurator's Office.[12] With the acquisition of this important panel, a prominent addition was made to the Italian High Renaissance holdings of the Picture Gallery for the Central Italian School and a rare altarpiece from this period, preserved in original condition, secured.

9 Laderchi 1848 and 1856 (both cit. n. 7).

10 Around 1858, Ortolano's painting was owned by the collector Alexander Barker in London, who presented it in an exhibition: see George Scharf, *Artistic and Descriptive Notes on the most Remarkable Pictures in the British Institution*, London 1858, 51–53, no. 19 (https://archive.org/stream/gri_33125008298016/gri_33125008298016_djvu.txt [last accessed: 20 October 2020]). It was purchased in 1861 for the National Gallery in London.

11 According to Luigi Napoleone Cittadella, *Benvenuto Tisi da Garofalo. Pittore ferrarese del Secolo XVI*, Ferrara 1872, 38, the *Resurrection* was still owned by Ubaldo Sgherbi at the moment of publication ('[…] Risurrezione di G. C., che vedevasi nella Chiesa Arcipretale di Bondeno, ora di proprietà del negoziante Ubaldo Sgherbi').

12 The documentation of the purchase can be studied in the archive of the Picture Gallery of the Kunsthistorisches Museum, Zl. 9/Gal./1962/XIV. The confirmation of payment is dated 30 November 1962.

3. THE PAINTING

The scene takes place at sunrise in a populated landscape with rolling hills. In the background at left, a town lies at the foot of a pointed mountain; on the right, houses with a tower on a promontory can be seen, before which the three Marys are depicted on the way to Christ's grave.

Before this landscape backdrop, the miracle of the resurrection occurs. The scene with Christ hovering above the grave follows the traditional iconography of the resurrection and emphasizes the unattainability of the Son of God for humanity. Although the unopened grave is uncommon in the iconography of the early Italian Renaissance, it was, interestingly, depicted relatively often from the fifteenth century in combination with the levitating Christ.[13] Following a medieval tradition[14], the closed sarcophagus symbolizes the virginal womb of Mary, the Mother of God. The subject of rebirth, or the beginning of new life expressed in the resurrection, is thus explicitly emphasized.[15]

A white robe with loose folds wraps the lower body of the Resurrected and is thrown over his left shoulder from behind. The upper body is bared so that, as signs of his suffering, the side wound is visible along with the wounds on his hands and feet. He holds in his left hand the staff of the Resurrection flag, which waves above his head like a baldachin, a symbol of Christ's victory over death, while his right hand is raised in a gesture of blessing.

The sarcophagus stands in the middle of the scene, arranged frontally below the figure of Christ. This is reproduced in Renaissance forms, generally based on 'classical' antiquity. The corners of the lid terminate in acroteria. The front is vertically divided into three sections; in the middle is a niche in which a statue, probably of Moses, is depicted in grisaille. His gaze is directed upward toward the Resurrected, at his feet are the tablets of the law.[16] Viewed theologically, Moses prefigures Christ and the tablets of the law form the basis for the New Testament. The depiction of the prophet in the lower part of the sarcophagus emphasizes that the New Testament is based on the Old.

A number of guards are grouped to the left and right of the grave, some with windblown hair, depicted in different postures expressing fear and astonishment. They are overwhelmed by the miracle and cover their eyes before the light of God. The reactions evoked in the individuals by the event express great agitation, but this is mitigated by the overall effect of the picture. The painter sought a balanced, harmonious scene, which he achieved through a symmetry of colour and composition within the two groups of figures.

The staging of Garofalo's *Resurrection of Christ* recalls that of Madonnas classically enthroned atop marble bases with saints before a landscape, in a Giorgionesque or Venetian manner, and is found in the painter's many altarpieces created between 1515 and 1520.[17] The focus of the composition is now not the Madonna but the resurrected Christ. The colouring, too, recalls Giorgione and Titian. In many figures, on the other hand, the influence of Raphael is

[13] Pia Wilhelm, *Auferstehung Christi*, in: *Lexikon der christlichen Ikonographie*, vol. 1 (1968), 202–218, here: 217.

[14] Theologians such as Ephrem the Syrian, Augustine, and Bede proposed this comparison. See Louis Réau, *Iconographie de l'art chrétien*, vol. II: *Iconographie de la bible. Nouveau Testament*, Paris 1957, 544; Wilhelm 1968 (cit. n. 13), esp. 216 f.

[15] Réau 1957 (cit. n. 14), 544.

[16] According to the traditional iconography, Moses is recognizable by horns or rays visible on his head after he received the tablets on Sinai, a sign of his encounter with God. These are not depicted in Garofalo's painting, however the tablets of the law serve as clear evidence for an identification as Moses. Without shifting the interpretation, however, the figure could also be interpreted as a personification of the Old Testament. The connection between the Old and New Testaments would be equally expressed in this iconographic variant. Thanks to Mino Gabriele for support in the analysis of the painting's iconography.

[17] See Fioravanti Baraldi 1993 (cit. n. 1), cat. nos. 42, 43, 52, 53, 65.

evident. Perhaps Raphael's *Transfiguration*,[18] his final painting left unfinished due to his sudden death, served as a model for Garofalo's *Resurrection*. The Ferrarese painter could have had the opportunity to see preparatory drawings for the painting in Raphael's workshop during his second stay in Rome, around 1517–1519. Perhaps he was inspired by the division of the composition into two levels and the figure of Christ hovering in the air. Raphael's countless pictorial inventions, which Garofalo could admire in Rome, formed an inexhaustible source of inspiration – not only for the luminous figure of Christ but also for the tomb guard seated in the right foreground. The latter appears to be a citation from the *Expulsion of Heliodorus from the Temple* in the Vatican Stanze – a figure recorded by Raphael on a sheet now in the Ashmolean Museum in Oxford.[19] A study for an unrealized *Resurrection* by Raphael, depicting the grave, angels, and guards in the lower register, appears to be another significant model.[20] Garofalo's altarpiece is closely related to this sheet compositionally. The latterly inserted figure of the soldier also appears derived from the parallel figure on the right side of this sketch.

3.1 ART HISTORICAL INTERPRETATION OF THE TECHNICAL DATA

On the basis of the infrared reflectogram *(see fig. 3)* and x-radiograph *(see fig. 7)* made during the current conservation treatment, the development of the composition reveals a methodical approach. The insights gained from the images allow the following reconstruction of the picture's creation.[21]
Garofalo prepared the composition carefully. Vasari reports that he employed jointed models made of clay and wood to study the positions of figures and record them on paper, thereby emphasizing the importance of observation from nature.[22] Although his drawn oeuvre is relatively small and no sheets related to the *Resurrection* are known, it can be assumed that Garofalo made both preparatory drawings and compositional sketches. The infrared reflectogram shows an underdrawing executed in a dry medium. Lines drawn using a ruler divide the scene *(see fig. 9)*, while the figures are generally sketched with free lines *(see fig. 12b)*.
The x-radiograph reveals that the relatively few pentimenti are largely confined to the figure of Christ and the sarcophagus. Garofalo corrected the foreshortening of the blessing arm during the painting process, moving it slightly upward; he narrowed the fold of the robe below the arm and shifted the position of the foot to the right *(see fig. 14b)*. With minimal changes, Garofalo corrected the figure of Christ to determine his proper position in relation to the sarcophagus. The changes to the sarcophagus likewise relate especially to its spatial relationship with the resurrected Christ. The lid originally had a high, narrow, gabled roof that – like that executed – terminated in acroteria. In the first version, Jesus's foot rested directly on the lid. To visualize the movement of the Resurrected into heaven, Garofalo changed the shape of the lid, making it wider and lower. The change to the Moses statue followed that of the sarcophagus. This was originally larger and stood on a round base *(see fig. 17a)*. The painter

18 Rome, Pinacoteca Vaticana, inv. no. 40333.
19 Malagutti 2013/14 (cit. n. 1), 19, fig. 9.
20 Oxford, Ashmolean Museum, inv. no. PII558; ex. cat. Achim Gnann (ed.), *Raffael*, Vienna (Albertina) 2017, 278 f., cat. no. 87; Malagutti 2013/14 (cit. n. 1), 21 f.
21 For a detailed description of the picture's creation from a technical perspective, see section 4.
22 Vasari 1881 (cit. n. 1), 464. See also Alessandra Pattanaro, *Per Garofalo disegnatore: uno studio per la pala di Modena e qualche riflessione sull'uso dei modelli di terra e di legname*, in: Prospettiva 119–120, 2005, 105–111.

reduced the figure of the prophet and placed it in a niche, flanked on either side by simple rectangular panels. The initially suggested egg and dart decoration of the cornice was discarded *(see fig. 17a)*. The first version of the division of the façade is recognizable in the vertical lines visible in the infrared reflectogram *(see fig. 9b)*. The redesign of the sarcophagus lid, particularly the earlier version of the pointed gable, is clearly recognizable in the underpainting visible in the x-radiograph *(see fig. 9a)*.

As a consequence of the changes to the sarcophagus, Garofalo appears to have felt it necessary to add to the composition in the foreground. He hence inserted the figure of the seated, bare-chested soldier on the right. Unlike his pendant on the left, which was planned from the beginning and thus held in reserve *(see fig. 10a)*, this figure is clearly painted over the final version of the sarcophagus. The infrared reflectogram shows that the painter first sketched the soldier over the sarcophagus in a free underdrawing before completing him in paint. The figure's naked upper body echoes that of Christ. With his gaze directed to the left, the soldier leads the viewer's eye from the right foreground to the seated man in armour on the left who in turn looks upward, thereby creating a visual connection to the resurrected Christ. Through successive changes and improvements in the course of the painting process, Garofalo created a monumental and balanced composition developed from a combination of 'controlled' dynamism and lively colouring.

The *Resurrection of Christ* represents Garofalo's stylistic highpoint following his second Roman sojourn. As noted above, his most important source of inspiration for this painting was the art of Raphael, particularly his frescoes in the Stanze and the *Transfiguration*. Garofalo transcribed these impulses in this imposing work, both in relation to the compositional structure and in the many citations from the great master's creations. Around 1520, in this particularly fruitful phase of Garofalo's output, the Raphaelesque aspects meet an important component: the naturalism of Venetian painting, which was prominently represented and extremely influential through the works of Giovanni Bellini, and particularly due to the presence of Titian and Dosso Dossi at the court of Alfonso I d'Este in Ferrara. In the *Resurrection of Christ*, Garofalo achieves a successful synthesis of these ground-breaking artistic currents, which coalesce in a charming and balanced 'classical' style. It is a style that rightly distinguishes Garofalo as the most important representatives of Raphaelism in Emilia.

4. PAINTING TECHNIQUE – PICTORIAL DEVELOPMENT – TECHNICAL OBSERVATIONS

4.1 METHODOLOGY

Scientific study occupied an important place in the current conservation efforts. Technical investigations – particularly photography under visible and ultraviolet light, infrared reflectography, and x-radiography – as well as scientific analyses of pigments and binding media together with the clarification of the paint stratigraphy, were indispensable prerequisites for the subsequent, comprehensive conservation treatment. The application of these methods also offered information on the development of the picture, painting process, and conservation history. Although the results of these analyses are best understood in the following sections, a selection are presented separately here.

Through infrared reflectography *(fig. 3)*, information on the creation of paintings, sketches or ideas, and the composition can be gained.[23] For Garofalo, for instance, it can be seen whether he prepared the motifs of his painting in great detail or only as loose sketches.

In the *Resurrection of Christ*, it is notable that the underdrawing of the landscape, figures, and textile passages appears largely executed freehand, hence presumably not following a model, and that the thickness and intensity of the (black chalk) lines vary slightly. These were not strictly followed in the later, painterly execution. There are nonetheless a number of exceptions, particularly in the group of figures at left, where detailed indications of drapery folds and shadows with hatching are visible, exactly matching the final painting *(fig. 4)*.

Based on its size, it can be assumed that the altarpiece was painted vertically with the aid of a ladder. As the contours of the figures show similarities with depictions in other works by Garofalo, and because of the size and complexity of the groups of figures, it is conceivable that Garofalo also employed cartoon models for the basic composition. Corresponding traces, such as pouncing points from the transfer of a design to the prepared panel, are not present, however. The pouncing points were probably connected to lines or wiped away.

The changes to the composition between the underdrawing and the painting as executed, discovered using infrared reflectography and x-radiography, are also largely visible in the relief of the paint surface. Examples include Jesus's weight leg and right arm *(fig. 5)*. Some heads in the figure groups were also reworked by the artist during the first phase of establishing the composition, with strikingly broad and vigorous dark lines *(fig. 6)*.

[23] Through infrared reflectography, lines of underdrawing can be made visible when black, carbon-containing media were employed.

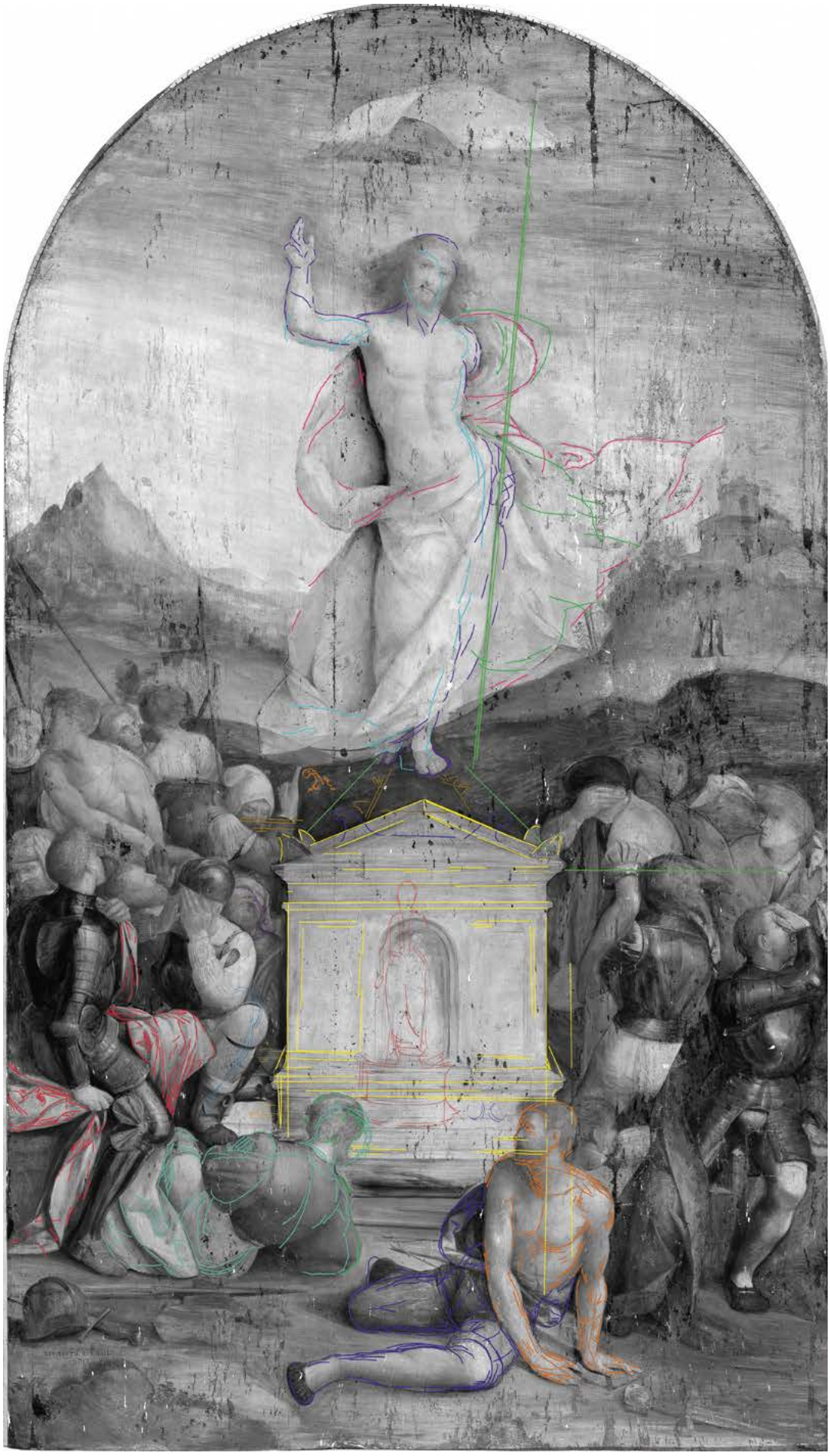

Fig. 3: Infrared reflectogram, with diagram of compositional changes around the sarcophagus.

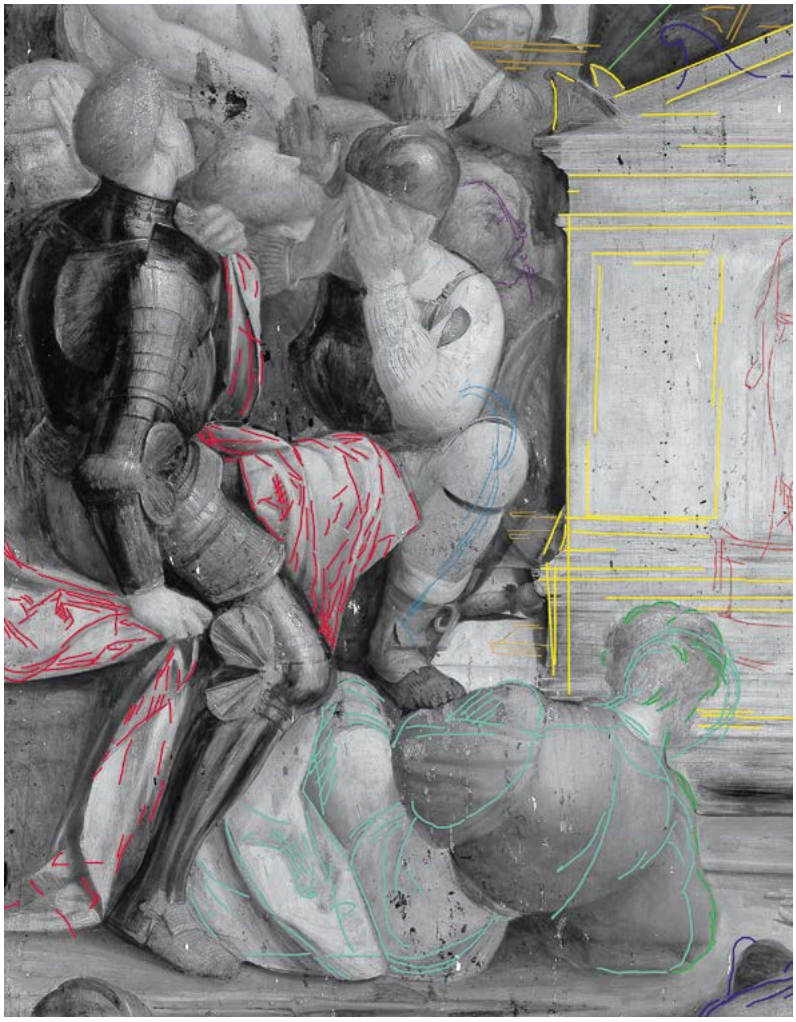

Fig. 4: Infrared reflectogram, detail of the standing soldier in full armour (red) and the reclining soldier in the green garment (turquoise) from the figure group at left.

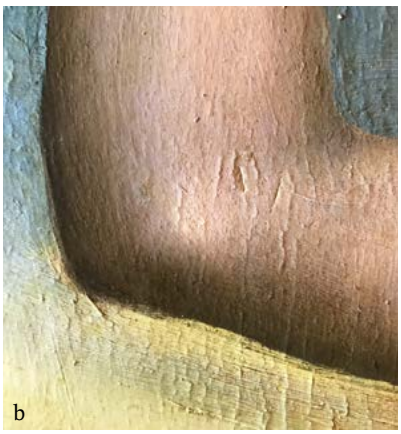

Fig. 5: a. X-radiograph, detail of Christ's right arm.
b. Detail of Christ's right arm.
c. Detail of Christ's right hand, which was held in reserve; the flesh paint partially overlaps the impastoed paint of the sky at the edges.
d. Detail of Christ's weight leg and right foot.

Fig. 6: Detail of the head of the standing soldier from the group of figures at front right.
a. Infrared reflectogram.
b. Visible light.

X-radiography *(fig. 7)* documents both the construction and the condition of the wood panel. Thus, for instance, the original carpentry of the panel as well as later interventions are revealed.[24] Information on Garofalo's painting technique can also be gained. Broad white strokes reveal the application of the lead white–containing imprimitura using a broad brush *(fig. 8)*. A number of pentimenti are likewise recognizable in the x-radiograph, e.g. in Jesus's right arm and feet. Here the painter's first composition was reworked with paint containing lead white, and these areas thus appear light. Comparison of the x-radiograph with the painting as executed confirms that the pentimenti largely occurred during the painting process *(see fig. 5)*.
The sarcophagus and the surrounding groups of figures to the left and right deserve particular attention. The execution of the first design was already well advanced when Garofalo made modifications in the area of the sarcophagus. The accumulation of the lead white–containing brushstrokes testifies to compositional changes made after paint was already applied *(fig. 9)*. Only the comparison of the infrared reflectogram with the x-radiograph allows the complex sequence of pentimenti in this area to be reconstructed to some degree. For the development of the final composition of the sarcophagus described in the following section, however, the question of whether the pentimenti reflected the artist's own conception or occurred at the behest of the patron must remain unanswered.

[24] See section 5.2.1 Support.

Fig. 7: X-radiograph.

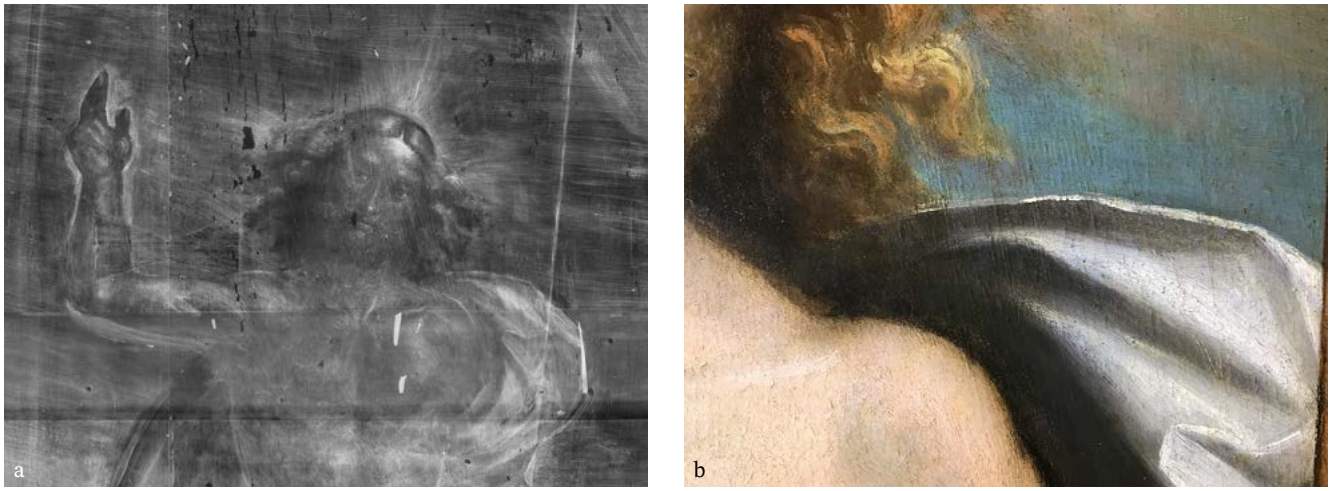

Fig. 8: a. X-radiograph, detail of Christ's head: The application of the imprimitura with quick, broad brushstrokes is visible.
b. Detail of Christ's left shoulder: Here the application of the imprimitura is also evident in visible light.

4.2 PAINTING TECHNIQUE - PICTORIAL DEVELOPMENT

The altarpiece was constructed from multiple planks glued together (see section 5.2.1 Support) and the surface coated with glue before the application of the ground layer. There followed multiple layers of a glue-bound gypsum ground; the final layer, the imprimitura,[25] contains lead white and a small amount of lead-tin yellow (see Section 4.3.1 Painting Media and Paint Stratigraphy).[26]
After the preparation of the smooth ground and the application of the imprimitura as a thin intermediate layer, the underdrawing was executed. The imprimitura thus preceded the establishment of the composition. The underdrawing appears to employ a dry rather than a liquid medium, presumably black chalk. Garofalo also used a dry medium in the underdrawing of the pentimenti. The fine surface texture of the imprimitura, applied with a broad brush, allows the better transfer of the chalk.[27] Clearly interrupted (dotted) lines can sometimes be observed, where the chalk only transferred to the high points of the brushwork. In some areas, the underdrawing of pentimenti occurred after the application of the first layers of underpainting, directly onto the paint surface.
It seems likely that Garofalo used cartoons to aid in the complex composition of the monumental altarpiece. Guidelines were also used. Particularly in the area of the sarcophagus, vertical lines were drawn to define the proper position.
A vertical line, corresponding to the left edge of the sarcophagus, ends at the reclining soldier wearing the green garment in the picture's left foreground. This could suggest that the figure was always planned there. Another indication is that, in the x-radiograph, an area of reserve held during the painting process for a first indication of the head is recognizable. The angle

[25] The imprimitura not only modulates the absorption of the ground, it also increases the reflection of light and gives an initial tone for the subsequent painting, which is influenced by it.
[26] The results are described in greater detail in section 4.3 Technical Investigation.
[27] David Bomford (ed.), *Underdrawings in Renaissance Paintings*, London 2002, 61–73; Andreas Siejek – Kathrin Kirsch, *Die Unterzeichnung auf dem Malgrund. Graphische Mittel und Übertragungsverfahren im 15.–17. Jahrhundert* (Kölner Beiträge zur Restaurierung und Konservierung von Kunst- und Kulturgut, vol. 11), Munich 2004, 182–201.

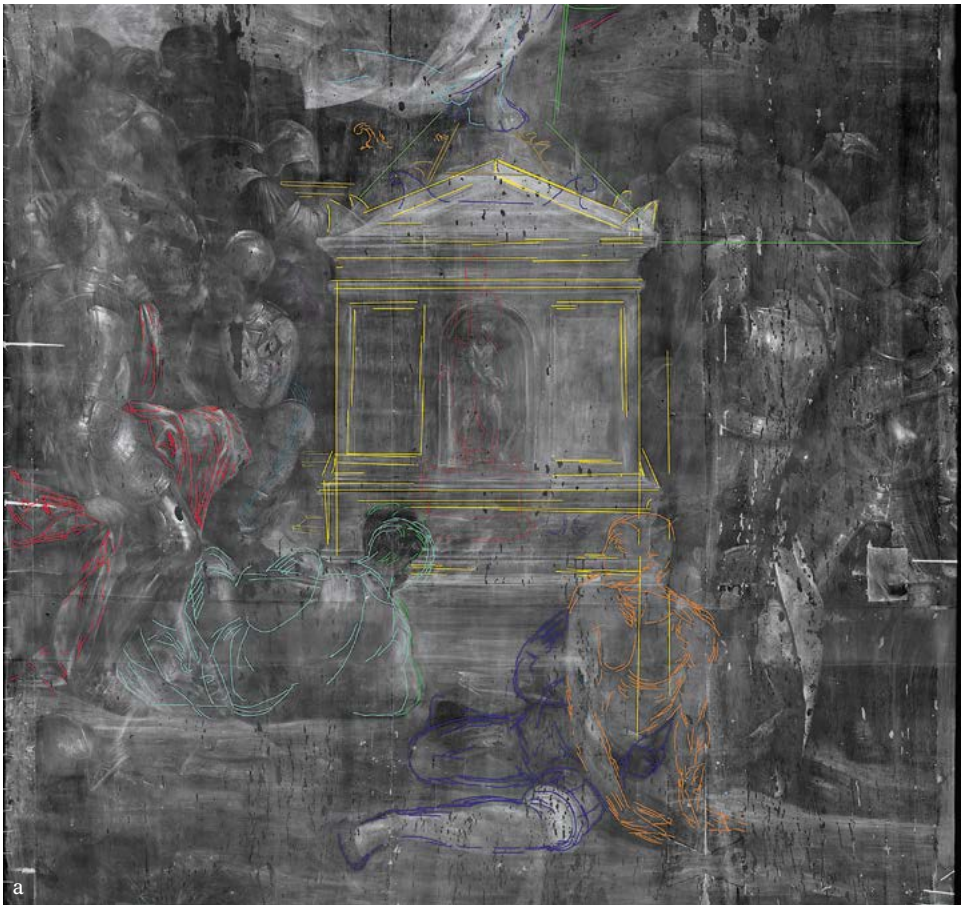

Fig. 9: Detail of the sarcophagus.
a. X-radiograph.
b. Infrared reflectogram with diagram: first placement of the sarcophagus (orange), statue in front of the sarcophagus (red); second placement of the sarcophagus (yellow), perspective and horizon lines (green).

Fig. 10: Detail of the head of the reclining soldier in the left foreground.
a. X-radiograph: In the sarcophagus, the head was kept in reserve during the painting process.
b. Infrared reflectogram: The lines of underdrawing in the head are sketchily executed.
c. Detail of the locks of hair, which overlap the paint of the sarcophagus.

of the head was later slightly changed such that, through a shift to the upper left, the curls lie atop the already executed paint of the sarcophagus *(fig. 10)*. In contrast, the right border of the sarcophagus continues below the figure of the soldier with the nude upper body *(see fig. 9)*. This could suggest that this figure was added to the composition later. The x-radiograph reveals that the soldier's head was only executed after the final, detailed rendering of the sarcophagus, above this paint layer. This indicates that the figure was not planned originally *(fig. 11)*.

A further interesting detail is that for the partially clothed soldier seated in the foreground – in contrast to his otherwise more sketchy and minimal underdrawing – Garofalo rendered the final form of the muscular upper body with numerous parallel lines, working with great precision. Christ's naked upper body is underdrawn in a similar manner *(fig. 12)*. These two together represent the main figures in the composition.

Because of the alteration to the size and position of the sarcophagus and resulting compositional change, individual heads and postures of figures were later adjusted and corrected during the painting process with bold chalk lines. In the infrared reflectogram, the profile of the soldier at the front right of the group of figures at right shows powerful, swiftly executed lines *(see fig. 6a)*. The head of the figure to the left of the grave was changed from profile to frontal view with reinforced lines. For the final execution of the head – the type appears conspicuously often in Garofalo's work – there is no underdrawing *(fig. 13)*.

The change to the vertical position of Christ's head presumably occurred at the same time as the shift of his weight leg due to the alteration to the sarcophagus. In the final painterly execution, Jesus's head is tilted to the right, without additional underdrawing. The body is thereby given a flowing, serpentine movement *(fig. 14)*.

Furthermore, the garments of the figures were generally schematically indicated with only a few summary notations for painting. It is striking that the group of figures on the left side on the picture shows much more detailed underdrawing than that on the right. Garofalo presumably began to develop the composition here. The standing soldier in the splendid full-body

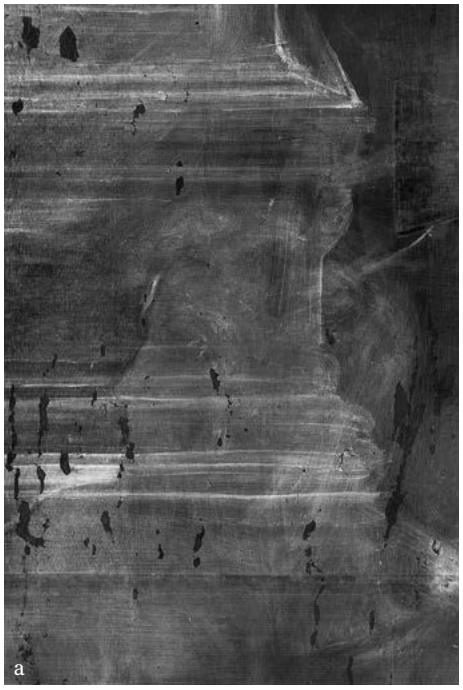

Fig. 11: Detail of the head of the seated, bare-chested soldier.
a. X-radiograph.
b. Visible light.
c. Raking light. The horizontal brushwork of the paint of the sarcophagus is visible. The contour of the profile was corrected in the final step.

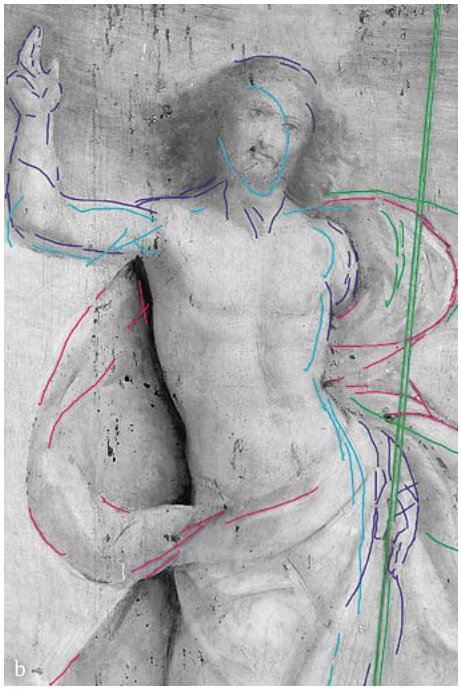

Fig. 12: a. Infrared reflectogram, detail of the seated, bare-chested soldier: body (orange), garments (violet).
b. Infrared reflectogram, detail of Christ's bare upper body: First placement (light blue), second placement (violet); drapery, first placement (green), second placement (red).

Fig. 13: Detail of the head of a figure in the middle of the picture, to the left of the sarcophagus.
a. Infrared reflectogram.
b. Visible light.

armour at the left edge and the reclining soldier in the green garment in the foreground show detailed indications of folds and shadow passages marked with parallel hatching. These differ from the garments (e.g. for Christ) and contours of figures in which lines appear freely drawn and less dependent on a model. They are also less closely followed in the painterly execution. The final depiction of Jesus's body and white robe appear to have only been worked out during the painting process *(see figs. 5 and 20)*.

It can certainly also be stated that the overall compositions of the figure groups on both sides were planned in this form from the start, even if, due to the change in the sarcophagus, a number of pentimenti were made, especially to the heads.

Another interesting detail is found in the area of the roof-shaped lid of the sarcophagus: lines pressed into the still-wet paint of the acroteria during the painting process *(fig. 15)*.[28] These perspective lines, which are also visible in the infrared reflectogram, converge at Christ's weight leg *(see fig. 9)*.

In the x-radiograph, it is also evident that the sarcophagus was smaller and narrower, was positioned higher, and was decorated with volutes. A drawing on the reverse of the support, on the outer right plank – in nearly the same position as on the painted side – is very similar to the volutes in the infrared reflectogram.

[28] The benefit of incisions over drawn lines is that they are better visible further along in the painting process.

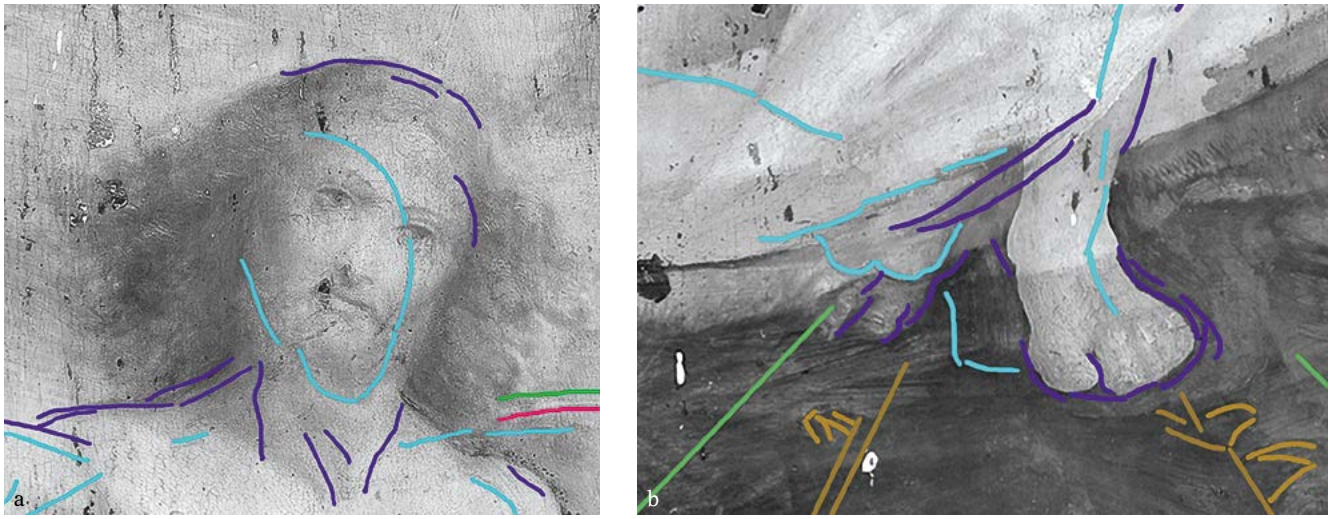

Fig. 14: a. Infrared reflectogram, detail of Christ's head angled to the right: First placement (light blue), second placement (violet). b. Infrared reflectogram, detail of the shifted weight leg due to the change to the sarcophagus: First placement (light blue), second placement (violet).

Fig. 15: Detail of the lid of the sarcophagus: incision of a perspectival line leading to Christ's weight leg.

This, interestingly, reveals another volute on the right, beside the figure, who points to Christ with his index finger and simultaneously holds an object, a stone or a coin. In contrast to the other volutes, largely recognizable in the x-radiograph through the lead white–containing paint *(see fig. 9)*, this volute is only indicated in the underdrawing and is reversed compared with the drawing on the back of the panel *(fig. 16)*. Paint for this version of the volute is neither visible in the infrared reflectogram nor in the x-radiograph. The underdrawing was thus part of the first placement of the sarcophagus, in front of which a larger statue on a circular pedestal was originally planned *(fig. 17a)*.[29] Beside the pedestal, geometric (egg-and-dart) shapes for the decoration of the sarcophagus as later laid in are recognizable, which were not executed in paint.

[29] See section 3. Painting.

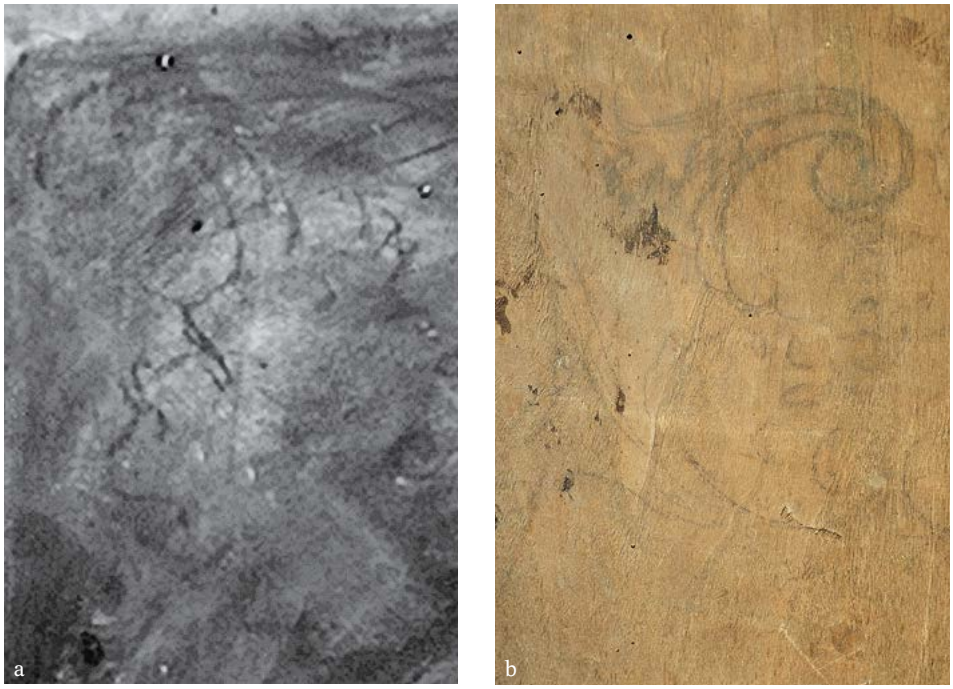

Fig. 16: a. Infrared reflectogram, detail of the volute to the left of the sarcophagus.
b. Detail of the volute drawn on the back of the panel in visible light.

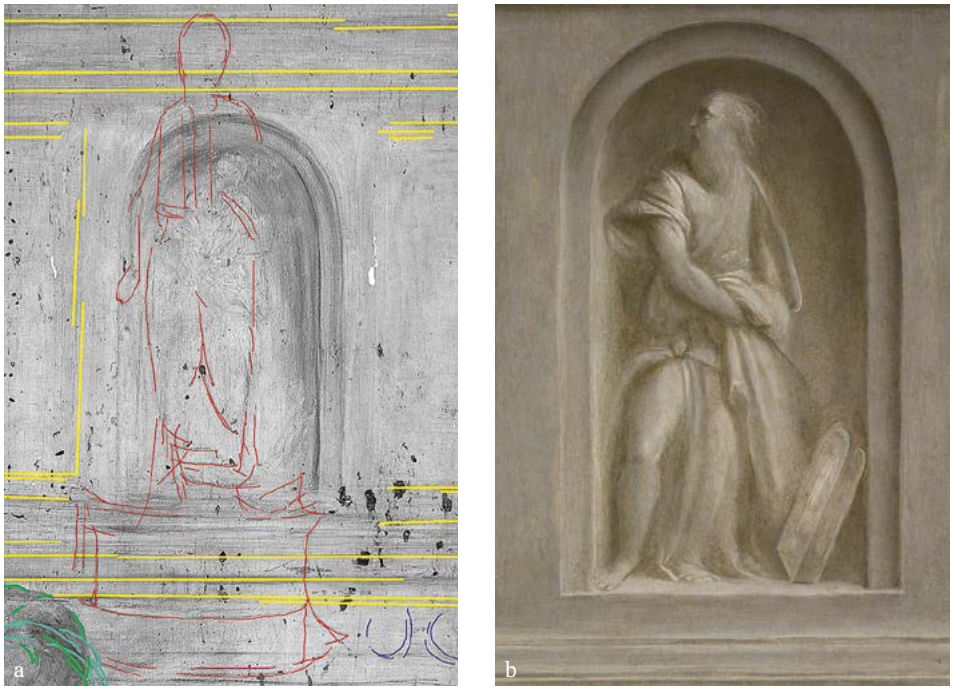

Fig. 17: a. Infrared reflectogram, detail of the statue in front of the sarcophagus in its first form (red).
b. Detail of the 'Moses' statue in visible light.

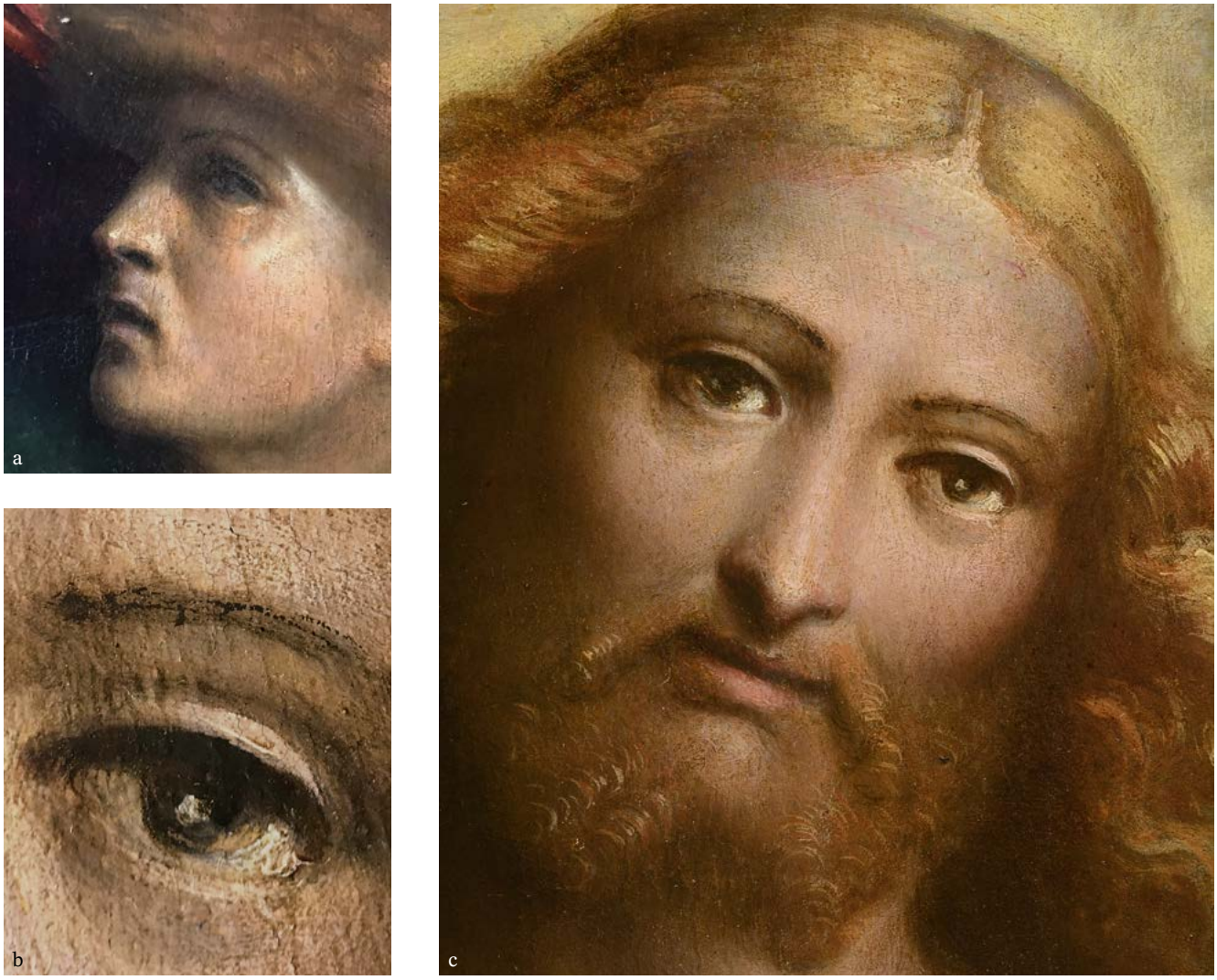

Fig. 18: a. Detail of the head of the soldier standing at right rear, from the group of figures at right.
b. Detail of Christ's left eye.
c. Detail of Christ's head.

4.2.1 FLESH

The flesh areas of the individual figures were largely held in reserve. The handling is smoother and less impastoed than the multi-layered paint application of the landscape and garments. The main areas were modelled over a lead white–containing layer with light-dark transitions through grey-brown shadow passages and lead white highlights. There is no detailed internal drawing. Details of the faces and reflections in the eyes and mouths are executed with finer brushstrokes. The black brushstrokes of the eyebrows appear to have pearled up from the light flesh colour, cannily employed design elements exploiting the principle of 'fat over lean' *(fig. 18)*.[30]

[30] Iris Schäfer, *Gewebeabdrücke in farbigen Lasuren spätmittelalterlicher Tafelmalerei*, in: Zeitschrift für Kunsttechnologie und Konservierung 13/1, 1999, 40–49, here: 42: 'the rule "fat over lean" was sometimes not respected, and in fine linear details even consciously ignored, as characteristic pearling up of the paint attests.'

Fig. 19: a. Detail of the flag.
b. Detail of the juncture between the sky and the flag.

Fig. 20: a. Detail of the white robe in the upper right half of the picture, at the border with the sky.
b. Detail of the background landscape at centre right, at the transition to Christ's white robe.

4.2.2 PAINT APPLICATION

The colour of the sky displays a lively facture and 'relatively' open manner of painting. The blue tone was applied with rapid, broad brushstrokes (ca. 1–1.5 cm) of liquid paint. The light and dark areas lack clear boundaries. The imprimitura is sometimes visible in the depths and in transitions to other colour passages and is exploited to create the effect *(fig. 19)*.
The lively colourism of the textile passages was achieved through the application of multiple layers of paint. In the areas held in reserve, the lower layers of the garments were executed on the desired surfaces in a smooth paint with little impasto. Thus e.g. the white colour of Christ's robe was first applied to the reserved areas. Next, corrections were made at the borders of the robe to achieve the final form. There are thus areas that lie above the paint of the sky and others in which the paint of the background landscape covers parts of the white robe.
The painting of the background landscape varies from liquid, wet-in-wet areas to impastoed passages with visible brushstrokes *(fig. 20)*.
The flag was likewise held in reserve in the sky. The white flag with the red cross, the symbol of Christ's resurrection, is smoother and thinner than the paint application in the sky. Brushstrokes that limit the area of the flag and slightly correct its contours are evident. The cross was painted last.
Jesus's left hand holding the staff was laid above the already executed paint of the white garment. Through lines drawn with a ruler, the staff of the flag

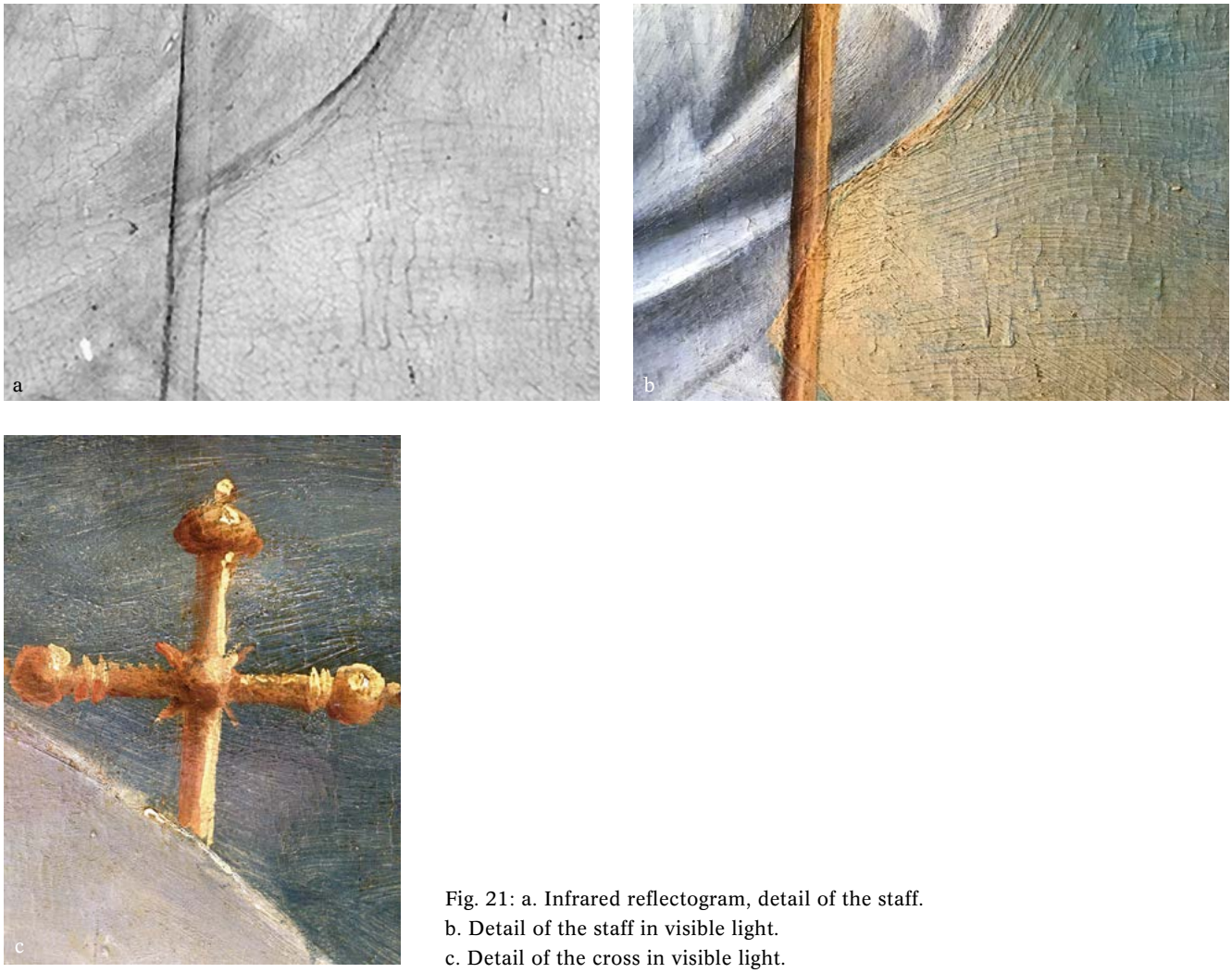

Fig. 21: a. Infrared reflectogram, detail of the staff.
b. Detail of the staff in visible light.
c. Detail of the cross in visible light.

was also underdrawn and painted in the final step. The fine, straight, broken strokes are visible in the infrared reflectogram, drawn over the paint of the sky and the white robe. The carbon medium transferred only to the high points of the brushwork. This confirms that the underdrawing of the staff with the cross was one of the final steps in the painting process, which is also recognizable in visible light *(fig. 21)*.

Christ's right hand was also kept in reserve from the paint of the background. The definitive form of the arm was achieved using the blue background colour of the sky to work out the final contour. The reason for the reduction of the arm could also be a heightening of the perspective foreshortening in the monumental work. The x-radiograph shows these painterly changes clearly, due to the lead white–containing paint *(see fig. 5)*.

The infrared reflectogram reveals that the outcropping in the middleground of the picture is laid in with loose, fluid brushstrokes. Because of the change to the composition of the sarcophagus and Jesus's posture, his weight leg was extended further into the already indicated rocks. The dark zone creates the impression that Christ hovers, emphasizing the character of the apparition. Through the shift of the weight leg to the right and the right leg downward, the fall of folds in Jesus's white robe also changed. The position of the feet is more standing than floating, however, as Christ presumably originally stood on the sarcophagus when the grave was positioned higher *(see figs. 5 and 14)*.

Fig. 22: Detail of the sun.

Fig. 23: Detail of the three weeping Marys on the way to Christ's grave.

4.2.3 PAINTERLY ACCENTS

A number of features that illustrate the richness of artistic detail and the artist's painterly capabilities reveal themselves to the attentive viewer in many particulars, briefly outlined here.

Garofalo depicted a morning atmosphere, with the sun rising over a city on the horizon at left, in a luminous yellow tone. The sun is rendered through an impastoed arc of paint as one of the final accents on the orange paint of the sky *(fig. 22)*.

On the horizon at the right background and thus not in the centre of the action, 'the three Marys' are shown, rendered in detail and richly coloured despite the distance *(fig. 23)*.

The radiant figure of Christ in his fluttering robe dominates the scene. The soldiers and other witnesses react to the resurrection differently, which is further emphasized through the vivid colours of their garments.

Particularly painterly accents are found in the standing soldier in full armour on the left side of the picture: the armour mirrors his red garment, emphasizing the metallic character and smooth reflective surface *(fig. 24a)*. The blue accent in the grey hose of the seated, bare-chested soldier is also an interesting detail. The fabric reflects the blue undergarment of the hose, thereby assuming the character of a smooth, even surface such as satin *(fig. 24b)*.

Fig. 24: a. Detail of the armour of the standing soldier in the left foreground.
b. Detail of the grey hose of the bare-chested soldier in the foreground.

Fig. 25: Detail of the figure raising his hand.

This blue tone is repeated in the mountainous landscape and the sky. The white of his left stocking reappears in Jesus's light robe.
The raised hand of the figure that was changed from an originally profile view to a frontal one (in the group of background figures to the left of the sarcophagus; *see fig. 13*) was particularly emphasized with bluish contours and bright accents of light *(fig. 25)*.
The white, feathered plume of the figure's headgear in the left background represents another artful detail. With fine brushstrokes, the artist creates the light, airy character of a feather blown by the wind *(fig. 26)*.
The bow and arrow in the foreground in front of the sarcophagus are also executed with detailed brushstrokes. The triple white fletching, the spiral-grooved cylindrical shaft, and the nock to receive the bow string are clearly recognizable on the arrow *(fig. 27)*. The weapons appear as though randomly scattered on the ground, but achieve a spatial delineation of the foreground, middleground, and background with their foreshortening and overlapping. Their arrangement emphasizes the depth, leading the viewer into the events taking place at an undefinable distance.

Fig. 26: Detail of the feathered headgear.

Fig. 27: Detail of the bow and arrow in the foreground, in front of the sarcophagus.

4.3 TECHNICAL INVESTIGATION

The Conservation Science Department analysed 32 samples from the front and reverse of the painting using light microscopy (LM)[31], scanning electron microscopy with energy-dispersive x-ray detection (SEM/EDX)[32], and gas chromatography-mass spectrometry (GC-MS).[33] In order to study the paint stratigraphy and the pigments and binding media used, 21 samples were prepared as paint cross-sections. The inorganic components were determined using SEM/EDX and the organic binding media classes for the individual cross-section layers indicated through (histo-)chemical staining. Further investigation and identification of particular binding media or mixtures was generally undertaken using GC-MS analysis, on samples suitably prepared or removed directly for that purpose. The methods employed also sought to reveal or clarify changes in the substance of the object caused by damage or past restoration measures.

The comparison of the investigation results from the current painting with those from already analysed works by the same master from the museum's holdings as well as published studies from other collections made it possible to gather information on the continuity of Garofalo's painting technique.

[31] Axioplan2, Zeiss, Germany.

[32] FEI Quanta 200F with EDX system (energy dispersive x-ray detection).

[33] 6890N gas chromatograph coupled with a quadrupole mass spectrometer, model 5973N, both Agilent Technologies, USA.

4.3.1 PAINTING MEDIA AND PAINT STRATIGRAPHY

Following Italian tradition of 'gesso', the panel has a light (off-white coloured) ground made from gypsum (calcium sulphate). To determine the binding medium used, on two samples the ground was mechanically separated from the remaining paint layers with the aid of a stereomicroscope and subsequently analysed with GC-MS. The detection of amino acids suggests that an animal glue was used to bind the gypsum, although due to the small sample size a more precise classification of the proteinaceous binding medium was not possible.

To prepare a surface that was as flat as possible for the application of paint, this underlayer was sanded (in alternating directions) in multiple working steps. To prevent the absorption of the precious paint, but also to achieve a high light reflection and thereby great luminosity for the paint layers, an overall layer of lead white, the so-called imprimitura, was laid over the highly absorbent ground. Using SEM/EDX, in many of the cross-sections some tin could also be determined along with the main lead signal in the imprimitura: hence, a small amount of lead-tin yellow was added to the lead white.

Through detailed study of the painting (especially in raking light), both the initial consistency of the imprimitura layer and its method of application can be evaluated. The imprimitura was distributed over the ground with a broad brush; the striated texture of the thick paint is clearly recognizable in the x-radiograph due to the high lead content and occasionally also in visible light *(see fig. 8)*.

The paint structure above is characterized by the overlapping of many thin layers. An opaque layer usually follows the imprimitura, thin enough to not wholly mask its luminosity. Further modelling occurred through the application of multiple glazes, with coordination of the colouration of the opaque underpaint and the translucent layers above. Hence, for example, an opaque red underpaint of lead white with vermilion was followed by medium-rich layers of red lake *(fig. 28)*; above an opaque layer of lead white, lead-tin yellow, and carbon black, copper green glazes were applied, likewise with a high proportion of binding medium *(fig. 29)*.

From the layer sequences of the two cross-sections illustrated here, it is also evident that Garofalo usually worked from darker to lighter tones. When necessary, local highlights of reflected light are placed on the glazed layers in thick, opaque paint (impasto).

Of the colourants used it can be determined that Garofalo's palette in this painting is characterized by the brilliant, highly luminous colours typical of the artist. Through the skilled combination of pigments and dyes he achieved a variety of tones and thus nuanced colour effects.

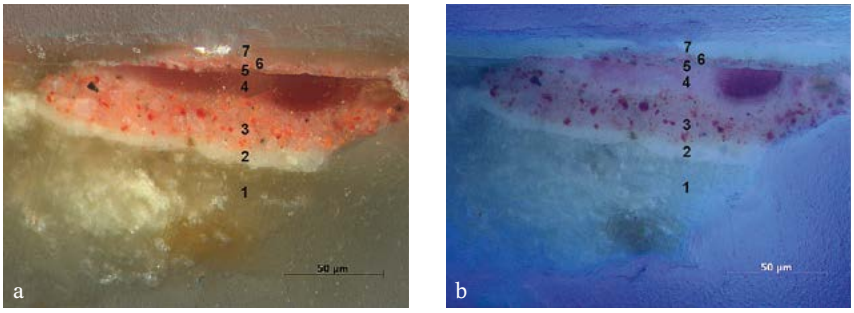

Fig. 28: Cross-section (a. VIS and b. UV, both 500x) of a sample from the red robe (soldier in the foreground, group of figures at left):
1. Ground: gypsum; 2. White imprimitura: lead white, occasional lead-tin yellow; 3. First red layer: lead white, vermilion, red lake; 4. Second red layer (glaze, high organic content): red lake, slight lead signal (some lead white or a drier); 5. Thin organic intermediate layer; 6. Third red layer (retouching): barium sulphate and zinc white (or lithopone), cadmium selenide and/or sulphide; 7. Varnish.

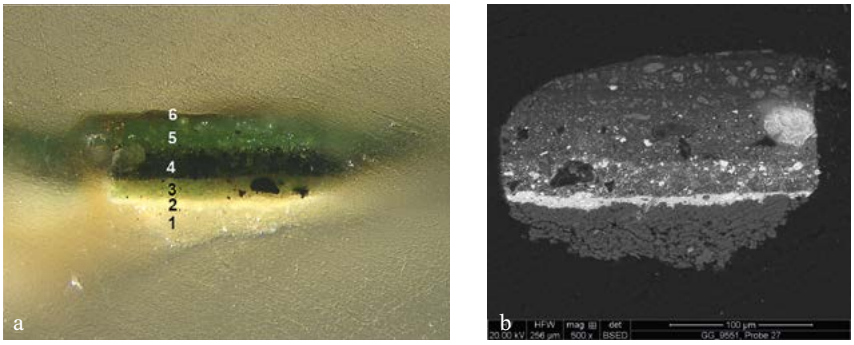

Fig. 29: Cross-section (a. VIS, 200x and b. SEM/BSE, 500x) of a sample from the green garment of the reclining soldier turning his head, left foreground:
1. Ground: gypsum; 2. White imprimitura: lead white, occasional lead-tin yellow; 3. Light green layer: lead white, lead-tin yellow, copper green, carbon black; 4. Dark green layer: high organic content, copper green, lead-tin yellow, little ochre and chalk; 5. Light green layer: highly organic, copper green; 6. Browned glaze: highly organic, copper green.

4.3.2 EXCURSUS ON THE GLAZING TECHNIQUE

Largely mineral pigments were available to artists of the Renaissance. To create new possibilities in their palette and expand the variety of tones, a new technique emerged with oil painting: glaze painting.[34] This is a layered technique with sequences of multiple, in part translucent colour layers. Dependent on the transparency of the individual paint layers, the overall effect is achieved by the combined contributions of all the layers. The reflection of light through one or two transparent layers (executed in low-pigmented, medium-rich mixtures) is usually constrained by an opaque, light underpaint. Through different toning and layering, not only can many

[34] Laurence de Viguerie – Guylaine Ducouret – Marine Cotte – François Lequeux – Philippe Walter, *New insights on the glaze technique through reconstruction of old glaze medium formulations*, in: Colloids and Surfaces A: Physicochemical and Engineering Aspects 33, 2008, 119–125; Helena Melo – Jana Sanyova – António João Cruz, *An unusual glazing technique on a Portuguese panel painting from the second half of the 16th century: materials, technique and reconstructions*, Preprints of ICOM-CC's 16th Triennial Conference in Lisbon, 2011.

colour nuances be achieved, the painting method also allows for colours with great depth effects and increased saturation and luminosity. The drawback of this technique lies in the considerable time required, as quick working by the artist is not possible due the drying necessary between the applications of the individual layers.

Among the reds, the opaque pigment vermilion has dominated since antiquity. It is valued for its high covering power, but the luminous red also has the detriment of an orange undertone. Its incompatibility with copper pigments and instability (blackening)[35] were also known, particularly manifest in aqueous techniques. The artists of the Renaissance overcame these faults by employing vermilion in different mixtures as underpaint, glazed with various coloured lakes (for example madder or carmine).[36]

As an intense green, verdigris, a copper acetate of variable chemical composition and thus varying tonality ranging from dark blue-green to luminous turquoise, was principally available from the Middle Ages. This had the most intense colour of the available green pigments but displayed a lower covering power than malachite. Verdigris was notorious for its instability, and numerous historic manuscripts warn of its use (Cennino Cennini, Strassburg Manuscript); de Mayerne even refers to the pigment as the 'enemy of all colours'.[37]

The literature reports highly varied recipes for processing verdigris into a transparent green paint, so-called copper resinate. Chemically, this consists largely of copper salts of abietic acid ($C_{19}H_{29}COOH$) and is a product of boiling copper salts with natural resins (usually colophony, larch turpentine, or mastic) in a drying oil. A dark green, thick resin paste was formed that had to be thinned before application as a glaze. Like verdigris, copper resinate glazes can turn brown on aging.

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35 Chemically, vermilion or cinnabar is mercury sulphide, which appears in three forms: the red cinnabarite (trigonal crystal system), the black metacinnabarite (cubic crystal system), and the black-violet hypercinnabarite (hexagonal crystal system); all three forms appear as minerals in nature (hypercinnabarite very rarely), but can also be synthetically produced. Cinnabar was already used as a pigment in antiquity and its instability was also known early on (*Des Marcus Vitruvius Pollio Baukunst*, translated by August Rode, vol. 2, Leipzig 1796; https://digi.ub.uni-heidelberg.de/diglit/vitruvius1796b/0134 [last accessed: 27 October 2020]). In the literature, the UV-induced transformation of the crystal modification (cinnabarite to metacinnabarite) is primarily given as the explanation for the blackening, however the accompanying elements of cinnabar, such as chlorine, also appear to play a role in the colour change (Rutherford J. Gettens – Robert L. Feller – W. T. Chase, *Vermilion and Cinnabar*, in: Ashok Roy [ed.], *Artists' Pigments. A Handbook of Their History and Characteristics*, vol. 2, Washington – Oxford 1993, 159–182, here: 167; Marine Cotte – Jean Susini – Nicole Metrich – Alessandra Moscato – Corrado Gratziu – Antonella Bertagnini – Mario Pagano, *Blackening of Pompeian cinnabar paintings: X-ray microspectroscopy analysis*, in: Analytical Chemistry 78/21, Nov. 2006, 7484–7492, https://doi.org/10.1021/ac0612224).

36 Coloured lakes are organic dyes, largely obtained from plants though in some cases also from animals such as scale insects, fixed on inorganic supports such as chalk or aluminium sulphate.

37 Renate Woudhuysen-Keller, *Aspects of Painting Technique in the Use of Verdigris and Copper Resinate*, in: Arie Wallert – Erma Hermens – Marja Peek (eds.), *Historical Painting Techniques, Materials, and Studio Practice: Preprints of a Symposium, University of Leiden, the Netherlands, 26–29 June 1995*, Los Angeles 1995, 65–69, here: 65.

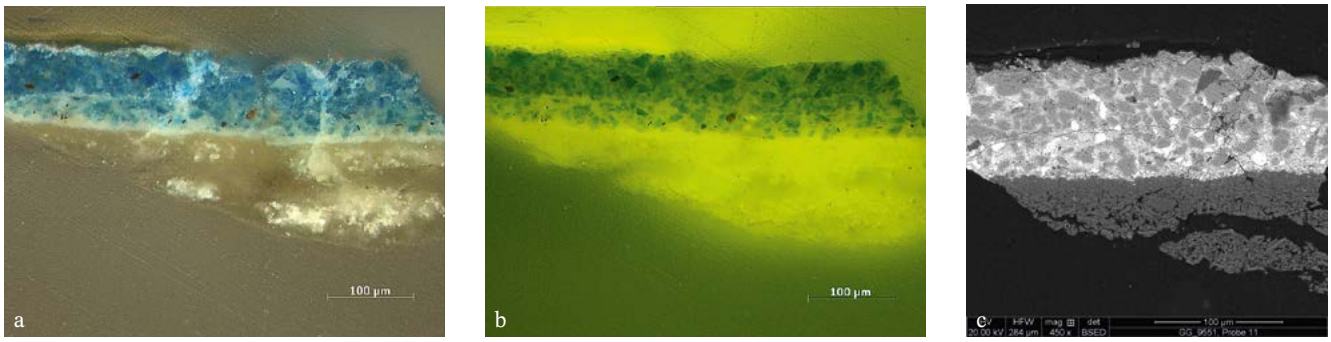


Fig. 30: Cross-section (a. VIS and b. UV, both 200x; c. SEM/BSE, 450x) from the blue hose of the seated soldier: build-up of the blue paint in multiple layers using increasingly coarse particles of azurite.

Pre-treated drying oils were used as the binding medium for the thin, smooth glazes. Thickened by warming, pre-polymerized oils are distinguished by quicker drying and improved film formation. The brushstrokes dissipate more easily and become invisible, resulting in extremely smooth surfaces. Some paintings also show signs that the glazes were dabbed with textiles after their application to remove excess paint and achieve the thinnest possible glaze layer.[38]

4.3.3 COLOURANTS

As the common white pigment, lead white was employed in light areas and in mixtures for darker passages. As a yellow pigment, lead-tin yellow is found in the imprimitura, in yellow areas, and also in other mixtures, e.g. in greens. Earth pigments in many different hues are found, i.e. from various ochre and brown tones to dark brown umber, either alone or in admixture with other pigments and lakes; the same is true of carbon black, as e.g. plant black, bone black, and/or lamp black.

In blue areas of the painting, for instance parts of the sky and in different garments, azurite was determined as the only blue pigment. The use of azurite is normally characterized by a multi-layer build-up: an underlayer using fine-grained azurite mixed with lead white was applied first; coarsely ground, more intensely coloured azurite, with only slight additions of lead white, was applied above *(fig. 30)*.[39]

Green elements in the painting are composed of a combination of blue or green and yellow pigments. An initial opaque layer of azurite (or sometimes also copper green) with additions of lead white and lead-tin yellow is usually present, above which Garofalo laid one or more glazes of copper green with slight additions of lead-tin yellow or ochre, with increasing amounts of organic binding medium. Depending on the desired lightness of the green tone, these glazes were sometimes muted with carbon black *(see fig. 29)*. Today many copper glazes unfortunately appear browned due to the age-induced changes described above.

[38] Jill Dunkerton – Nicholas Penny – Marika Spring, *The Technique of Garofalo's Paintings at the National Gallery*, in: National Gallery Technical Bulletin 23, 2002, 20–41, here: 31.

[39] Roy 1993 (cit. n. 35), 23–35.

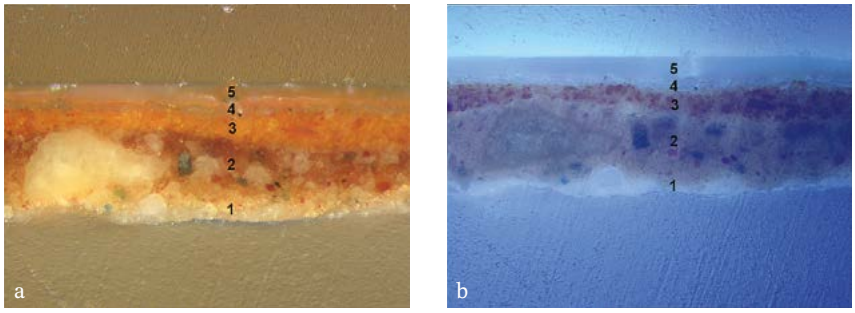


Fig. 31: Cross-section (a. VIS and b. UV, both 500x) of the orange hose of the reclining soldier turning his head, left foreground:
1. Trace of the imprimitura: lead white; 2. Dark red layer: lead white, lead-tin yellow, arsenic sulphide (orpiment or realgar), ochre, red lake, copper pigment; 3. Orange layer with yellow highlight: realgar with siliceous impurity, areas of lead-tin yellow on the surface as a highlight; 4. Glaze: highly organic, chalk; 5. Varnish.

Red details in the painting show a similar build-up of paint layers: over an opaque layer consisting of lead white, vermilion, and a little red lake, glaze layers of red lakes follow, sometimes with lead-containing additions (lead white or driers, sometimes also glass – see below), with increasing amounts of organic binder. The flesh passages likewise consist of lead white, vermilion, and red lake, with some ochre and carbon black as well.
The analysis of the orange areas is particularly worthy of note (*fig. 31*). Here it is clear that Garofalo was certainly familiar with the Venetian painting technique, or rather the *Venetian palette* (the latter term, while not wholly unambiguous, seeks to describe the typical palette of Venetian Renaissance painters such as Giovanni Bellini, Titian, etc.).[40] He, too, employed the arsenic sulphides realgar (As_4S_4) and orpiment (As_2S_3), yellow to light-red pigments considered typical of Venice in this period and often used there by artists beginning around 1490. Through the proximity of Garofalo's workplace, Ferrara, to Venice and the new profession of *vendecolori* (merchants specializing in the trade and sale of painting materials)[41] developing there at the end of the fifteenth century, these then novel pigments were also available to Garofalo.

[40] Barbara H. Berrie – Louisa C. Matthew, *Material Innovation and Artistic Invention: New Materials and New Colors in Renaissance Venetian Paintings*, in: Scientific Examination of Art. Modern Techniques in Conservation and Analysis (Arthur M. Sackler Colloquium, National Academy of Sciences, Washington, D.C., March 19–21, 2003), Washington, D.C. 2005, 12–26, https://doi.org/10.17226/11413 [last accessed: 29 October 2020].

[41] https://www.nga.gov/conservation/science/16th-century-pigments.html [last accessed: 29 October 2020].

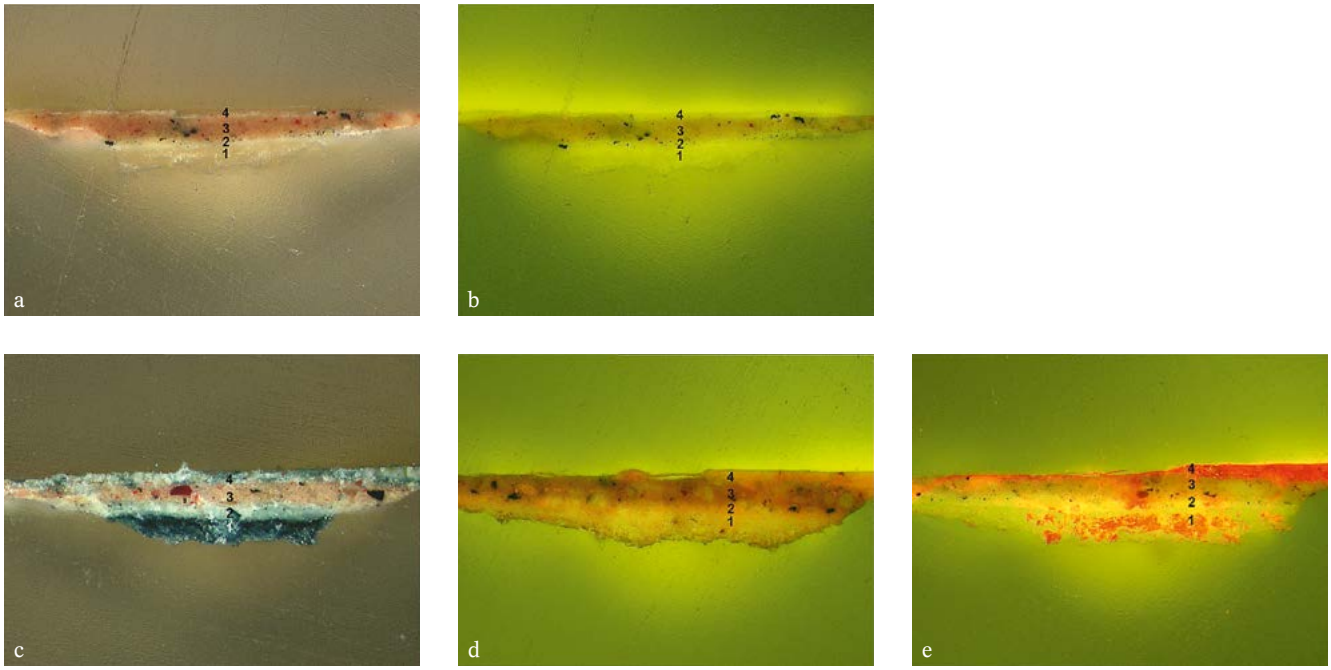


Fig. 32: Photomicrograph for (histo-)chemical staining of binding media, cross-section from the flesh of the seated soldier, foreground: 1. Ground: gypsum; 2. Lead white with some chalk; 3. Red layer with lead white, vermilion, carbon black; lead-tin yellow, ochre; 4. Varnish.
a. Image for comparison before staining, VIS, 200x.
b. Image for comparison before staining, UV, 200x.
c. Protein staining, VIS, 200x.
d. Resin staining, UV, 200x.
e. Oil staining, UV, 200x.

4.3.4 BINDING MEDIA

The precise identification of the organic binding media is of great theoretical interest, but poses a significant practical challenge due to the complexity of the mixtures used, the age-related changes in their composition and the small sample sizes available for analysis.

As a binding medium for paints, oil offers the advantages of high luminosity and brilliance, as it does not become matte on drying but rather maintains its gloss. Oil painting also convinces because of its translucency – that is, the colour reflection of the individual paint layers – and through its great colour depth and intensity. To augment this effect, ground glass was sometimes added.[42] Typical sixteenth-century glass had a high concentration of lead.[43] As lead has a siccative effect, the addition of glass also increased the drying behaviour. These advantages of the oil binding medium enabled artists completely new working methods.

To differentiate and localize the binding media in the individual paint layers, the cross-sections were (histo-)chemically stained *(fig. 32)*: determinations on the use of proteins, natural resins, and drying oils[44] in the individual paint layers could thus be made. The positive staining for protein of the ground (colour change to dark blue) supported the assumption that a typical gesso was used. The imprimitura did not show a clear medium indication with any of the stainings. This is because the lead pigments in it require little binding medium on grinding, and the sensitivity of the staining

[42] Berrie – Matthew 2005 (cit. n. 40), 17.

[43] Ulrich Birkmaier – Arie Wallert – Andrea Rothe, *Technical Examinations of Titian's Venus and Adonis: A Note on Early Italian Oil Painting Technique*, in: Arie Wallert – Erma Hermens – Marja Peek (eds.), *Historical Painting Techniques, Materials, and Studio Practice: Preprints of a Symposium, University of Leiden, the Netherlands, 26–29 June 1995,* Los Angeles 1995, 117–126, here: 123.

[44] Protein staining with amido black dye AB2; staining for natural resins with fluorescent alkanna dye; staining for oils with fluorescent dye rhodamine B.

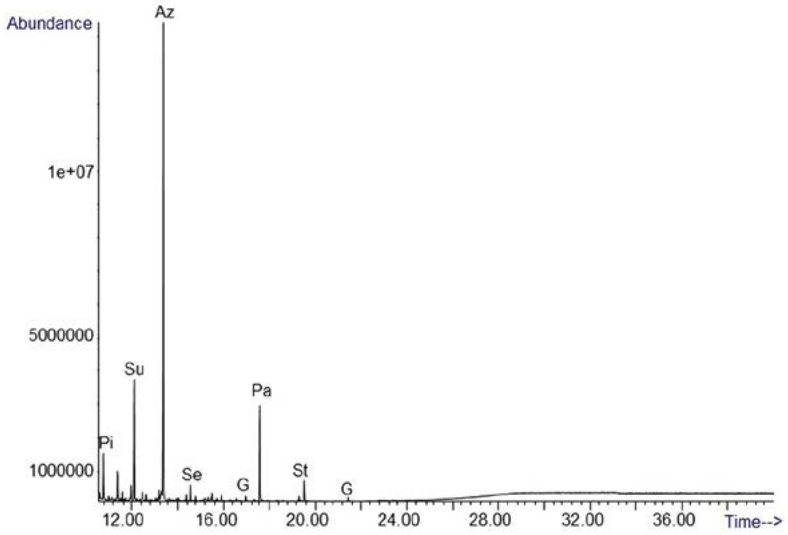


Fig. 33: TIC-chromatogram of the paint film from a sample from the blue-green garment of the standing soldier at right: indication of typical fat components glycerol (G), pimelic acid (Pi), suberic acid (Su), azelaic acid (Az), sebacic acid (Se), palmitic acid (Pa), stearic acid (St).

method for these slight concentrations is too low. The red paint shows a positive staining result for both resin and oil (orange-red fluorescence); these two binding media are also present in the varnish. The blue staining on the uppermost surface of the paint layers is a clear indication for the already described consolidation measures with proteinaceous media.

In addition to linseed oil, walnut oil was preferentially used in Italian paintings, especially with white and blue pigments: it is lighter in tone and tends to yellow less.[45] Due to its greater tendency to turn brown, linseed oil was more often used for darker colours.

As using the (histo-)chemical staining only allows a classification into the binding media classes protein, oil, and natural resin, but no precise identification within these, individual additional samples were also analysed with GC-MS. The use of proteinaceous binding media in the ground has already been described (see section 4.3.1 Painting Media and Paint Stratigraphy).

For four additional samples the paint layers were separated from the rest of the section and investigated via GC-MS for the presence of oils, waxes, and natural resins. The use of a drying oil could be confirmed in all of the samples. The analyses were characterized by high concentrations of azelaic acid (1,7-heptane-dicarboxylic acid, a saturated fatty acid) *(fig. 33)*, a natural oxidation product of drying oils. As a consequence of oxidation, the reduced amounts of palmitic and stearic acid, which serve as markers for a specific oil classification, made a precise determination of the type of oil difficult. That and the presence of binding media mixtures prevented an unambiguous characterization of the oil used as linseed, poppy, or walnut.

[45] Sabine Stanek – Václav Pitthard – Katharina Uhlir – Martina Griesser – Elke Oberthaler, *Survey of the Bruegel Paintings of the Kunsthistorisches Museum from a Technological Point of View,* in: *Brueghel. The Hand of the Master. The 450th Anniversary Edition. Essays in Context*, Vienna 2020, 248–261, here: 258.

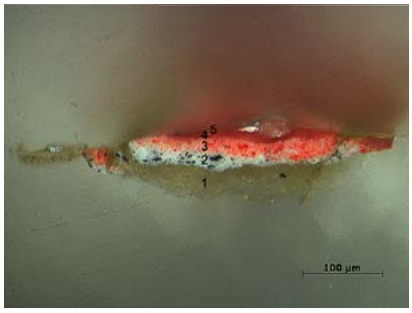


Fig. 34: Cross-section (VIS, 200x) of a sample from Garofalo's *St Roch* (Kunsthistorisches Museum, Picture Gallery, inv. no. 295), red robe: 1. Ground: gypsum; 2. Grey imprimitura: lead white, some carbon black; 3. First red layer: vermilion, lead white (or red lead), some red lake; 4. Second red layer: higher organic content than layer 3, red lake, slight lead content; 5. Remains of varnish.

4.4 COMPARISON OF FINDINGS WITH OTHER WORKS BY GAROFALO

In a number of samples from Garofalo's *Resurrection of Christ*, with the main component lead white a slight admixture of lead-tin yellow was detected in the imprimitura *(see figs. 28 and 29)* – as in four paintings by Garofalo in the National Gallery, London. Similarly composed imprimiture appear to have been popular during the first half of the sixteenth century and have been observed in numerous paintings by contemporaries including Ortolano, Raphael, and Lorenzo Lotto.[46]

An imprimitura tinted slightly grey using carbon black, typical of Garofalo's rival Dosso Dossi, was also determined in a number of works by Garofalo in the National Gallery, London, and in his *Triumphal Procession of Bacchus* in the Dresden Gemäldegalerie Alte Meister.[47] Such preparatory layers, often dark grey however, were common between 1530 and 1540, especially in Northern Italy.[48] This is interesting for the dating of two other works by Garofalo in the Picture Gallery of the Kunsthistorisches Museum, the small panel *Noli me tangere* (poplar, inv. no. 6757) and the *St Roch* (canvas, inv. no. 295), both previously dated 1525/30. These two paintings show a grey layer (composed of lead white and carbon black, *fig. 34*) above a gypsum ground; binding medium analyses detected walnut oil in the paint layers.

The small differences in the colouring of the imprimitura aside, Garofalo's paintings (the three works from the Kunsthistorisches Museum, eight from the National Gallery, London, and one from Dresden) appear very similar in both their materials and painting techniques: over the gypsum ground is a thin isolation, primarily of lead white; the paint layers above employ a glazing technique in drying oil, executed using pigments common during the Renaissance (lead white, lead-tin yellow, orpiment/realgar, vermilion, red lake, azurite, copper green (verdigris), ochre or umber, and carbon black).

4.5 CHANGES TO THE PAINT LAYERS

Major changes were apparent in a number of the cross-sections, particularly blanching in the uppermost layers. These could be localized to the areas with pronounced white, turbid spots on the paint surface that were visible after the removal of the Japanese paper facings (see section 5.2, Condition, and *fig. 45*). The cross sections revealed that these changes largely affected the varnish *(fig. 35)*.

In a number of cross-sections, however, it could be observed that, along with the varnish, the uppermost paint layer was also somewhat affected. The damage, probably caused by a combination of consolidation medium and moisture, unfortunately extended to the paint layers. *Fig. 36* contrasts a relatively well-preserved area (left) with a damaged one (right). In the latter, materials from earlier restoration appear to have penetrated more deeply (the varnish in this sample is also considerably thinner than in the comparative one). The backscattered electron image (BSE) from the scanning electron microscope shows that the phenomenon spreads from the sample surface to the first blue layer; individual pigment particles in this paint layer appear to have separated from the paint matrix.

46 Dunkerton – Penny – Spring 2002 (cit. n. 38), 26; Jill Dunkerton – Susan Foister – Nicholas Penny, *Dürer to Veronese. Sixteenth-Century Paintings in the National Gallery* (National Gallery Publications), London 1999, 219.

47 Christoph Schölzel, *Die Restaurierung des 'Triumphzuges des Bacchus' von Garofalo*, in: Beiträge zur Erhaltung von Kunst- und Kulturgut 1, 2004, 36–53, here: 45.

48 Dunkerton – Penny – Spring 2002 (cit. n. 38), 26.

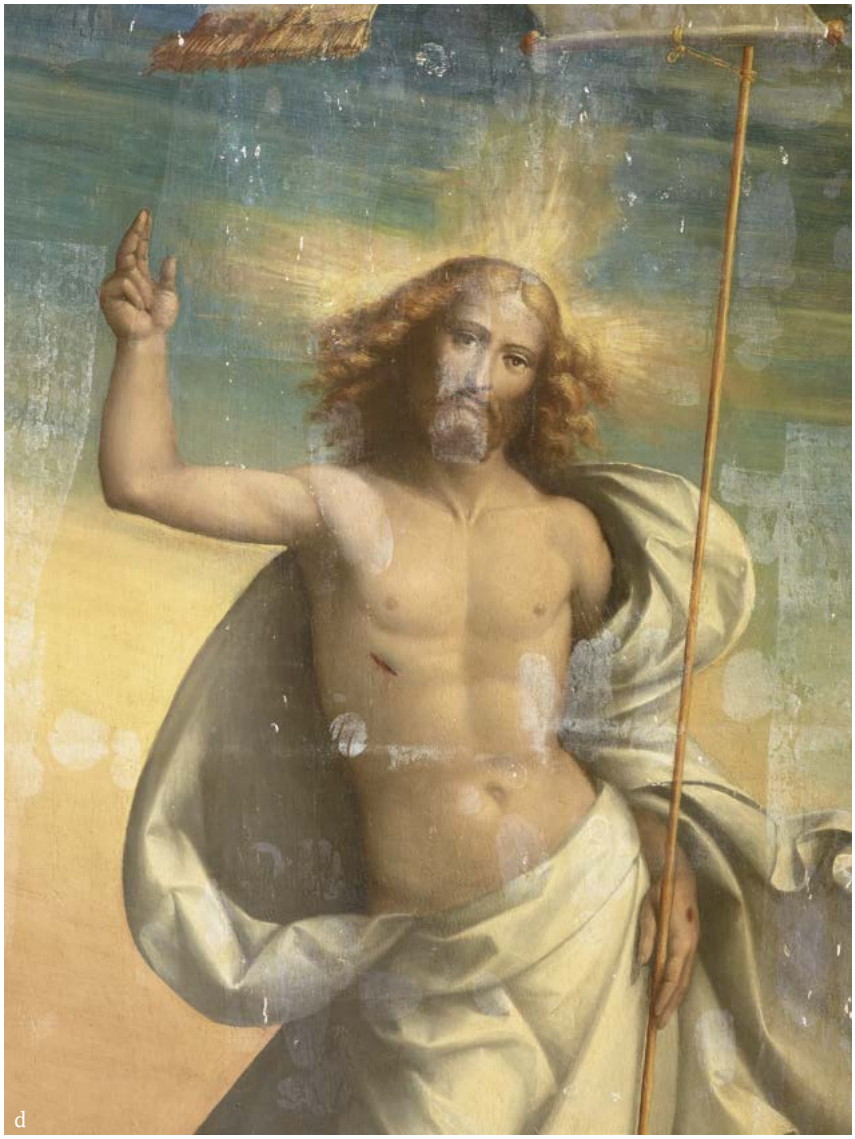


Fig. 35: a. Detail of blanched varnish: the spots are largely round.
b. Macro photograph of a damaged area.
c. Cross-section (VIS, 200x) of the background (sunrise) next to Christ's left elbow.
d. Detail of the figure of Christ after removal of the Japanese paper facing: numerous white, opaque spots interrupt the depiction.

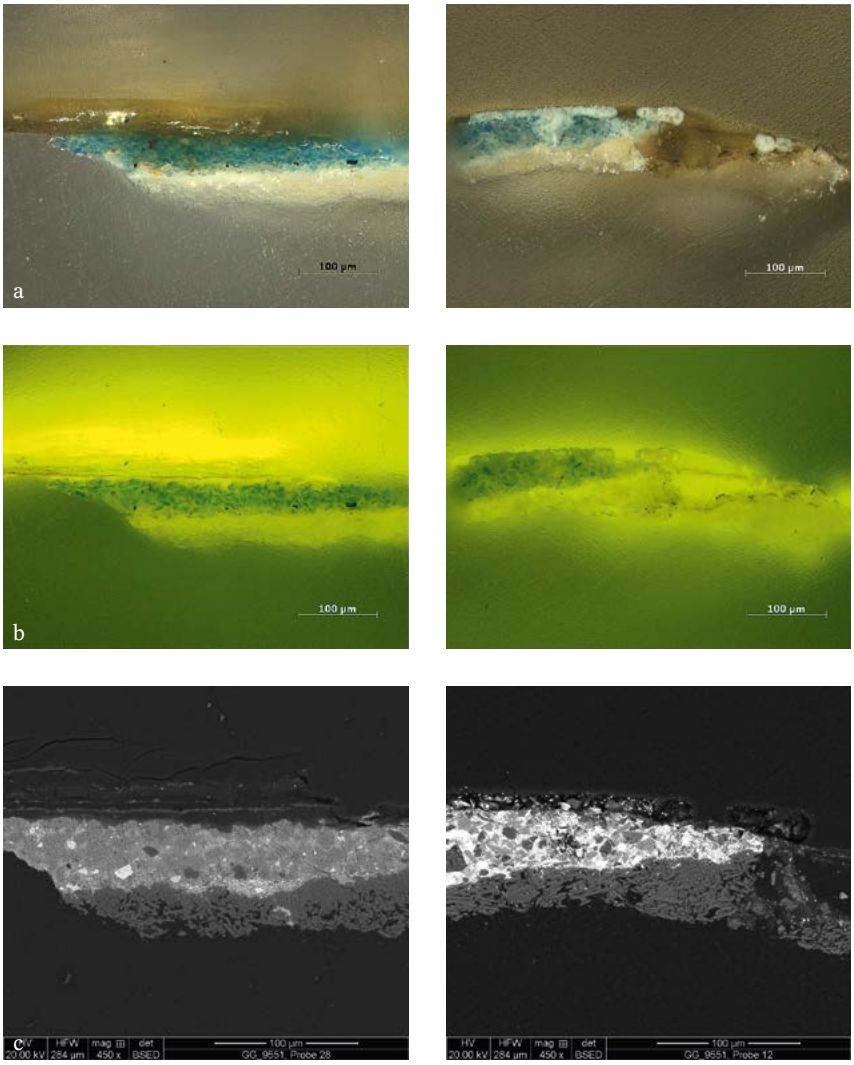


Fig. 36: Comparison of cross-sections (a. VIS and b. UV, both 200x; c. SEM/BSE, each 450x) of a relatively intact (left) and a blanched (right) area of blue.

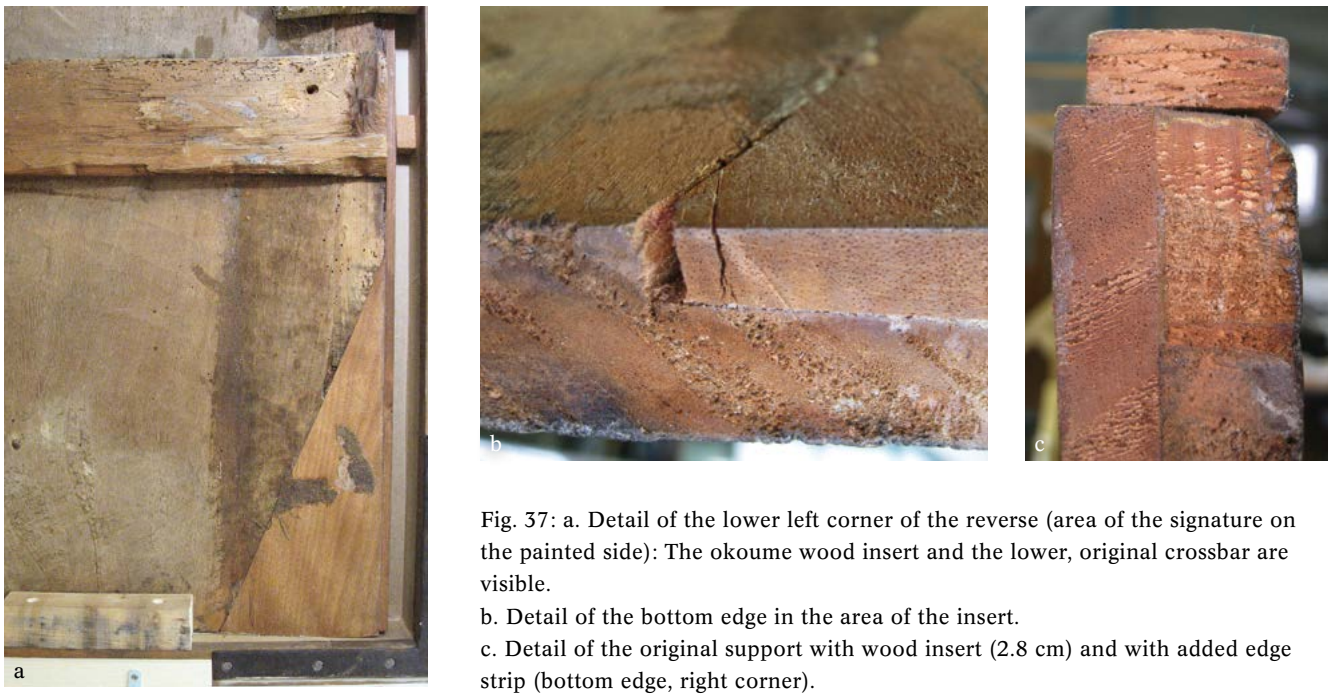


Fig. 37: a. Detail of the lower left corner of the reverse (area of the signature on the painted side): The okoume wood insert and the lower, original crossbar are visible.
b. Detail of the bottom edge in the area of the insert.
c. Detail of the original support with wood insert (2.8 cm) and with added edge strip (bottom edge, right corner).

5. CONSERVATION OF THE PAINTING

As mentioned above, following its acquisition in 1962, the painting could no longer be presented in the Picture Gallery of the Kunsthistorisches Museum from 1976 due to severe damage. The poor condition of the monumental altarpiece (acute lifting of the paint layer, yellowed varnish, earlier water damage, etc.) made a comprehensive conservation treatment necessary, which was guided by an interdisciplinary team of curators, conservators, and scientists.

5.1 CONSERVATION HISTORY

Conservation reports from shortly after the purchase of the altarpiece in 1962 already detail its poor state of preservation.[49] Damages listed include severe woodworm activity with numerous visible worm channels and a loss of adhesion in the paint layer. As a result, initial consolidation measures were undertaken and a comprehensive conservation treatment begun.[50] The following interventions to the support were presumably also begun during this first phase of conservation: the insert on the reverse of the panel at the lower-right corner, in the area of the signature (executed in okoume wood[51]), and the affixing of 10 mm wide strips to stabilize the open-pored, worm-damaged edges of the poplar panel at the left and right edges and the semi-circular top *(fig. 37)*.[52]
Another entry,[53] already from the next year, documents the unsatisfactory results of these first conservation measures. It was thus again attempted to secure the loose areas of the paint layer. The conservation documentation unfortunately gives no information on the methods employed or the consolidation materials. That the second treatment likewise failed to stabilize the painting in the long term is indicated by another entry, from 1976:[54] after only ten years, acute lifting and blister formation were again observed.

[49] Purchase documents (Zl. 9/Gal/1962, Acquisitions: Section XIV, Garofalo, *Resurrection of Christ* Altarpiece) indicate that there was no right of return after the purchase, as the painting was bought for half of its actual value. This observation can also be seen as an indication of the painting's extremely poor condition.

[50] Conservation treatment from spring 1963 to 1965 (Franz Sochor, Valerie Raschka, Josef Kimmel): 'Condition of the picture: Very blistered. Worm-eaten. Overpainted. Yellow varnish. Measures undertaken: Covering, setting down numerous blisters [Zustand des Bildes: sehr blasenkrank. Vom Wurm zerfressen. Übermalt. Gelber Firnis. Vorgenommene Arbeit am Bild: Abdeckung, Niederlegen von zahllosen Blasen].'

[51] Dendrochronological investigation by Peter Klein, Universität Hamburg, Institute of Wood Biology, report from 10 June 2012: 'The later 20th century additions are made of the tropical wood "okoume". Okoume comes from Africa and was certainly not used in Europe before the 19th century, availability only in the 20th century is even more likely.'

[52] The large insert in this area was probably undertaken because of the severe insect damage. Both interventions occurred after 1963 and were probably carried out in the Kunsthistorisches Museum. Unfortunately, there are no detailed notes on the structural work on the support in the museum's documentation, however the choice of materials and execution are similar to conservation practices in the museum at the time.

[53] Conservation treatment in November 1965 until autumn 1966 (Franz Sochor, Valerie Raschka): 'Condition of the picture: The entire panel is sewn with blisters. Numerous losses (through lost blisters). Shrinkage along the grain direction. Measures undertaken: Setting down blisters, closing of losses [Zustand des Bildes: Die ganze Tafel von Blasen übersät. Zahlreiche Fehlstellen (durch bereits abgefallene Blasen). Schrumpfungen längs der Holzfaserrichtung. Vorgenommene Arbeit am Bild: Niederlegen der Blasen, Schließung der Fehlstellen].'

[54] 1976 (Josef Kimmel): 'Condition of the picture: Recent severe blistering. Measures undertaken: Comprehensive setting down [Zustand des Bildes: neuerlich starker Blasenbefall. Vorgenommene Arbeit am Bild: durchgehende Niederlegung].'

Fig. 38: a. The painting overall with Japanese paper facing.
b. Overall of the reverse of the poplar panel before conservation treatment.

Among the causes are certainly to be found the poor environmental conditions in the gallery at the time.[55] A comprehensive setting down of the endangered areas was undertaken.
Repeated conservation measures required in panel paintings by Garofalo due to adhesion problems with the paint layers have also been documented in other museums. For these institutions, the procedure of transferring the paintings from wood to canvas seemed a possible solution.[56]
Similar considerations were also posed in the course of another conservation campaign at the Kunsthistorisches Museum, in 1981. The staff conservator Josef Kimmel[57] was charged with developing the structural treatment, and Hubert Dietrich[58] was to head the restoration. Because of the altarpiece's troubled prehistory, however, the difficulty of the task at hand was evident and

55 Elke Oberthaler, *Zur Geschichte der Restaurierwerkstätte der 'k. k. Gemälde-Galerie'*, in: ex. cat. *Restaurierte Gemälde. Die Restaurierwerkstätte der Gemäldegalerie des Kunsthistorischen Museums 1986–1996*, Vienna (Kunsthistorisches Museum) 1996/97, 26–33.

56 Christoph Schölzel, *Gemälde aus Dresden. Bewahrung und Restaurierung der Kunstwerke von den Anfängen der Galerie bis 1876*, Dresden 2012.

57 Picture Gallery curatorial files, nos. 292-VK/81 and 26/Gal/81.

58 Hubert Dietrich was active both as professor at the University of Applied Arts, Vienna, Faculty of Conservation and Restoration, and as conservator for the Picture Gallery of the Kunsthistorisches Museum.

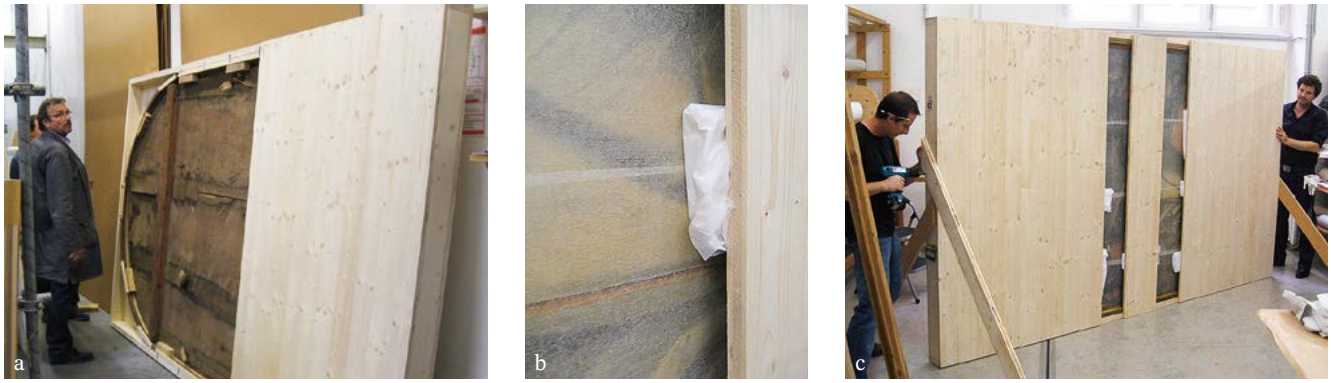


Fig. 39: a. Transport of the painting in a custom-built auxiliary frame, in paintings storage.
b. Detail of the construction with supporting layers of foam.
c. Set-up in Paintings Conservation at the Kunsthistorisches Museum.

expertise from external institutions was already sought in advance of the planning.[59] The conservation was never undertaken, however. Instead, to prevent further paint losses, the face of the painting was secured with Japanese paper[60] and in 1990 the altarpiece was removed to storage, then in Inzersdorf (Vienna) *(fig. 38)*.

5.2 CONDITION

After 21 years, the altarpiece had to be moved again because of the closure of the Inzersdorf storage facility in 2011. Nitrogen treatment was undertaken beforehand, to securely eradicate any woodworm activity. After the construction of a special auxiliary frame[61] for the transport, the painting was moved to Paintings Conservation at the Kunsthistorisches Museum in September 2011 *(fig. 39)*.
There, as a first step, detailed documentation of the condition was undertaken. Both the material composition of the painting itself and the extent and current state of the numerous past interventions were to be precisely recorded.

59 The then director of the Kunsthistorisches Museum, Friederike Klauner, placed a request for special vacation for Mr Josef Kimmel to the Federal Ministry for Science and Research on 20 May 1981: 'for this purpose it is absolutely necessary to study comparable material and cultivate exchange of experience with Italian conservators at the Soprintendenze of Florence and Siena.' Picture Gallery curatorial files, nos. 292-VK/81 and 26/Gal/81.

60 At the moment of the transport around 1990 to the storage facility in Inzersdorf/Vienna (Traviatagasse), the face of the painting was already completely secured with Japanese paper to prevent further losses to the paint film. According to information from Karl Schütz, this measure was undertaken at the end of the 1970s by Ehrhard Stöbe or Ms Köb. The paint film was not consolidated after the transport.

61 An auxiliary frame was built around the existing frame of the altarpiece to allow sheets of wood to be attached on both sides – both to prevent diagonal twisting and to allow the surface to be supported on the front and reverse with foam blocks.

5.2.1 SUPPORT

The monumental altarpiece with a semi-circular top, with the dimensions 315 × 181.5 cm and a weight of 110 kg, still keeps its original support, as the potentially fatal intervention of transferring the paint film (from wood to canvas or to another wooden support) was, as mentioned above, luckily never undertaken.

The panel is composed of three wide poplar planks[62] with vertically oriented grain and a thickness of 2.5–3.5 cm. The two widest[63] come from a single, thick board that was split along its length. One of the planks was flipped before gluing the two together to prevent deformation of the support.[64] A third, somewhat narrower plank (44.5 cm wide) was attached on the right; this shows the most severe woodworm damage and is the worst preserved in comparison with the other planks.[65]

At either side of this assemblage of three main planks, another narrow plank, almost a strip, was added. This was presumably done to achieve the ideal width for the semi-circular top.[66] The glue joints of the planks were secured on the reverse with dovetails.[67] The right plank shows two larger wood inserts[68] on the paint film side: as the x-radiograph clearly reveals different applications of the ground, these were probably not executed at the same time. The insert that appears lighter in the radiograph may have been made after the ground was applied.

62 Dendrochronological investigation by Peter Klein, Universität Hamburg, Institute of Wood Biology, report from 10 June 2012 (see n. 51): The original panel is made of poplar (*Populus sp.*). The upper and lower crossbars are made of spruce (*Picea sp.*). The 87 annual rings of the lower crossbar could be assigned to the years 1517–1431 using the comparative chronology for the Alpine region: 'The youngest annual ring dates to the year 1517. As usually only the bark was removed in the production of planks from spruce, a felling date of 1517 for the tree can be assumed and, with a minimal wood storage time of two years, an earliest working to a plank is conceivable from 1519. The dovetails are likewise poplar (*Populus sp.*)'.

63 The arrangement of the planks to form a large panel was probably consciously chosen such that none of the joints would disturb the depiction (the danger of wood movement at these interfaces was well known). In comparison, Garofalo's *Ascension of Christ* in Rome, Galleria Nazionale d'Arte Antica, Palazzo Barberini, is assembled from multiple horizontal planks, the curvature of which disrupts the depiction. The Florentine panel painting tradition likewise considered the tendency of wood to move. Thus, narrow lateral planks were commonly attached to one wider middle plank, as e.g. in the support construction of Bronzino's portraits.

64 Seen from the panel reverse, the wood grain of the upper middle plank is found in the lower area of the right plank.

65 This is probably a plank containing sapwood, which would explain the severe woodworm infestation. The wood grain is very uneven and contains knots.

66 The width of the individual planks, seen from the panel reverse, from left to right: 5.5 cm – 44.5 cm – 57.5 cm – 67 cm – 5 cm.

67 The technique of dovetail inserts along glue joints is found in numerous works from Garofalo's oeuvre, as e.g. the altarpiece of *The Virgin and Child Enthroned with Saints William of Aquitaine, Clare (?), Anthony of Padua, and Francis* (London, National Gallery, inv. no. NG 671). See Dunkerton – Penny – Spring 2002 (cit. n. 38), 22 f.

68 Both the wood inserts, which were presumably executed because of faults in the panel (perhaps disturbing knots) and the massive woodworm infestation confirm the suspicion that this piece must be a tangential plank from the outer part of the trunk, with sapwood.

An additional dovetail, somewhat larger than those on the panel reverse, is visible at the glue joint in the lower area. This was inserted from the front of the panel, presumably to secure an insufficient gluing of the two planks. Only after this measure was the ground applied *(fig. 40)*.[69]
The x-radiograph also shows dowels along the joints, located in the middle between the dovetail inserts. Additional dowels along the narrow planks at the sides are somewhat smaller *(see figs. 7 and 40d)*.[70]
Numerous nails of different size and length are evident at the edges in the x-radiograph.[71] The large number of nails again illustrates the persistent poor condition of the panel, as all are later additions. The longer, hand-made nails sought to lend additional stability to the narrow original lateral strips, probably to additionally secure the glue joints already weakened by woodworm activity.[72]
The smaller nails secure the narrow, 10 mm wide strips added at the edges (see section 5.1, Conservation History), which were added in the Kunsthistorisches Museum to protect the open-pored poplar.
The support is additionally braced on the reverse through the insertion of two opposing, trapezoidal crossbars. Both are made of spruce. The crossbar at the lower edge of the painting is original. Dendrochronological studies suggest a felling date of 1517.[73] That at the upper edge is a later addition *(fig. 41)*.[74] At an unknown moment, the original crossbar was reduced to 3.9–4.7 cm. This was presumably done to give some allowance for the strong tendency of the planks to warp and to reduce the resulting tension in the support, especially in the area of the signature.[75]

69 The wood in the area of the glue joints damaged and weakened by woodworm infestation was strengthened and reglued with a wedge-shaped wood insert during conservation measures at the Kunsthistorisches Museum (presumably simultaneous with other wood repairs on the reverse).

70 The dowels connecting the main planks are ca. 12–14.5 cm long, those at the edges ca. 8–10 cm. Both dowel types are ca. 1 cm in diameter.

71 Particular thanks are due to Ina Slama, who solved the difficult problem of obtaining an x-radiograph of the altarpiece in the vertical position (film: Agfa Structurix D4 30 × 40 cm; Isovolt Seifert & Co x-ray tube, working distance 110 cm). The individual digital films were mosaiced by Michael Eder, Department of Visual Media.

72 This intervention presumably occurred when the painting was still in the parish church of Bondeno or before the sale around 1855.

73 See n. 62.

74 Water damage could have been the reason for removing the upper original crossbar; tidelines visible in the wood lead to this supposition. The water damage likely occurred during the original installation of the painting in the parish church of Bondeno. The intervention was perhaps undertaken around 1855, when the altarpiece was sold to a private person, as water damage would have had to be treated before the sale and transport.

75 The original crossbar is 10.5–12.5 cm wide. It narrows to the left, as it was inserted from right to left into a dovetailed channel. Including the dovetail, it is 3.9–4.7 cm thick. The upper, replaced crossbar has the opposite orientation and narrows to the right, from 12 cm to 10.2 cm. The trapezoidal form was achieved by nailing on a thin strip, which narrows from 2.7 cm to 0.7 cm. The replaced crossbar was not thinned.

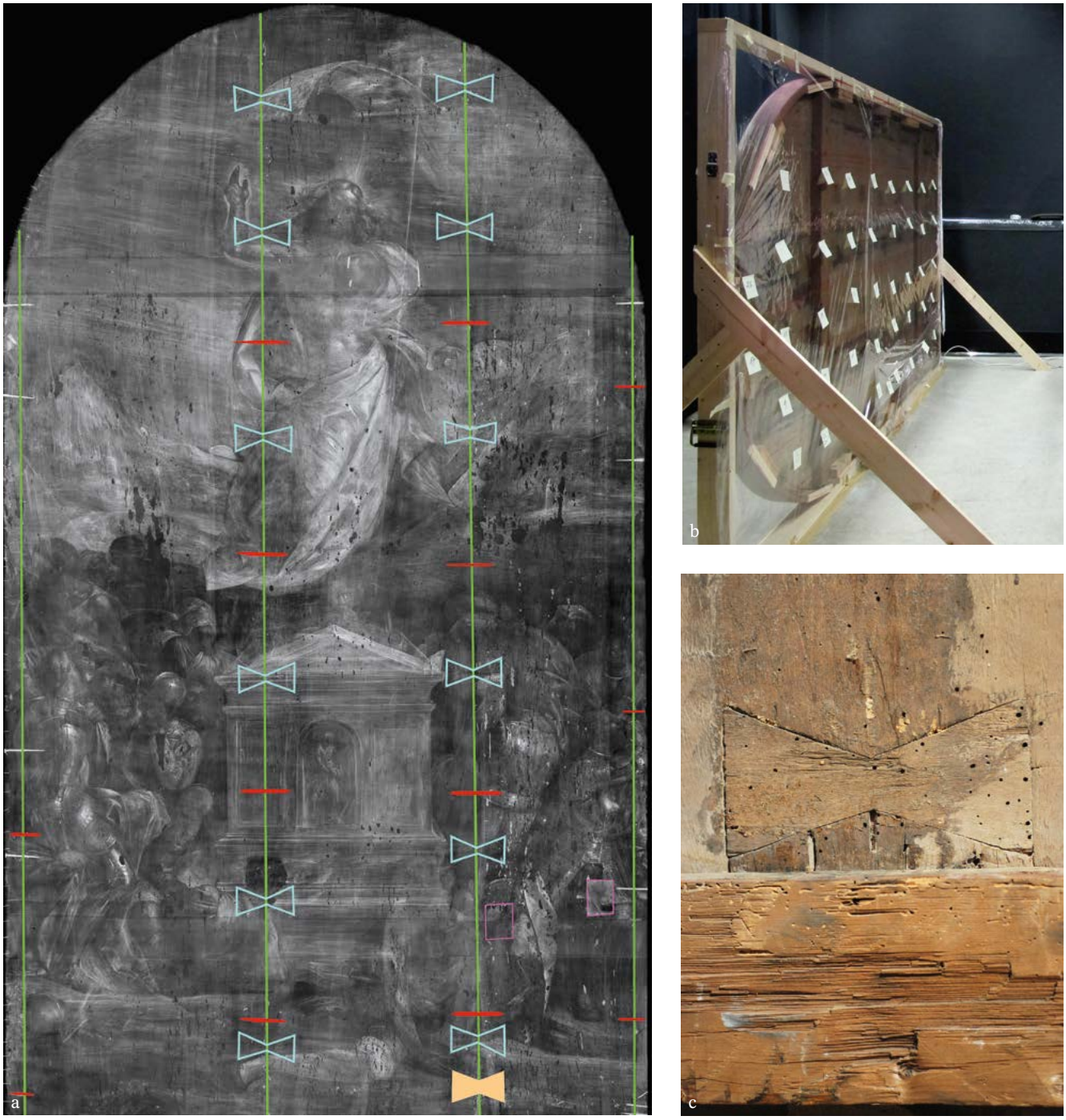


Fig. 40: a. Overall x-radiograph with diagram of the support indicating panel construction: glue joints (green), dovetails (front yellow, reverse blue), dowels (red), inserts (front magenta).
b. X-radiography was done with the fragile panel vertical to avoid introducing stress. The x-ray film was attached to the surface, which was faced with Japanese tissue, using special tape.
c. Detail of the support in the area of the joint with poplar dovetail insert in the area of the lower, original crossbar.

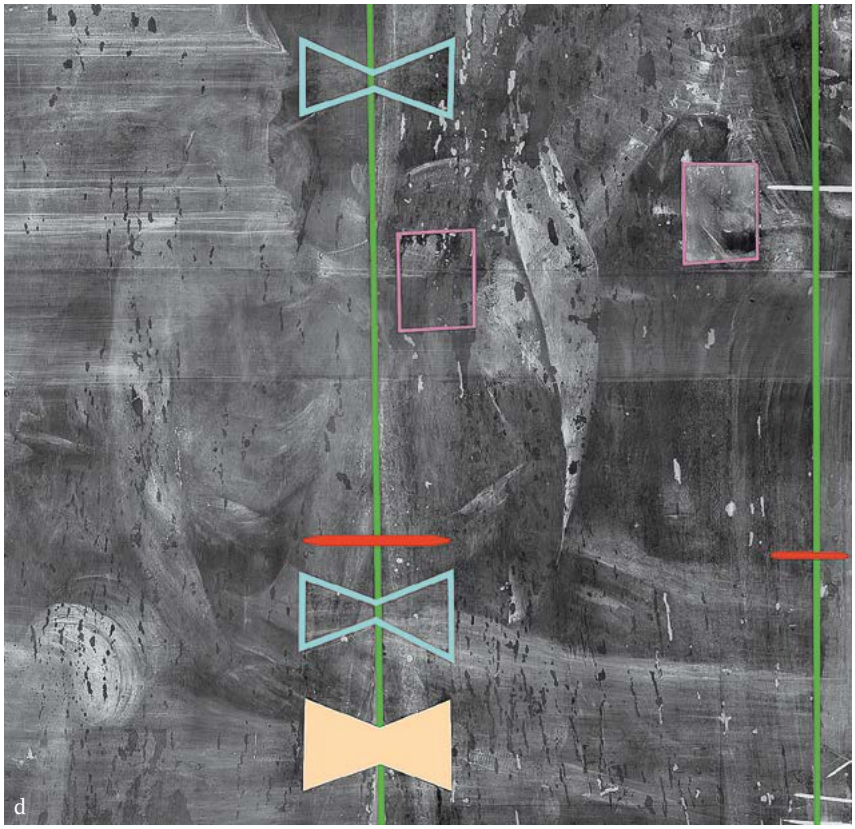


Fig. 40: d. Detail of the x-radiograph with wood inserts visible (front magenta) and the dovetail inserted from the front (yellow) that additionally stabilize the joint at the lower edge.

Fig. 41: a. Detail of the upper, replaced crossbar.
b. The upper crossbar, right edge (the annual rings are horizontal).
c. The lower, original crossbar, right edge (the annual rings are vertical).

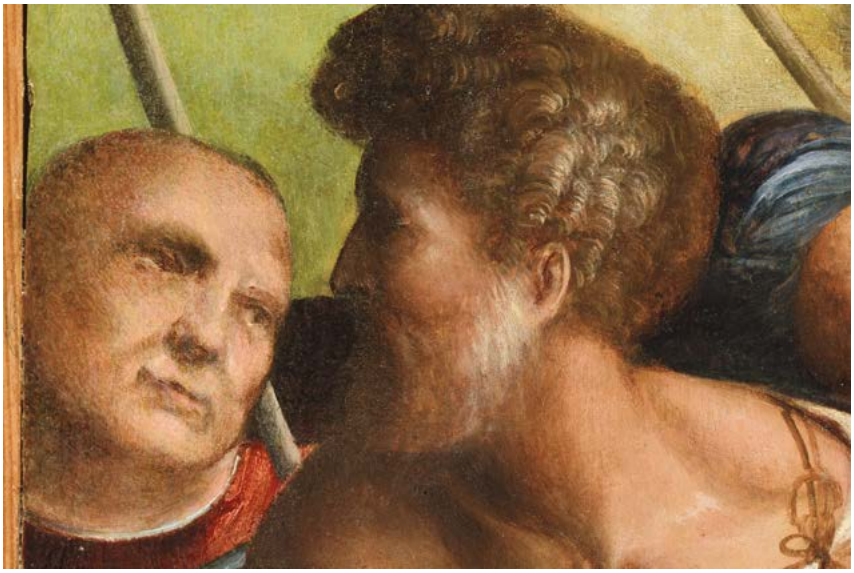


Fig. 42: Trimming at the left edge of the panel, which cut through the head of a figure.

Observing the sides of the panel, it is clear that the original borders of the paint and ground are not present, an indication of slight trimming. Somewhat more material was presumably removed from the left edge, where the head of a figure is somewhat cut *(fig. 42)*.[76] Sawmarks are also visible at the lower edge, suggesting another reduction to the panel. The panel now does not rest on the middle of the lower edge, rather the outer sides bear the weight; the cutting also tilted the depiction slightly to the right.

To secure the weakened glue joints, presumably during a later intervention, numerous strips of canvas were affixed to the panel reverse. Pieces of canvas in different lengths were attached both along and across the joints using animal glue.[77] Below the canvas strips is a dark coating, in which linseed oil, some beeswax, pine resin, and benzoin[78] were identified. The latter addition sought both to increase the adhesive strength of the glue and serve a protective function (presumably against further woodworm infestation). This measure was unfortunately unsuccessful as the glue joints were further damaged by insects, evidenced by the hollow worm channels found during the condition assessment. The adhesion of the canvas strips is very uneven.[79] The canvas itself has a simple, irregular weave and has become very hard and brittle through its saturation with animal glue and the oil coating. The strips are heavily soiled and also show tidelines. The animal glue and the oily coating have darkened and differ greatly in colour from the wood. Numerous dark splatters suggest the means by which the medium was added: with the painting positioned face down, presumably on sawhorses, the glue was generously applied with a brush.

[76] The differing widths of the narrow, added strips of 5 cm on the left and 5.5 cm on the right (seen from the front) are also evidence of slight, differing trimming of the left and right edges.

[77] All analyses of binding media were performed by Václav Pitthard using GC-MS: report of 25 June 2012, samples 1–3.

[78] Benzoin occurs naturally in a number of plants. The aromatic resin is formed in different types of trees in the genus styrax (*Styracaceae* family). It was used for its sticky but elastic consistency, but also possesses antibacterial qualities. See John S. Mills – Raymond White, *The Organic Chemistry of Museum Objects*, Oxford – Boston 1994, 95.

[79] For successful application the glue, with additives, must fill any spaces, and there can be no new insect channels.

Fig. 43: a. Detail of the reverse showing the strip of wood at the upper left edge: The panel is weakened by earlier woodworm activity.
b. Detail of the paint layer at the upper right edge: The paint layer has suffered numerous losses.

Overall it can be observed that, despite numerous past conservation measures, the panel is now in a greatly weakened state *(fig. 43)*.

5.2.2 PAINT LAYERS

To assess the face of the painting, in a first step the Japanese paper applied to the entire surface to secure the fragile paint film had to be removed. Prior analyses confirmed that the paper was attached with a mixture of glue and starch.[80] It could thus be taken off with slight moisture (distilled water) *(fig. 44)*.
After the complete removal of the facings, the painting surface showed conspicuous alterations: in addition to the yellowing caused by the aging of the natural resin varnish,[81] numerous spots disturbed the appearance. These cloudy, white areas, usually round or rectilinear in shape, could be explained by the painting's turbulent conservation history *(fig. 45)*.
The attempts of earlier conservation treatments to secure the endangered paint layer led over time to a varied mixture of consolidation materials on the surface. The result was a blend of different amounts and combinations of wax, glue, and varnish, as well as fibres from the facing paper. As a consequence, the paint film had become hard and brittle in the affected areas, and fine hairline cracks had developed in the varnish layer that dominated the appearance.
The exposed disturbing, cloudy, whitish areas are a result of earlier measures involving locally applied, aqueous consolidants. For these, a small piece of Japanese paper was laid on the afflicted area and the consolidant (a mixture of glue and starch – i.e. paste – or only cellulose) was applied with circular movements of the brush, through the paper and into the paint film. If the entire rectangular surface of the Japanese paper was not fully brushed with consolidant, the moisture was limited to the round areas, which were visible after the removal of the paper. In total, the sequence of individual, uncoordinated interventions led to the blanching of the varnish and the

[80] GC-MS analysis Václav Pitthard, report of 25 June 2012, sample 4.
[81] The painting was stored in a dark room for 35 years. The interplay of darkness and the oily components in the extremely thick varnish may have influenced the discolouration process.

Fig. 44: a. Overall photograph in UV light.
b. The panel before conservation treatment, after complete removal of the Japanese paper facing.

paint film. Finally, renewed moisture penetration during the overall facing with Japanese paper caused additional, substantial stress to the blanched varnish and partly also to the paint layers, already damaged by various consolidation media *(fig. 46)*.

Aside from the spotty appearance, the aforementioned earlier loss of adhesion was evident in the form of lifting paint: the paint layer suffered from the shrinkage of the wooden support caused by inappropriate environmental conditions, and developed flaking and blisters as a reaction to this movement along the wood grain direction *(fig. 47)*.

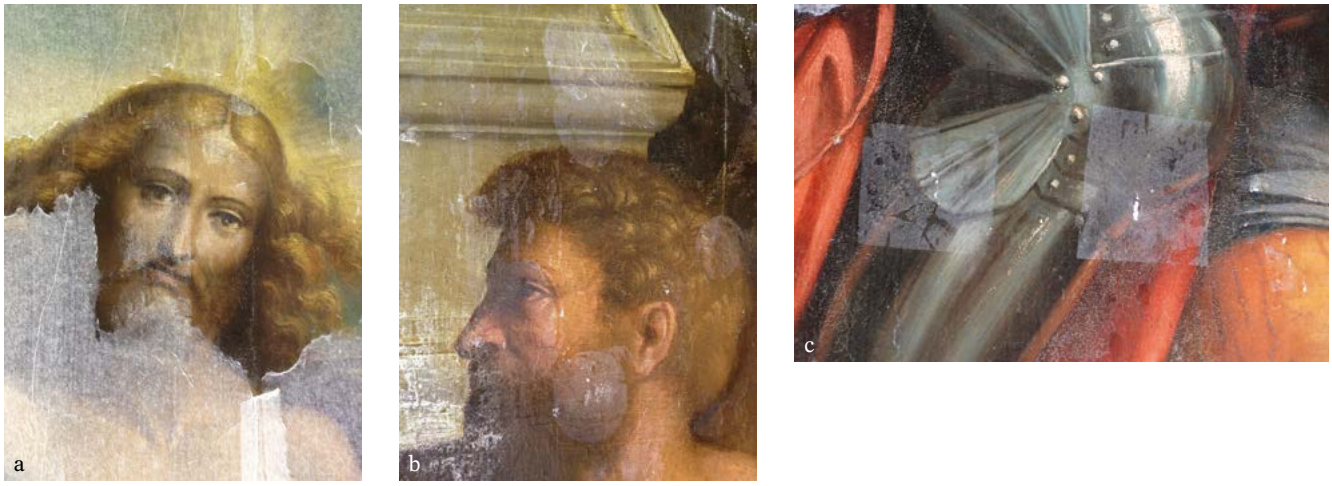


Fig. 45: a. Detail of the head of Christ during removal of the Japanese paper facing and starch adhesive with distilled water.
b. Detail of the soldier's head in the foreground after removal of the facing.
c. Detail of the knee of the standing soldier at the left edge after removal of the facing: square areas of consolidation are visible.

Fig. 46: a. Detail at Christ's feet: Blanching of the paint and remains of old material damaged the paint layer.
b. Detail of the figure to the right of the sarcophagus: Blanching of the varnish and paint film from different consolidation campaigns is visible.

Traces of multiple past restorations could be identified in the form of darkened retouching, overpaint, and old fills; untreated wormholes were also present on the paint film side.
In the x-radiograph,[82] numerous areas with different x-ray absorption provide information on later additions and improvements, and thus indications of the true scope of the paint loss.[83] It is also obvious that the paint layer is in poorer condition on the right side than on the left.

[82] In the x-radiograph, chalk-glue fills appear dark and fills with lead white impurities are light.

[83] Because of the exposure conditions, the degree of woodworm damage cannot be directly assessed from the x-radiographs. Due to the panel thickness of 24–32 mm, higher excitation parameters were required (39 kV, 4 mA, 2 min). Under these measurement conditions, the fine woodworm channels could not be captured on film.

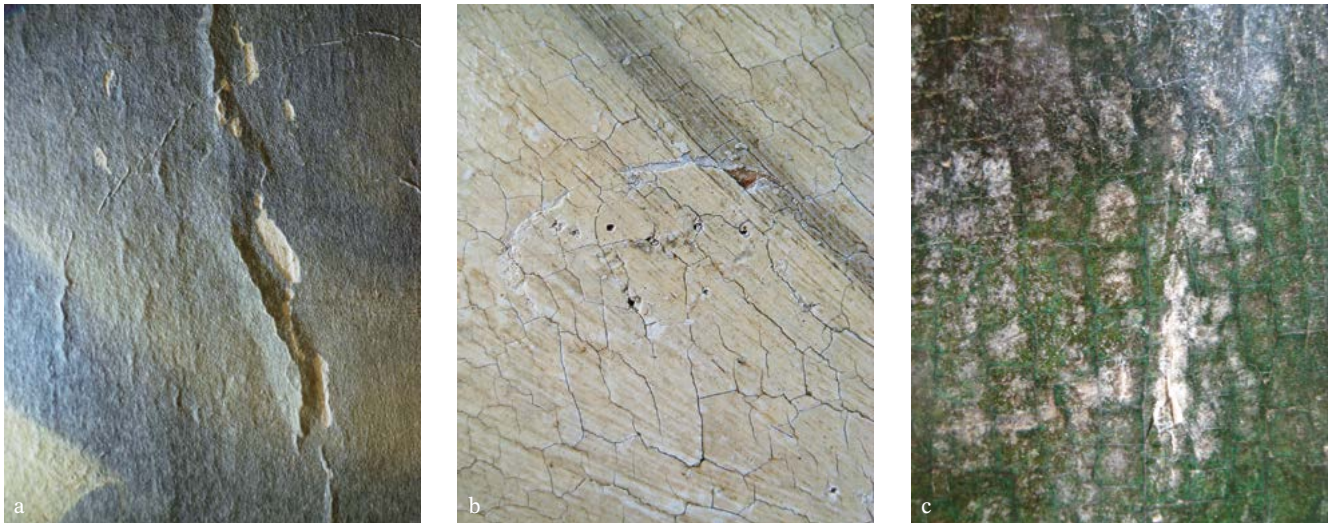


Fig. 47: a. Detail of the sky: Small blisters were secured with Japanese paper to prevent further paint loss.
b. Detail of Christ's white robe: Small holes are evidence of earlier consolidation attempts.
c. Detail of the green garment of the reclining soldier in the left foreground: Different layers of adhesive, yellow varnish, and paper fibres – embedded in the varnish – disturbed the paint film.

In summary, it can be observed that the current condition of the altarpiece reflects its chequered fate in private ownership. Many of the measures undertaken were accompanied by irreversible consequences. The conservation treatment of the altarpiece thus not only faced the challenge of preserving the painting's original substance, but also that of reckoning with past conservation measures.
The following damages were to be addressed in the comprehensive conservation treatment, and future degradation forestalled through preventive measures:

- Damages to the poplar panel:
  - Earlier woodworm infestation
  - Cracks, holes, thinned and cracked sections of wood
  - Old water damage
  - Later wood additions causing tension
- Damages to the paint layer:
  - Extensive lifting along the wood grain, and blister formation
  - Remains of various earlier consolidation media, paper fibres, and old chalk fills on the original paint
  - Blanching of the paint film and varnish
  - Extensive overpainting and darkened retouching
  - Yellowed, opaque varnish
- Framing:
  - Lack of mechanical stability

5.3 CONSERVATION AND RESTORATION

After the nitrogen treatment and the already mentioned transport of the painting in a specially constructed auxiliary frame, all working steps were carried out with the painting vertical in order to minimize movement-induced stress to the support. Due to its size, the altarpiece had to rest on its right side *(fig. 48)*.
The conservation of the support and the paint layer stood at the centre of the following measures. The preservation of the original substance of the

Fig. 48: Set-up with newly constructed auxiliary frame (unframed) in the conservation studio.

painting, with minimal invasive measures, was the primary goal. It was also sought to extend future cycles of restoration as much as possible, to minimize subsequent interventions to the painting. In securing the paint layer, the consolidation of the paint and the structural measures on the wooden support were mutually dependent: in the past, the treatment of the paint layer had been prioritized regrettably often over that of the panel. This was reflected in the documentation preserved, which primarily recorded work on the panel front. The current conservation hence sought to encompass both work on the painted side and on the reverse.
Both sides of the painting were first carefully cleaned – by dry means[84] and in part with slight moisture and solvents.

5.3.1 TREATMENT OF THE SUPPORT

The consolidation of the woodworm-damaged areas was carried out with Paraloid® B67 and B72.[85] After drying, the losses were filled with old conifer wood and wood putty.[86] Next, all cracks in the support *(fig. 49)* and the slightly open glue joints on the middle of the panel reverse could be secured (see also section 5.2.1 Support).[87]

[84] Dry cleaning of the support was done using brushes, a vacuum, microfibre dusting cloths, and fine-pored PU sponges. Remains of synthetic adhesives (Ponal) from attaching the lateral protective strips were softened with acetone compresses and removed mechanically.

[85] 15–25% Paraloid® B67 dissolved in petroleum spirits (b.p. 100–140°C, petroleum naphtha, index-No. 649-32-00-1) and 15–25% Paraloid® B72 dissolved in toluene (both Merck).

[86] Fill material made from club moss spores (*Lycopodium sp.*) and Plexisol® P 550 TB 40% (Plexisol®, a LASCAUX product, butyl methacrylate, is a thermoplastic synthetic resin [T_g 40–50°C] with a high viscosity, soluble in nonpolar solvents).

[87] Christina Young – Paul Ackroyd – Roger Hibberd – Stephen Gritt, *The Mechanical Behaviour of Adhesives and Gap Fillers for re-joining Panel Paintings*, in: National Gallery Technical Bulletin 23, 2002, 83–96.

Fig. 49: a. and b. Gluing of cracks at the lower edge.
c. and d. Gluing the crack at the dovetail to the left of the joint, before and after treatment.

The 10 mm wide wooden strips at the edges attached with wood glue (Ponal)[88] and in parts additionally with nails were kept. These had been added in the past to protect the damaged, open-pored edges of the poplar panel.[89] To reduce tensions in the strip nailed to the arched top, this was weakened with additional, 5 mm deep cuts to the exterior edge. The canvas strips over the joints were largely retained, except where there was greater woodworm damage to the support or the joint had opened.
During the treatment, the environmental conditions and the tendency of the painting to move were monitored using a potentiometer[90] to observe changes in the support before and after the weakening of the massive upper, later crossbar[91] (5.4–6 cm in thickness) through cross-grain cuts, 1–1.2 cm deep and ca. 6–7 cm apart *(fig. 50)*.[92]

88 Ponal is a formaldehyde-free dispersion based on polyvinyl acetate (PVAc), also known as white glue.
89 See n. 84.
90 Rissfox® Mini data logger for analysis of crack movements and changes in length as well as ambient humidity and temperature, Scanntronik Mugrauer GmbH, available at: http://www.scanntronik.de/Produkt_Rissfox_Mini_deu.php [last accessed: 30 October 2020].
91 See section 5.2.1 Support.
92 Because of its size and the spatial logistics, a surface scan of the entire panel with a laser before and after the weakening of the upper crossbar was not possible. The point measurement with the potentiometer (Rissfox®) at the left edge in the area of the crossbar showed a movement of ca. 5 mm. There were further slight movements over the entire panel surface after the separation of all connections with the auxiliary frame. One can speak of a slight convex movement spread over the entire picture surface.

Fig. 50: Detail of the upper crossbar: Cuts were made with a Japanese saw.

Fig. 51: a. to c. Movement measurements with the potentiometer (Rissfox®).

Likewise during the conservation phase, the movement tendency at the lower edge was also measured over a longer period with the potentiometer *(fig. 51)*.
The lower, original crossbar had already been thinned during an earlier structural intervention to a thickness of 3.9–4.7 cm (see section 5.2.1 Support). The resulting splintering was secured with fish glue.[93]

[93] High tack fish glue (56K6000), Norland Products Inc., 2540 Route 130, Suite 100, Cranbury, NJ 08512 USA, available at: sales@norlandproducts.com [last accessed: 30 October 2020].

Fig. 52: Detail of the orange garment of left figure in the middleground.
a. Blanching after removal of the facing paper.
b. Paper remains at areas of loss and abrasion impaired the paint layer.
c. After cleaning and retouching.

5.3.2 TREATMENT OF THE PAINT LAYER

The round and rectilinear blanching of the varnish and paint layer apparent after the removal of the Japanese paper facings *(see fig. 44b)* and the various remains of old restoration material could be reduced sometimes with water, sometimes with organic solvents, aided by mechanical action with sharp knives *(fig. 52)*. As a next step the consolidation of the paint layer was essential, as this showed extensive lifting over the entire surface. For this, sturgeon glue was used as the consolidant.[94] The introduction of the consolidant was initially verified under the microscope and later under 3x magnification with a loupe.
Woodworm exit holes on the paint film side were consolidated with Paraloid® B72 and filled with wood putty using small spatulas and dental probes *(fig. 53)*. More than 480 differently sized holes were treated in this way.
The extremely yellowed varnish and numerous darkened retouches disturbed the picture's appearance. These were reduced with solvents in different mixtures,[95] with specially prepared solvent gels,[96] or mechanically with a scalpel *(fig. 54)*. This exposed areas that had been deliberately broadly overfilled and overpainted to mask abrasion or local losses as well as areas of apparently undamaged original paint. The blanching of the paint and varnish layers could be almost completely reduced through the cleaning. In some dark areas, unfortunately only a reduction of the blanching was possible.

94 7% sturgeon glue with slight addition of Dowanol™ (Dipropylene glycol n-butyl ether).
95 Isooctane and ethanol in 1:4, 1:2, and 1:1 mixtures.
96 Red, green, and lead white–containing ochre coloured overpaints were removed using thick applications of a solvent gel containing acetone (3.75 ml), H_2O (12 ml), benzyl alcohol (10 ml), 0.5 g Carbopol, 1.25 g Ethomeen C25 (pH 7, 60 s application time) or thin applications of a solvent gel containing ethanol (70 ml), isooctane (40 ml), 0.5 g Carbopol, 1.25 g Ethomeen C25 (pH 7, 30 s application time).

Fig. 53: a. The wormholes were consolidated and filled with wood putty.
b. Detail of lifting paint caused by woodworm damage.

Fig. 54: a. Detail of Christ's white garment during cleaning with solvents.
b. Detail of the remains of the yellowed varnish.

Fig. 55: Detail of the group of figures on the right half of the picture after filling of losses.
a. In the area of the rocky outcropping.
b. To the right of the sarcophagus.

Fig. 55: c. Lower right corner beside the seated soldier in the foreground.

After the cleaning, all losses were filled with a putty of chalk and glue *(figs. 55 and 56)*.[97] The texture of the surrounding paint was imitated with white gouache to improve the integration of the large losses *(fig. 57)*. Before retouching, a varnish of mastic dissolved in turpentine (ca. 11%) was applied with a broad, flat brush to isolate the gouache[98] and saturate the colours for further retouching. Losses and abrasion were integrated with watercolours and finally with thin glazes of resin-oil colours *(fig. 58)*.[99]

97 Small losses were filled with gouache colours and a liquid chalk–glue putty (6% rabbit skin glue, 1:2 Champagne : Bologna chalks) in multiple layers.

98 Horadam® gouache colours.

99 Mussini® watercolours, Mussini® resin-oil colours.

Fig. 56: a. 10 mm wide strip of wood at the edge and filling of woodworm damaged areas with old spruce fibres and wood putty.
b. Detail after filling of the loss.

Fig. 57: Detail of the white robe during retouching. The paint texture was imitated with white gouache.

Two sprayed applications of varnish followed *(fig. 59)*.[100] To avoid possible threats to the substance of the painting in the future[101] such as wood movement and lifting of the paint layer, particular attention was placed on the microclimatic environmental conditions at its exhibition location. Temperature and humidity sensors were hence installed.[102]

[100] A sprayed natural resin varnish (6–8% mastic (Chios1A) in double rectified turpentine) unified the gloss of the paint surface.

[101] Inspection of the paint film, October 2019: condition unchanged, no new acute lifting observed since 2014. The surface gloss of the varnish appears even (see condition report by Ingrid Hopfner, Paintings Conservation, Kunsthistorisches Museum).

[102] Wireless data logger MSR 145 WD (Bluetooth): measurement/save rate: 1/s, acceleration: ±15 g, data capacity: 1,000,000 measurement values, available at: https://www.msr.ch/de/produkt/funk-datenlogger-msr145wd/ [last accessed: 30 October 2020]; Testo 184 H1, available at: https://www.testo.com/de-AT/testo-184-h1/p/0572-1845 [last accessed: 30 October 2020].

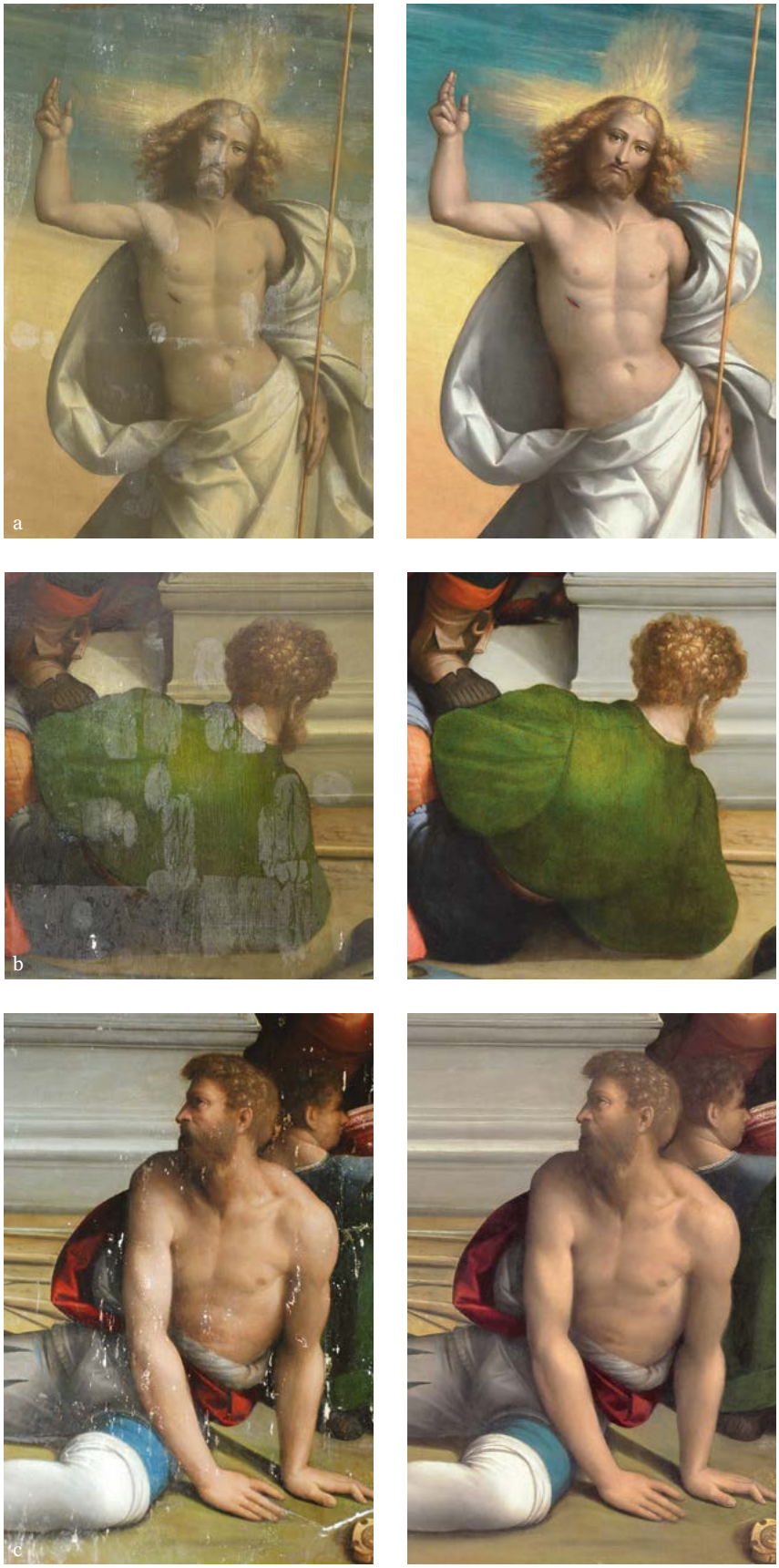


Fig. 58: a. Detail of the figure of Christ after removal of the facing paper (left) and after restoration (right).
b. Detail of the reclining soldier with the green garment after removal of the facing paper (left) and after restoration (right).
c. Detail of the seated, bare-chested soldier in the foreground after cleaning and filling of losses (left) and after restoration (right).

Fig. 59: a. The painting before treatment.
b. After cleaning and filling.
c. After treatment.

6. FRAME AND PREPARATION FOR FRAMING

Another necessity for the future preservation of this singular work was the construction of a new, stable frame,[103] to allow the tension-free mounting of the panel and thus an appropriate stability and presentation.[104] The old, non-original frame was far too narrow in width and slight in construction for the 110 kg painting.

To find the ideal sight size for the frame, the dimensions of the painting were traced on a transparent film and transferred to cardboard *(fig. 60)*. A CAD drawing[105] created a 1:1 model for the new frame, the basic elements of which were prepared with a CAD/CAM milling machine. The spruce frame was next glued together from multiple pieces of wood. The creation of the arched top proved to be a particular technical challenge. Following this, the profile ornament was carved with a chisel *(fig. 61)*.

Before the application of the ground, the wood frame was coated with bone glue. A chalk–glue ground (a 4:1 mixture of Bolognese and Champagne chalks) and, depending on the type of gilding, yellow or in parts red bole formed the preparation for the gilding, which was partly polished and partly matte.[106] Out of stylistic considerations related to the altarpiece, a floral motif[107] was punched on the flat surfaces. After polishing the gold, the sheen was partially reduced with ground pumice[108] to give the frame a slightly aged appearance. The application of an overall shellac layer offered protection for the further working of the delicate gold. Following the application of a varnish toned with oil paints, the patina could be built up in multiple steps using watercolour glazes *(fig. 62)*.

A strip of balsa wood matching the curvature of the panel was inserted in the frame rebate to achieve the best possible surface for mounting the painting. A backing[109] was also prepared from two layers of fabric *(fig. 63)*.

[103] Claus Grimm, *Alte Bilderrahmen. Epochen – Typen – Material*, 3rd ed. Munich 1986.

[104] Construction of the frame by Rudolf Hlava, and Markus Geyer; gilding: Barbara Steiner, Markus Geyer, Rudolf Hlava and Michael Odlozil; digital editing of the model: Michael Eder.

[105] Wagner and Taschler, available at: https://www.schoenemoebel.at/ [last accessed: 30 October 2020].

[106] Areas with red bole received polished gilding; areas with yellow bole receive matte gilding executed with skin glue.

[107] The motif ultimately executed was determined after numerous experiments. To present the painting in a visually appealing way, both the choice of punchwork design and the frame shape represented major challenges. The frame of the painting *Sacrificial Death of Marcus Curtius* by Paolo Veronese (Kunsthistorisches Museum, Picture Gallery, inv. no. 6744) served as a model for the final profile.

[108] The porous, glassy volcanic rock (silicate) is used as a fine powder for intermediate polishing (e.g. in shellac polishes) or to fill pores.

[109] Cut and sewing: Michaela Kratochwil and Eva-Maria Jerabek, Textile Conservators, Kunsthistorisches Museum.

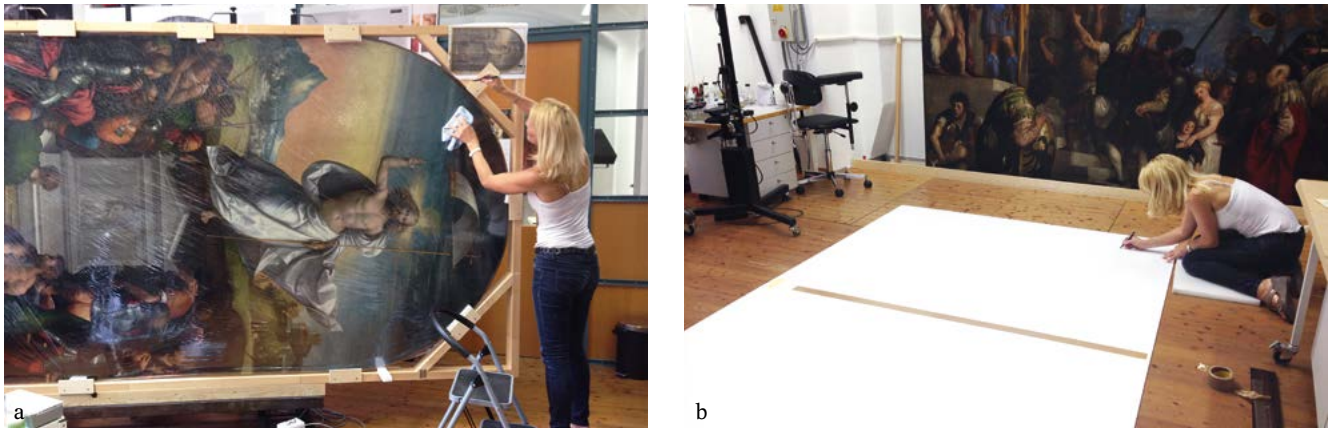


Fig. 60: a. and b. The shape of the painting was traced on plastic film and transferred to cardboard in order to determine the ideal sight size for the frame.

Fig. 61: a. The reverse of the frame during gluing.
b. Construction of the face of the frame.
c. Joining the individual pieces of wood for the arch.
d. Carving ornament with a chisel.

Fig. 62: a. Applying the ground to the frame.
b. Gilding the frame.
c. Punching the floral motif.
d. Patinating the gilding.
e. Detail of the finished frame.

Fig. 63: a. and b. Attaching strips of balsa to the frame rebate.
c. Trimming and attaching the backing.

7. TRANSPORT AND INSTALLATION IN THE PICTURE GALLERY

Because of its large format, great weight, and fragility, a wooden transport frame was used to transport the restored painting into the Picture Gallery[110] – to minimize tensions during movement of the painting and lend additional stabilization. Multiple wooden planks were secured to the front and reverse of the transport frame to prevent distortion of the support due to its considerable weight. This measure was especially done to prevent diagonal distortion when handling the panel. The space between the perpendicular planks and the panel was further cushioned (on both the front and reverse) with foam blocks covered in tissue paper to achieve optimal support over the entire picture surface. Because of its size, the painting had to be brought horizontally (on its right side) to the main entrance of a museum in a truck. Six people then carried it up the main staircase into the Gallery.

Aided by the transport frame and the uniform stabilization of the entire picture surface, the painting could again be laid flat on the floor and uprighted for mounting in the frame. The entire transport was monitored with a vibration logger.[111]

The frame, custom built by the carpenters, was separately transported in the same way. In the Gallery, the frame was placed upright and held vertical by lateral wooden supports. The altarpiece could then be mounted in the frame. To secure it, two blocks of wood with foam cushioning facing the panel[112] were screwed to the frame at both the upper and lower edges, along the centre axis. At the sides, flexible plates with Teflon strips[113] were attached to hold the painting but allow some movement on slight changes to the panel (e.g. on changes in room humidity). To achieve the best possible and complete contact of the uneven lower edge, small blocks of wood were fitted, which also corrected the slightly askew vertical position before treatment. To allow the heavy panel to slide on its lower edge, a 2 mm thick strip of polycarbonate[114] was screwed to the bottom of the frame rebate. Its smooth surface should allow the movement of the wood blocks, which are additionally treated with soap. After the mounting in the frame, the painting was hung on cables.

After this enormous effort of conservation and framing, precautions were likewise taken to preserve and protect the artwork. It was important to shield the reverse of the painting from dust and, as much as possible, from short-term changes in room humidity. This is to be achieved through two layers of a very smooth, densely woven, acid-free and dirt-repellent fabric,[115] which was attached to the back of the frame with Velcro *(figs. 64 and 65)*.[116]

One additional preventive measure, the protection of the front of the painting by glazing, could not be considered because of the size and already great weight of the object.[117]

110 This frame was also used in modified form as an auxiliary frame during the entire conservation process.

111 *Testo 184 G1*, available at: https://www.testo.com/de-AT/testo-184-g1/p/0572-1846 [last accessed: 16 November 2020].

112 Foam: black cellular rubber, Nuschei Spezialdichtungen GmbH, Vienna.

113 Spring plates: Temart® spring plate, available at: https://deffner-johann.de/de/temart-federblech-large-chromatisiert.html [last accessed: 14 December 2020] with strips from PTFE® (Polytetrafluorethylene) sheets, available at: https://www.s-polytec.de/kunststoffplatten/ptfe-platten/ptfe-platten-teflon-im-zuschnitt.html [last accessed: 14 December 2020].

114 192 × 9 cm, Wettlinger Kunststoffe Handelsg.m.b.H., Vienna.

115 Unisono III fabric, 100% cotton; black (100)/Création Baumann; Oddy tested for permanent use, KHM data sheet no. 23/10.

116 Belousek Leopoldine & Co GmbH, Vienna.

117 Altarpiece (110 kg) and frame (120 kg).


a

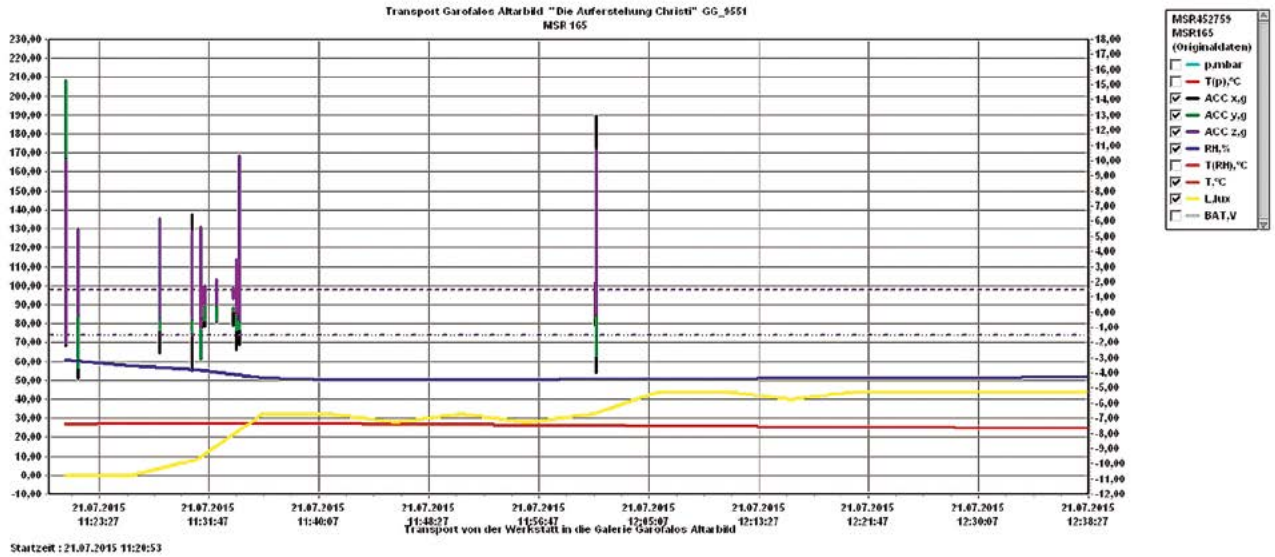

b


c


d


e


f


Transport Garofalos Altarbild "Die Auferstehung Christi" GG_9551
MSR 165
MSR452759
MSR165
(Originaldaten)
p,mbar
T(p),°C
ACC x,g
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ACC z,g
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BAT,V
21.07.2015 11:23:27
21.07.2015 11:31:47
21.07.2015 11:40:07
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21.07.2015 11:56:47
21.07.2015 12:05:07
21.07.2015 12:13:27
21.07.2015 12:21:47
21.07.2015 12:30:07
21.07.2015 12:38:27
Transport von der Werkstatt in die Galerie Garofalos Altarbild
Startzeit : 21.07.2015 11:20:53
g


h


i


j


k


l

Fig. 64: a. Transport frame with cushioning on the front and reverse for the horizontal transport of the painting.
b. Transport with a truck.
c. Transport up the main staircase of the museum.
d. Vertical positioning of the painting to mount it in the frame.
e. Transport of the frame up the main staircase.
f. Set-up for framing.
g. Shock logger and its readings: a slight number of impacts, minimum values of 2 g and two maximum values of 12 g and 15 g (m/s^2).
h. Securing the sides using flexible plates with Teflon strips.
i. The reverse after mounting in the frame.
j. Overall after attaching the protective backing.
k. Securing the panel along the middle axis at the upper and lower edges with two wooden blocks attached to the frame with screws.
l. Hanging the altarpiece from doubled cables using a jack.

Fig. 65: Final position after adjustment of the altarpiece.

8. THANKS

We sincerely thank the numerous colleagues, who helped in the realization of this difficult and comprehensive conservation project,[118] particularly Silvia Ferino-Pagden, former Director of the Picture Gallery, and her successor Stefan Weppelmann. Special thanks are also due to Elke Oberthaler, Head of Paintings Conservation of the Picture Gallery, for professional exchange and support, and to the Department of Visual Media (Stefan Zeisler, Andreas Uldrich, and Michael Eder).

[118] We would especially like to thank Anne Campman, Markus Geyer, Eva Götz, Rudolf Hlava, Sonja Kocian, Michael Odlozil, Ina Slama, Monika Strolz, and Elisabeth Wolfik for their support of the conservation treatment.

SUMMARY

Following its acquisition in 1962, Garofalo's 1520 *Resurrection of Christ* altarpiece, still on its original support, could no longer be presented in the Picture Gallery of the Kunsthistorisches Museum from 1976, despite two rounds of conservation measures, due to severe damage. The poor condition of the monumental work (acute flaking, yellowed varnish, earlier water damage, etc.) made a comprehensive conservation treatment necessary, which was supported by an interdisciplinary research team comprised of curators, conservators, and scientists.
In preparation and parallel to the conservation measures, the scientific study of the painting technique played an important role, aided by investigations including infrared reflectography, x-radiography, microscopy, and binding medium analysis.
The artist's use of a limited selection of painting materials could be confirmed: drying oil as the binding medium for the paint layers, gypsum as the ground, an *imprimitura* containing lead white, and pigments including lead white, azurite, vermilion, lead-tin yellow, ochre, carbon black, and copper green are common for the artist's period and region. The brilliant colourism of his palette, achieved through the use of a glazed painting technique, is impressive for this work and could be confirmed as typical for Garofalo's oeuvre through comparison with his other paintings.
The treatment of the altarpiece sought both the stabilization of the endangered substance (consolidation of woodworm-damaged areas, securing of lifting paint, regluing of cracks in the support) and the unified appearance of the picture through aesthetic measures (removal of overpainting, retouching, and yellowed varnish; compensation/integration of abrasion and losses) to allow the quality of the painting's brilliant colourism to again be appreciated. A new frame was also made and additional preventive measures undertaken to ensure that this masterpiece of Ferrarese Renaissance painting remains publicly accessible in the long term.

ZUSAMMENFASSUNG

Nach seiner Erwerbung 1962 konnte Garofalos Altarbild *Die Auferstehung Christi* aus dem Jahre 1520, mit noch originalem Bildträger, aufgrund massiver Schäden trotz zweier Restaurierungsmaßnahmen ab 1976 nicht mehr in der Gemäldegalerie des Kunsthistorischen Museums präsentiert werden. Der schlechte Erhaltungszustand des monumentalen Werks (akute Malschichtabhebungen, vergilbter Firnis, frühere Wasserschäden usw.) machte eine umfassende Restaurierung notwendig, die von einem interdisziplinären Forschungsteam, bestehend aus Kuratoren, Restauratoren und Naturwissenschaftlern, begleitet wurde.
Im Vorfeld und parallel zu den Restaurierungsmaßnahmen wurde der wissenschaftlichen Aufarbeitung der Maltechnik und Bildgenese des Gemäldes mithilfe von technologischen Untersuchungen wie Infrarotreflektografie, Röntgenaufnahmen, Mikroskopie und Bindemittelanalysen ein bedeutender Stellenwert beigemessen. Als Ergebnis konnte die Verwendung einer limitierten Auswahl von Materialien durch den Künstler bestätigt werden: Trocknendes Öl als Bindemittel der Malschichten, Gips als Malgrund, eine bleiweißhaltige Imprimitur und Pigmente wie Bleiweiß, Azurit, Zinnober, Bleizinngelb, Ocker, Kohlenstoffschwarz und Kupfergrün zählen zu den gängigen Malmitteln seiner Zeit und Region. Die durch Anwendung der Lasur-Maltechnik brillante Farbigkeit seiner Palette zeigte sich beeindruckend für dieses Werk und konnte durch Vergleich mit anderen Gemälden als typisch für Garofalos Œuvre verifiziert werden.
Die Restaurierung des Altarbildes erzielte sowohl eine Stabilisierung der gefährdeten Gemäldesubstanz (Festigung holzwurmgeschädigter Bereiche, Konsolidierung von Malschichtabhebungen, Verleimung von Rissen im Bildträger) als auch ein geschlossenes Erscheinungsbild durch konservatorische und ästhetische Maßnahmen (Abnahme von Übermalungen, Retuschen, vergilbtem Firnis; Schließung/Integration von Bereibungen und Fehlstellen), um die Qualität der brillanten Farbigkeit der Malerei wieder voll zur Geltung zu bringen. Außerdem wurde für das Gemälde ein neuer Zierrahmen angefertigt und weitere präventive Maßnahmen gesetzt, um dieses Hauptwerk ferraresischer Renaissancemalerei langfristig der Öffentlichkeit zugänglich machen zu können.

Figs. 1 and 2: Imperial Chinese lacquer screen, front and reverse. Qianlong Period (1736–1796), created in the 1770s. Weltmuseum Wien, inv. no. 71.233.

The Conservation of an Imperial Chinese Lacquer Screen for the Reopening of the Weltmuseum Wien

Christiane Jordan, Silvia Miklin-Kniefacz, and Richard Miklin[1]

1. SHORT OBJECT DESCRIPTION

One of the most important objects in the collection of the Weltmuseum Wien is the three-part lacquer screen (inv. no. 71.233) from the era of the Chinese emperor Qianlong (r. 1736–1796), the fourth ruler of the Manchurian Qing Dynasty (1644–1911). It was created during the 1770s and, based on its depiction of the mythical birthday festivities of the Queen Mother of the West, Xiwangmu, could have been commissioned by Qianlong for the eightieth birthday of his mother.[2]

Already impressive for its dimensions of ca. 330 cm (H) × 260 cm (W) × 30 cm (D), the structural construction of the object is made of wood. A multi-layered, three-colour relief (red, green, yellow) is applied to the front, masterfully executed in the traditional carved lacquer technique; the reverse is primarily treated in black lacquer with gold decoration *(figs. 1 and 2)*.

Though connected, the three panels of the screen do not form a flat surface: the two narrow side panels project forward at obtuse angles to the middle panel. The arrangement is typical of Chinese screens placed behind thrones. The throne that obviously formed an ensemble with this screen is today in the Victoria and Albert Museum, London (inv. no. W.399:1, 2-1922; *fig. 3*).[3] Until 1900, both objects were located in the palace of the imperial hunting park of Nan hai-tze (Nanhaizi)[4] once south of Beijing and have great iconographic and stylistic similarities. This is especially evident when comparing the cloud-shaped top elements of the screen with the inner back of the throne. Both show at their centres the ascending, five-clawed dragon, the most significant symbol of the Chinese emperor.[5]

The screen can be divided horizontally into three sections: base, middle picture surface, and crowning top element.

[1] The authors dedicate this article to Burgl Baustädter, in loving memory.

[2] See the catalogue entry by Bettina Zorn, *Thronstellschirm*, in: Christian Schicklgruber (ed.), *Weltmuseum Wien*, Vienna 2017, 282 f. The screen was most likely made in the imperial workshops in Beijing.

[3] http://collections.vam.ac.uk/item/O18895/throne-unknown/ (last accessed: 15 October 2020). Like all imperial thrones, the ensemble surely also originally included a matching footrest.

[4] Burgl Baustädter, *Der chinesische Rotlack-Wandschirm im Weltmuseum Wien*, in: Archiv für Völkerkunde 61/62, 2013, 133–149, here: 133.

[5] Craig Clunas, *Whose Throne Is It Anyway? The Qianlong Throne in the T. T. Tsui Gallery*, in: Orientations 22/7, 1991, 44–50.

Fig. 3: Throne, originally forming an ensemble with the screen. London, Victoria and Albert Museum, inv. no. W.399:1, 2-1922. (© Victoria and Albert Museum, London.)

The picture surfaces of the screen show a depiction of the mythical Pantao feast that spans all three panels.[6] This takes place in the garden of the Jade Palace of Xiwangmu, the Queen Mother of the West, in the mythical Kunlun mountains. Xiwangmu is the goddess of immortality and one of the most important female gods in Taoism. The peach trees in her garden bloom every three thousand years and are only ripe after another three thousand. The feast of peaches then takes place, also the birthday festival of Xiwangmu, to which she invites all gods and immortals.[7] Surrounded by a crowd of servants she receives her guests, who arrive by water, land, and air. Xiwangmu is recognizable by the mythical bird, the phoenix, on her head, and is flanked by two girls who hold feather fans above her *(fig. 4)*. On the front of the terrace are assembled Shouxing, the god of longevity, recognizable by his oblong head, and the group of eight immortals – Zhongli Quan with the fan, Zhang Guolao with the bamboo, Lu Dongbin with the sword, Li Teiguai with the crutch, Han Xiangzi with the flute, Lan Caihe with the basket of flowers, Cao Guojiu with the castanets, and, as the only woman, He Xiangu

6 An iconographically comparable screen with a throne is in the Asian Art Museum (*Museum für Asiatische Kunst*), Berlin. This ensemble with the depiction of the Pantao feast is about a hundred years old, however, and its overall impression is dominated by the shimmering, splendid colour of thousands of mother-of-pearl inlays. See Beatrix von Ragué, *Ein chinesischer Kaiserthron. Die Pfirsiche der Unsterblichkeit* (Bilderhefte der Staatlichen Museen – Preußischer Kulturbesitz Berlin, vols. 40–41), Berlin 1982.

7 On the front of the screen are more than a hundred figures and – as on the reverse – a multitude of animals and plants with concrete meanings. Only a few of the most important are described in the following short description. On symbolism in Chinese art, see i.a. Wolfram Eberhard, *Lexikon chinesischer Symbole. Die Bildsprache der Chinesen*, Kreuzlingen – Munich 2004; Terese Tse Bartholomew, *Hidden Meanings in Chinese Art*, San Francisco 2006; Patricia Bjaaland Welch, *Chinese Art. A Guide to Motifs und Visual Imagery*, Tokyo – Rutland, Vermont – Singapore 2008.

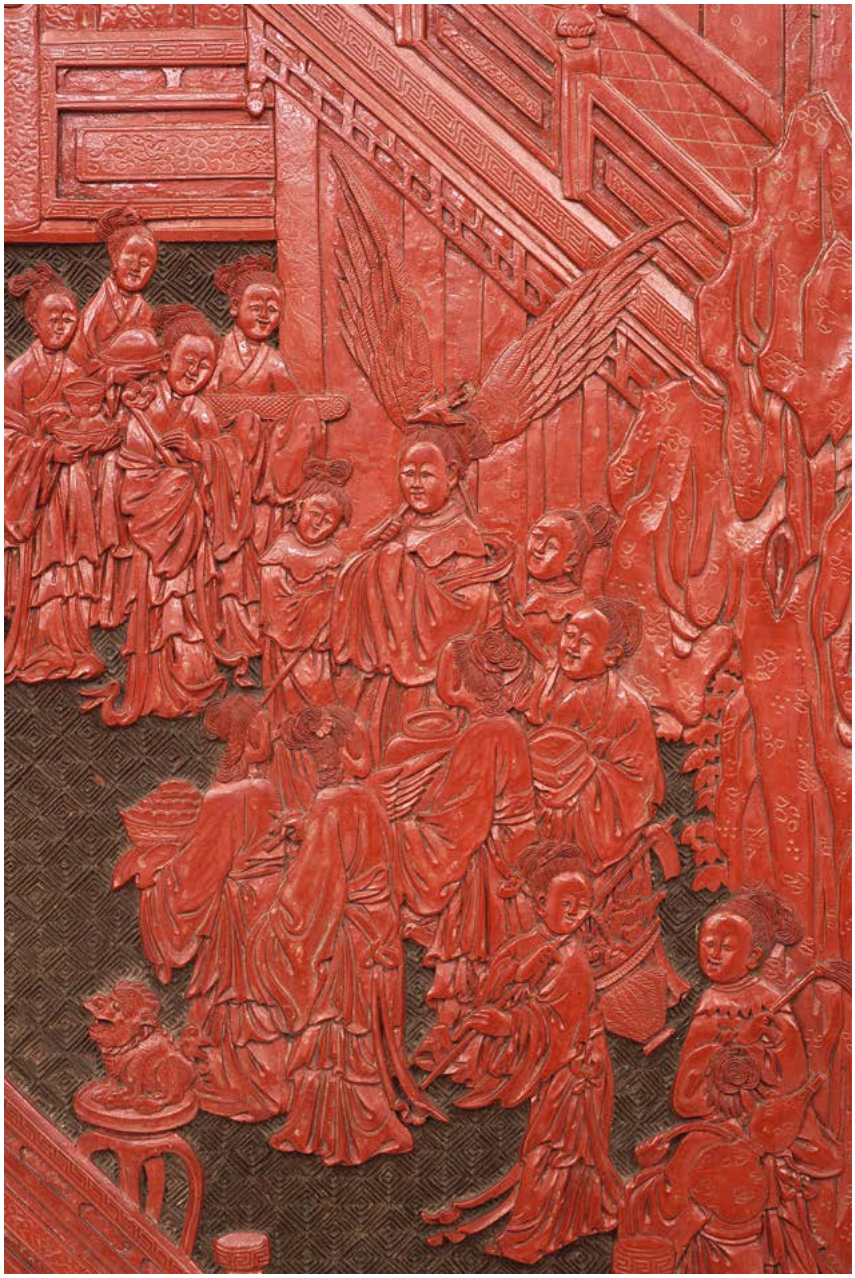


Fig. 4: Detail of the front of the screen: Xiwangmu, the Queen Mother of the West, surrounded by her servants.

Fig. 5: Detail of the front: Shouxing, the god of longevity, and the eight immortals on a terrace of the Jade Palace of Xiwangmu.

with the lotus flower *(fig. 5)* –, while ever more guests with gifts cross the bridge pictured at left. From the upper left, the moon goddess Chang'e with her female servants floats down from her palace, while from the waves the dragon kings of the four world oceans Ao Guang, Ao Qin, Ao Shun, and Ao Run offer their greetings to their host. Also visible in the lower part of the central panel are the immortal Liu Hai on a three-legged toad symbolizing wealth and longevity *(fig. 6)*[8], and Bo Luo Tuo She riding a tiger *(fig. 7)*[9]. In the middle of the left side panel, the three gods of happiness Shou Xing, Lu Xing, and Fu Xing cross the bridge, and in the lower half of the right panel Magu, the goddess of longevity, approaches accompanied by a doe. Various animals and plants are also depicted – including cranes and deer, pine and bamboo – considered symbols of long life in Taoism. All of the picture fields in the three panels are framed by multiple borders of different widths, in which meander-like and strictly geometric patterns alternate with flower and vine motifs *(fig. 8)*.

[8] According to Bruno J. Richtsfeld, the figure on the toad could also be the monk Shide, whose attribute is a broom. See Bruno J. Richtsfeld, *Onorato Martucci (1774–1846) und sein 'chinesisches Museum'*, in: Claudius Müller – Wolfgang Stein (eds.), *Exotische Welten. Aus den völkerkundlichen Sammlungen der Wittelsbacher 1806–1848*, Dettelbach 2007, 157–260, here: 191–194.

[9] To the originally sixteen younger Buddhas, called Arhat or Luohan, two were added in China, which were also assumed into the Taoist pantheon. Bo Luo Tuo She is the eighteenth Luohan, whose riding on a tiger symbolizes the triumph over evil. See Charles A. S. Williams, *Chinese Symbolism and Art Motifs*, 4th revised ed., Tokyo – Rutland, Vermont – Singapore 2006, 170–177.

Fig. 6: Detail of the front: the immortal Liu Hai (or the monk Shide) on a three-legged toad symbolising wealth and longevity.

Fig. 7: Detail of the front: the Luohan Bo Luo Tuo She, riding on a tiger, symbolizing victory over evil.

Fig. 8: Detail of the borders on the front: Meander-like and geometric patterns alternate with zones of flowers and vines.

Fig. 9: Detail of a border on the front: The endless knot is one of the eight Buddhist symbols incorporated into the flower and vine borders.

In the widest, outermost borders of each panel, the eight Buddhist symbols – victory banner, lotus flower, vase, pair of fish, endless knot *(fig. 9)*, dharma wheel, conch shell, and parasol – are included between the vines and flowers.[10] The stepped base is likewise divided into multiple borders. Meander-like bands with geometric patterns alternate with floral elements and occasional bats. The bat is considered a particularly lucky symbol because of the word's homophony with the character for luck (*fu*) *(fig. 10)*.

The opulent, cloud-shaped top elements of the screen are divided into multiple fields by borders with volute-like scrolled ends and blossom and vine patterns. The central field shows the aforementioned ascending five-clawed dragon with a flaming pearl in dense clouds, flanked by two further dragons seen from the side and bats. At the highest point of the screen above the head of the middle dragon is another flaming pearl, approached from both sides by dragons. Here, too, numerous bats are embedded in the dense cloud ornament.

The considerably simpler reverse of the screen is decorated with animals and plants. Five bats are depicted in the cloud-shaped top element, representing the five life wishes or virtues: prosperity, health, virtuousness, long life, and peaceful death. In the centre of the middle panel is a peach tree *(fig. 11)*, around which bats and cranes flutter *(fig. 12)*. A Chinese mahogany tree with two additional cranes is depicted on the left side panel, and on the right panel a wutong tree with a pair of deer *(fig. 13)*. Symbols for happiness and longevity likewise dominate the reverse of the screen.

On the upper corners of the base and the twelve feet are cast and fire-gilded brass or bronze hardware. While the hardware of the base continues the meander ornament of the carved lacquer, that on the feet is decorated with cloud shapes.

[10] Since the early seventeenth century, these Buddhist symbols were incorporated into Taoist symbolism. Here they also represent a long life. See Bartholomew 2006 (cit. n. 7), 185.

Fig. 10: Detail of the front: Appearing countless times on the front and reverse of the screen, the bat is a particular symbol of luck because of its homophony with the character for luck (*fu*).

Fig. 11: Detail of the reverse: A peach tree at the centre with ripe fruits, symbols of immortality, continues the subject matter from the front.

Fig. 13: Detail of the reverse: The two deer likewise represent longevity in this context.

Fig. 12: Detail of the reverse: The crane is one of many Chinese symbols of longevity.

The entire iconographic programme of the screen serves the glorification of the Chinese emperor as 'son of heaven'. When he took his place on the throne, he became a kind of guest of Xiwangmu and was thus assumed into the circle of immortals. The numerous symbols for happiness and long life on all parts of the screen additionally sought to support and promote the health and wellbeing of the emperor.

1.1 OBJECT HISTORY 1900–2004

In October 1900, during the violent clashes of the so-called Boxer Rebellion, the Austrian navy appropriated the screen in the palace of the imperial hunting park Nanhaizi near Beijing. The valuable asset was first stored in the former residence of the city prefect. There in April 1901, the Austrian Rear Admiral Count Rudolf Montecuccoli-Polinago carried out an inspection of multiple pieces of booty, among them a 'large red lacquer wall [*grossen Roth-Lackwand*]'. The transfer of the screen to Taku and its temporary safekeeping in the maritime museum in Santa Pola followed. In December 1902, the Imperial Royal Natural History Court Museum accepted the crate containing the object. After temporary storage in the library of the ethnographic department, the screen was presented from 1903 in the anthropological-ethnographic collection of the Imperial Royal Natural History Court Museum in a glass case in Hall XIV *(fig. 14)*.[11]
After its transfer from the Imperial Royal Natural History Court Museum to the *corps de logis* of the Neue Burg, the screen was installed there in 'Chinese Hall I', on the raised ground floor, in 1927. The festive opening of the Museum of Ethnology took place on 25 May 1928. The lacquer screen was continuously on view thereafter, as one of the most significant objects in the permanent collection.[12] In preparation for the major refurbishment of the Museum of Ethnology (today Weltmuseum Wien), in 2004 the object was disassembled and put in storage.

2. CHINESE CARVED LACQUER

2.1 HISTORY

The adhesive, protective, and simultaneously decorative functions of Asian lacquer, called *qi* in Chinese (*urushi* in Japanese), have been known in China for over eight thousand years. The oldest known archaeological lacquer object in China is a lacquered bow from the Neolithic period.[13]
Because of the protective and especially the water repellent and acid and base resistant qualities of the *qi* lacquer, food and drinking vessels, musical instruments, and furniture, as well as weapons and sarcophagi, were coated with it. Early lacquer objects were usually simply decorated with black and red lacquer, but over the course of the centuries numerous decorative techniques were developed, among them the multi-layered carved lacquer.

[11] For a more detailed object history of the screen, see Baustädter 2013 (cit. n. 4).
[12] The question of whether the screen was presented in a showcase or freestanding from 1927 to 1988 could thus far not be satisfactorily answered. Norbert Kirchner, M.A., the conservator in the former Museum of Ethnology, reported that in the late 1970s, the lacquer screen was located in a 'niche' on the mezzanine of the Ringstrasse side and from there transferred to the raised ground floor for the Japan/China reinstallation in 1987/88. The curator for East Asia, Dr. Bettina Zorn, informed the authors that the screen was displayed from 1988 to 2004 without a showcase.
[13] This is in the Kuahuqiao Relics Museum, Hangzhou. See Julie S. C. Chang, *A Cross-Disciplinary Approach to Chinese Lacquer Technology*, unpublished dissertation, University College London 2019, 25.

Fig. 14: Image of the lacquer screen from 1903 or 1904. Weltmuseum Wien, Photograph Collection, inv. no. 6.514. (Photo: Josef Szombathy, Curator of the Prehistoric Collections of the Imperial and Royal Natural History Court Museum.)

Asian lacquer is a natural sap harvested from trees of the sumac family (*Anacardiaceae*). It was long assumed that Chinese lacquer came exclusively from the species *Toxicodendron vernicifluum*. Recent investigations at the Getty Conservation Institute in Los Angeles[14], however, have shown that many Chinese lacquer objects – not only those for export – contain lacquer from *Toxicodendron succedaneum* (also called Vietnamese or laccol lacquer), along with numerous organic and inorganic additions.

The harvesting of the lacquer is very labour intensive and demands considerable experience. It can also only be done by persons not allergic to the lacquer. The yield is very slight: today a ten- to fifteen-year-old tree delivers ca. 200 g of lacquer in one season; previously the cultivation was less intense, allowing the tree to survive.[15] This made Asian lacquer a very precious material.

[14] See https://www.getty.edu/conservation/our_projects/education/radical (last accessed: 15 October 2020).

[15] In the modern tapping method, the tree is completely depleted and dies after the tapping season.

The special technique of carved lacquer has a long tradition. According to the famous treatise *Xiushilu* by Huang Cheng from the sixteenth century[16], the earliest historic text referring to lacquer production, the technique can be traced to the Tang period (618–907), although the oldest preserved carved lacquer objects date from the Song period (960–1279). The technique reached highpoints in the Yuan (1271–1368) and Ming (1368–1644) periods, after which courtly production decreased. Only in the Qianlong period did the tradition of carved lacquer arts in the imperial workshops see a renewed and final major flowering.[17]

Vessels and containers made from carved lacquer were of little practical use and were an extreme luxury because of their precious material and extremely time-consuming production. They were specially made for courtly use and highly prized as diplomatic gifts. Furniture and screens were seldom produced in this technique. Likewise seldom were combinations of carved lacquer with lacquer painting and other lacquer techniques.

2.2 TECHNIQUE

Carved lacquer is built up from numerous, sometimes up to hundreds of individual lacquer layers, into which figures and patterns are only cut or engraved after all of the layers have hardened. The different carved lacquer techniques have their own terms in Chinese: carved lacquer generally is called *diaoqi*, that consisting exclusively of red lacquer layers is called *tihong*, and carved lacquer with layers in different colours is called *ticai*.[18]

2.2.1 SUPPORT

Due to its good adhesion to almost all materials, the supports for East Asian lacquer vary, from paper and leather to woven bamboo and rattan to ivory, ceramic, and bronze. Traditionally, however, wood is most commonly used.

2.2.2 GROUND

The wood support is usually pre-treated with lacquer, animal glue, starch, or blood.

To level knotholes and irregularities and smooth the surface, nearly all lacquer works receive a multi-layered ground applied with spatulas. Textile or wood fibres or paper are usually embedded in this. The ground forms a levelling layer between the support and the lacquer and secures connections, joints and corners.

[16] The following information from the *Xiushilu* was taken from the dissertation Chang 2019 (cit. n. 13), itself based on the edition of the text in Shixiang Wang, *Xiu shi lu jie shuo: Zhongguo chuan tong qi gong yi yan jiu*, Beijing 1983.

[17] See Patricia Frick, *Schnitzlack*, in: Monika Kopplin (ed.), *Im Zeichen des Drachen. Von der Schönheit chinesischer Lacke*, Munich 2006, 92–95.

[18] Early carved lacquers with different coloured layers (usually red and black) and regular ornaments (double volutes) are called *tixi* (a synonym for the Japanese *guri*).

The materials and techniques of the ground differ according to period, quality, and location. According to the *Xiushilu*, the highest quality ground is filled with ground staghorn or pulverized porcelain, somewhat poorer categories with bone ash and pulverized oyster shells, the lowest quality with brick dust and clay. All powders were sieved into three grades of fineness.
For high-quality lacquer objects, lacquer was already used as a binding medium in the ground layer. In the commentary to *Xiushilu*, however, thick starch paste, pig blood, 'lotus paste', and glue are all also listed as lower-quality substitutes for lacquer – lower quality because of their weaker binding properties. Local traditions were also decisive for the choice of the materials, however. Thus, in northern China usually lacquer was used in the ground, in southern China blood and animal glues.

2.2.3 LACQUER LAYERS

After the ground, the lacquer layers follow. Various pigments can be mixed into the lacquer, but not all are compatible with Chinese lacquer: some turn it black and some delay the hardening. Thus, primarily, compatible red and black pigments have always been used (alongside the less common colours yellow, green, and blue).
The application of the lacquer layers was normally done with a brush, in three layers for normal lacquer works, for carved lacquer hundreds of very thin lacquer layers with each layer ca. 0.03–0.04 mm thick. Various oils are added to the lacquer to render the layers easier to carve. Each individual layer hardens within one to three days; the conditions for ideal polymerization are a temperature of 20–30°C and a relative humidity of 70–80%. Ideal working conditions also demand absolute freedom from dust.
After the hardening of a lacquer layer, an intermediate sanding takes place using abrasive stones or various plants (e.g. horsetail) before the next layer is applied. The process is repeated until the desired thickness is achieved. Independent of the size of the object, the buildup of the lacquer layers alone can take one to two years, before the decorative process of carving can begin.
The surface is polished after the carving, while the cut surfaces usually remain matte.

Fig. 15: Mortise and tenon connection of two parts of the base.

Fig. 16: Dovetail connection visible on the bottom of the base beneath the lacquer coating.

Fig. 17: Bamboo dowel between the inset panel and frame.

3. TECHNOLOGICAL FINDINGS

3.1 PRODUCTION TECHNIQUES

The three-part screen consists of two narrow side sections and a large middle panel. The three panels stand with pegs inserted into a likewise three-part base and are crowned with separate cloud-shaped top elements. Added carved elements are present at the outer edges on both sides.
All individual parts of the screen are made from wood and connected with simple mortise and tenon joints. The base elements have recesses into which tenons from the panels are inserted; likewise at the upper edges, the panels have channels into which tenons from the top elements are slotted. The parts are joined in the same way laterally: the middle parts have recesses that taper diagonally downward, into which tenons on the sides are inserted and slid downward into place *(fig. 15)*.
The individual wood elements are made from different wood profiles, which are connected and glued with invisible wood joints and bamboo dowels. The base shows a dovetail construction, for instance (connecting the sides to the bottom; *fig. 16*), and tenons in the middle. Because of the lacquer

Fig. 18: Iron nail on the reverse.

Fig. 19: Iron nails on the carved lacquer side.

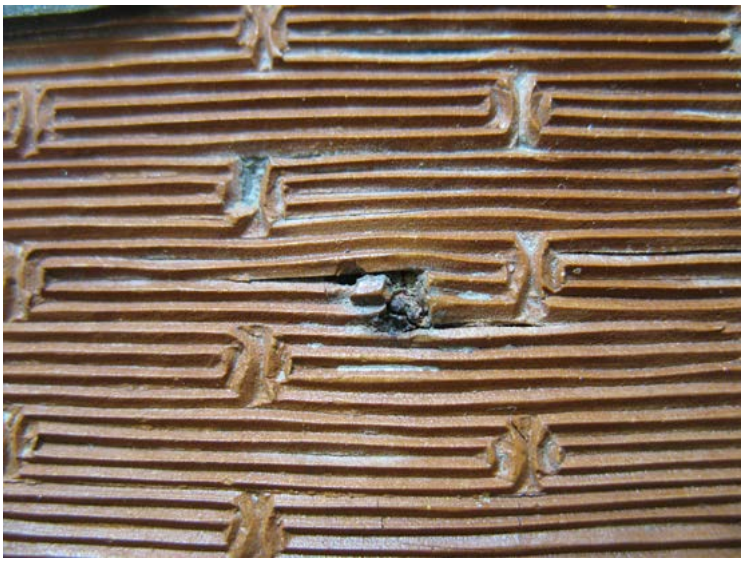


Fig. 20: Iron nail on the carved lacquer side (area of the patterned sky).

coating, however, it is not possible to precisely determine the wood construction with the naked eye.

The panels and top elements employ a rail and stile construction, although the number of planks from which the inset panels are made is not clear (only the long crack in the middle panel suggests a joint). The frame is connected to the inset panel with bamboo dowels *(fig. 17)*, and further small moulding strips are attached with glue and dowels. Numerous iron nails, the function of which could only partly be explained, were identified in the panels using magnets *(figs. 18 to 20)*. In the top elements, these could be related to the attachment of the ornamental profile on the reverse. All other nails, especially those recognizable on the front, are distributed over the entire surface, independent of the construction. Perhaps multiple planks were attached to the entire front surface to strengthen the panel *(figs. 21 and 22)*.

In losses to the coating, a woven textile is visible immediately above the wooden support, followed by a ground layer with embedded textile fibres, then another, coarse-grained grey ground layer. The fronts and all exterior

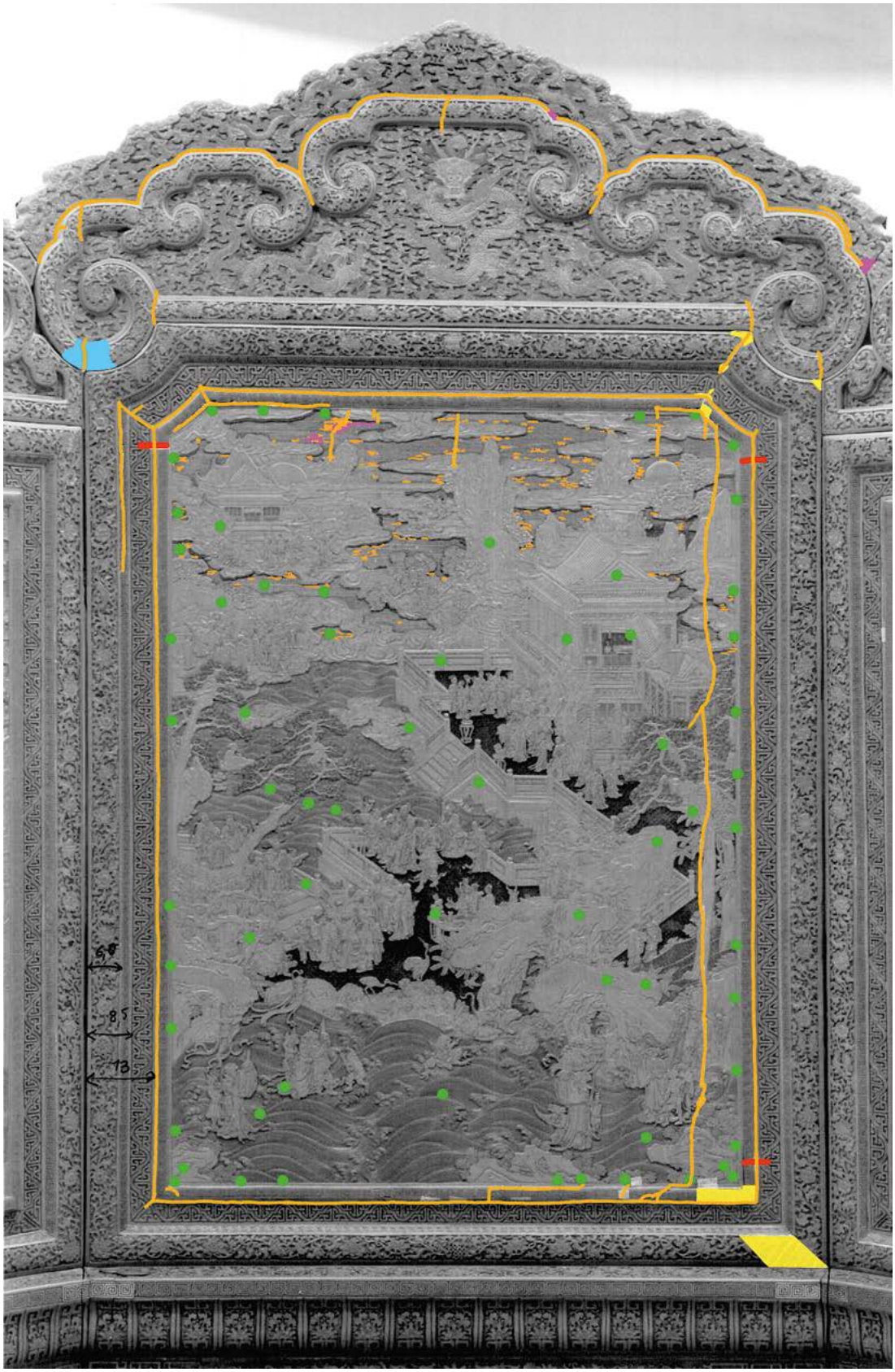


Fig. 21: Diagram of the front of the middle panel (the iron nails are shown enlarged for better legibility).

- Cracks, open joints, loose areas
- Nails
- Bamboo dowels
- Losses
- Wood repairs
- Overpaint

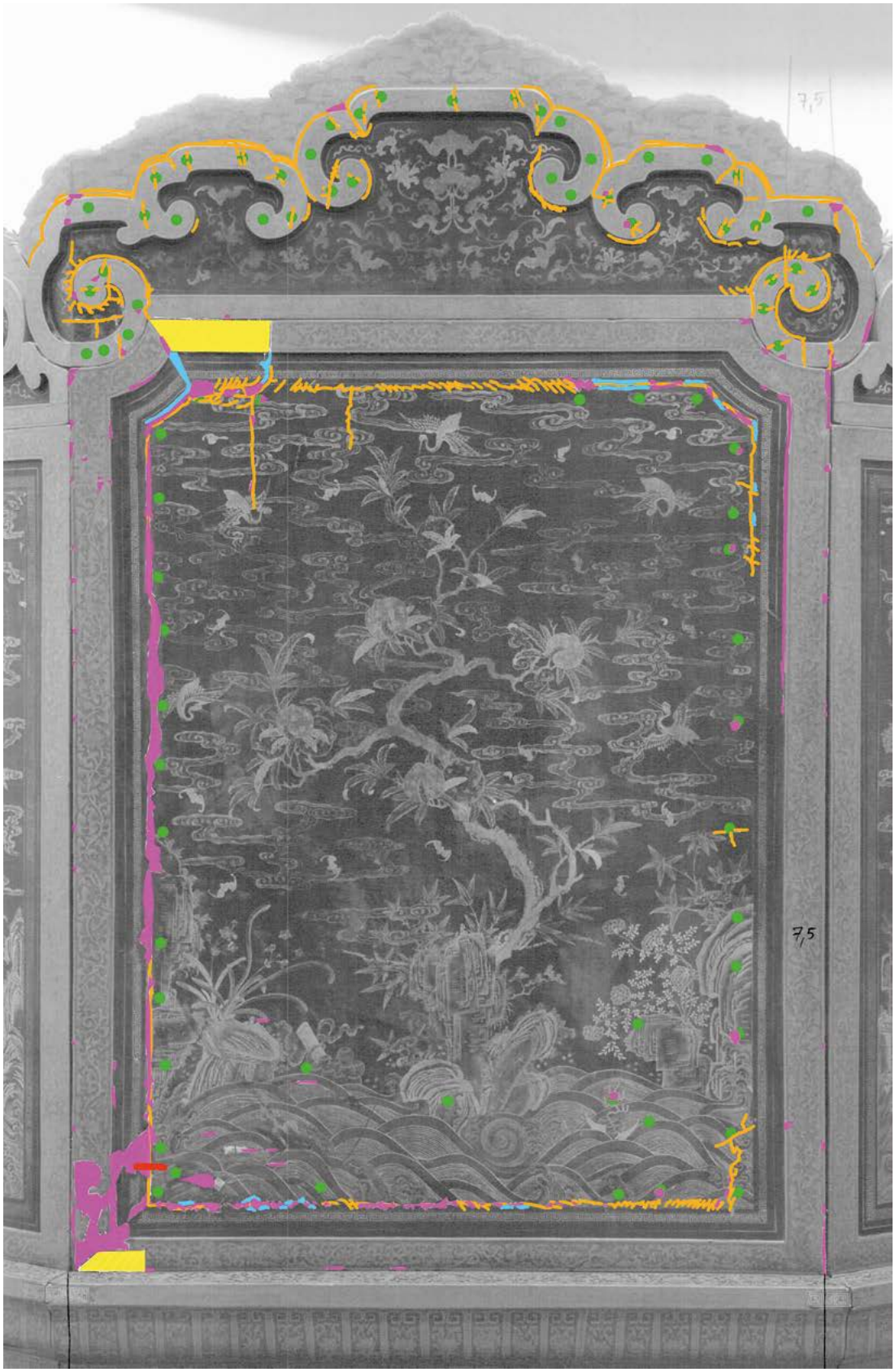


Fig. 22: Diagram of the reverse of the middle panel (iron nails enlarged).

- Cracks, open joints, loose areas
- Nails
- Bamboo dowels
- Losses
- Wood repairs
- Overpaint

Fig. 23: Loss on the edge of the base at the front: Through abrasion of the uppermost dirt and oxidation layers, the original colour is visible.

and horizontal surfaces are adorned with very fine, three-colour carved lacquer decoration. Above the ground on these surfaces is a sequence of lacquer layers, first yellow, then green, and finally red *(fig. 23)*.[19]
The woven textile – natural coloured on the base *(fig. 24)* and blue on the panels *(fig. 25)* – was presumably glued over the entire surface before the ground was applied to secure the wooden support against distortion and movement of the joints.
Aside from the small lateral additions, the reverses show no carved lacquer. The inset panels and top elements are lacquered black and decorated with three-coloured gold decoration and a grey border strip of metal powder (apparently tin), the rails and stiles of the reverse and the base reverse are red lacquer with lacquer painting in black and yellow (ochre paint), the inner sides of the panels and base are simply lacquered in red.

3.2 INVESTIGATIONS

3.2.1 METHODS

To gain an overview of the techniques and materials used in the lacquer screen, the following analytical methods were employed at the Conservation Science Department of the KHM-Museumsverband and the Getty Conservation Institute[20]: non-destructive investigation using x-ray fluorescence analysis (XRF) for the identification of pigments and metals; preparation of sample material as cross-sections and investigation using light microscopy; histochemical staining of the cross-sections for medium analysis; scanning electron microscopy with energy-dispersive x-ray spectroscopy (SEM/EDX)

[19] On *ticai*, see section 2.2 Technique.
[20] The analyses of the red and black lacquers were executed by Michael R. Schilling and Julie Chang using THM-Py-GC-MS; see the internal report *Chinese carved lacquer screen*, Getty Conservation Institute, June 2013.

Fig. 24: A natural-coloured woven textile is evident above the wooden support at losses on the base.

Fig. 25: At losses on the screen panels, a blue woven textile is visible below the ground.

for the analysis of inorganic components and their distribution; gas chromatography-mass spectrometry (GC-MS) for the detection of fats, resins, and proteinaceous binding media; and pyrolysis-gas chromatography-mass spectrometry using tetramethylammonium hydroxide (TMAH) for thermally assisted hydrolysis and methylation (THM-Py-GC-MS) for the identification of the lacquer.[21] The identification of blood was done at the Department of Biochemistry and Microbiology, University of Chemistry and Technology in Prague[22] using nanoscale liquid chromatography coupled to tandem mass spectrometry (nano LC-MS/MS).

By these means, the structure and components of all ground and lacquer layers were to be investigated and the textile fibres of the ground and the metal particles used in the gold decoration of the reverse determined. The extensive investigations also sought to clarify the relationship between inherent and external factors in the development of damages to the object.

[21] A comprehensive list of all investigations appears in Václav Pitthard et al., *The technical investigation of an eighteenth-century Chinese imperial carved lacquer screen and its role in developing an appropriate conservation treatment*, in: Studies in Conservation 61/3, 97–108.

[22] Analyses by Štěpánka Hrdličková Kučková.

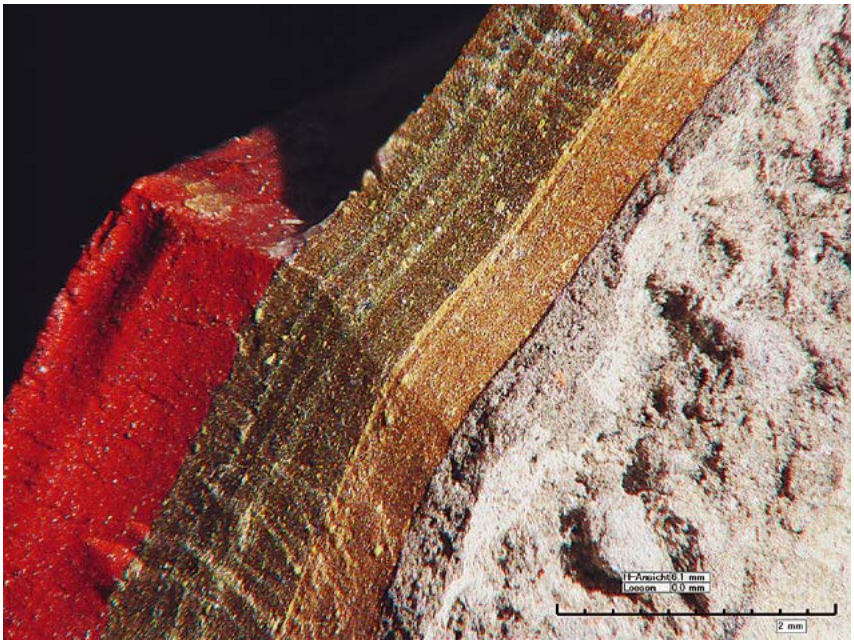


Fig. 26: The multi-layered lacquer application is visible in a fragment sample (Hirox 3D microscope, 50x).

Fig. 27: Cross-section of a sample taken from the front (visible light, 100x, assembled from multiple images because of the thickness of the layers).

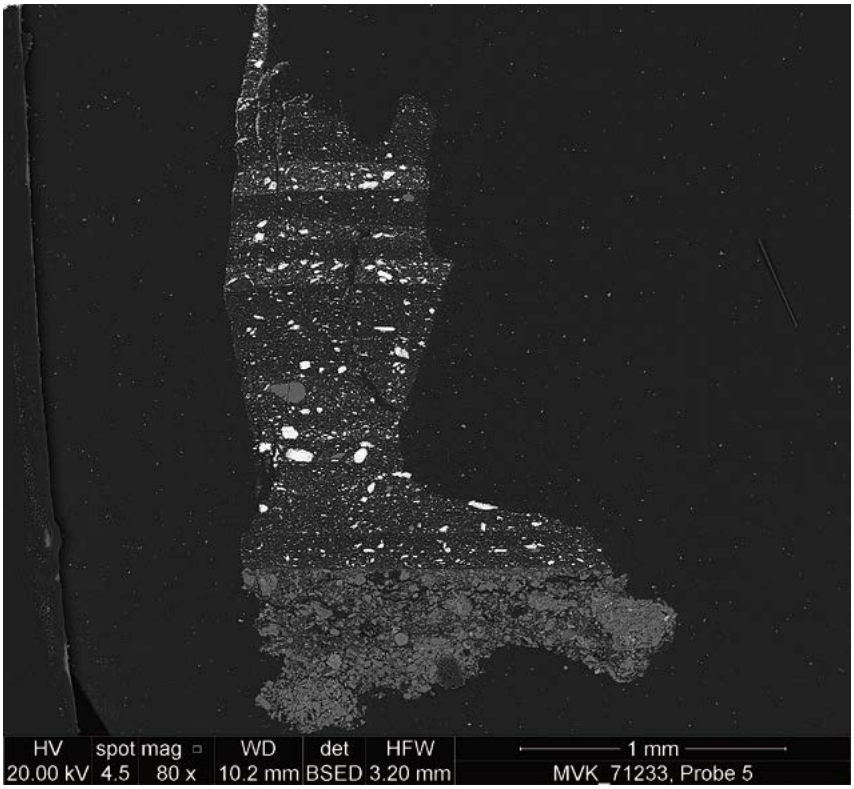


Fig. 28: Cross-section of a sample from the front (SEM/BSE, 80x).

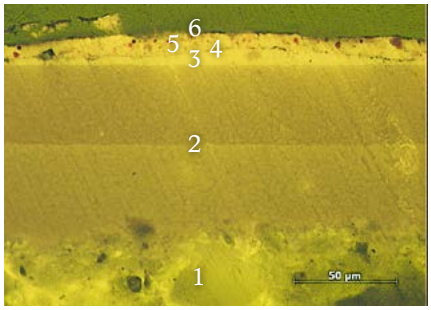


Fig. 29: Cross-section of a sample from the black lacquer with gilding on the reverse (UV, 500x):
1. green ground, 2. two layers of lacquer, 3. mordant layer, 4. thin layer of metal powder (silver–gold alloy), 5. thin red layer, 6. gold powder, compressed.

3.2.2 CROSS-SECTIONS/STRATIGRAPHIC INVESTIGATIONS

The layer structure could be revealed using the HIROX 3D microscope and light and electron microscopic investigations of cross-sections *(fig. 26)*: thick layers filled with granular grey material form the ground, into which the textile fibres were embedded. The carved fronts of the screen appear as three-colour reliefs, consisting of ca. 50–60 individual layers: the lowest ca. 15–20 layers are light brown lacquer (originally yellow), above are ca. 15–20 layers of dark brown (originally green), ca. 20 layers of red-pigmented lacquer are uppermost *(figs. 27 and 28)*.
On the reverse, the inset panels and the top elements were created using the black lacquer technique: atop the ground, two separate layers of black pigmented lacquer (with intermediate sanding) were applied and polished to a high gloss *(figs. 29 and 30)*. The decoration was painted freehand on the polished surface (lines with iron oxide red lacquer, surfaces with unpigmented lacquer) and gold powder of various alloys sprinkled onto the still-wet lacquer or gold leaf applied to a thin layer of lacquer mordant. Unlike in Japanese *maki-e*, no additional lacquer was applied to the scattered gold, which lends the Chinese gold lacquer its particular allure: the contrast between the glossy lacquer surface and matte gold decoration. A number of areas are decorated in gold leaf, recognizable for its smoother, shinier surface – also a conscious decorative accent *(fig. 31)*.

Fig. 30: Sample site for the cross-section in *fig. 29*.

Fig. 31: Gilding tones: 1. light gold ('blue gold' powder, gold–silver alloy), 2. 'true gold' (nearly pure gold powder), 3. silver (powder), 4. gold leaf (pure gold).

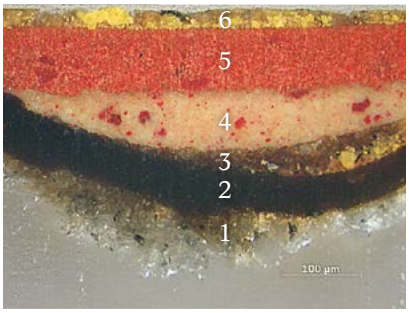


Fig. 32: Cross-section of a sample from the reverse (frame/red edge with yellow lines, visible light, 200x):
1. coarse ground, 2. lacquer, 3. two grey-brown layers with orpiment and ochre, 4. light red layer with cinnabar and lead white, 5. pure cinnabar layer, 6. ochre-coloured layer (orpiment with ochre).

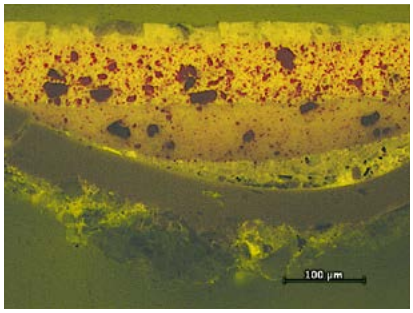


Fig. 33: Cross-section of a sample from the reverse (frame/red edge with yellow lines, UV, 200x).

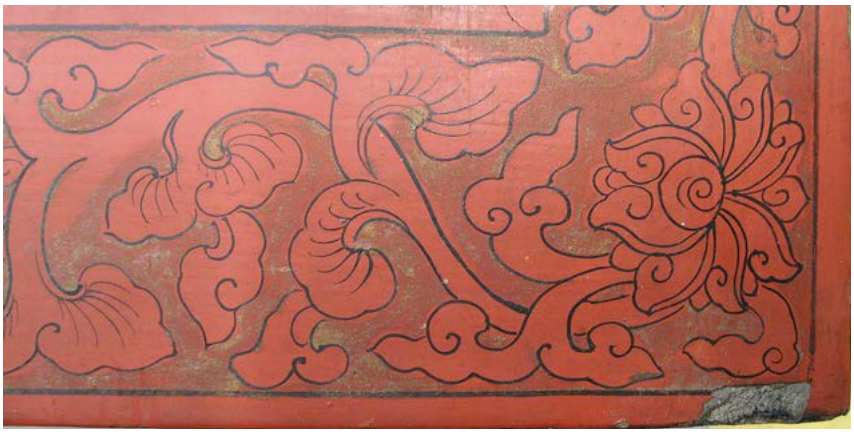


Fig. 34: Detail of the frame on the reverse: decoration with black lines and yellow fields.

Fig. 35: Detail of the back of the base: yellow lines.

On all other areas of the reverse (frame, base), above the ground was applied and polished first black lacquer (one layer) followed by red lacquer (two layers) *(figs. 32 and 33)*; these surfaces were subsequently decorated with black lines, yellow fields *(fig. 34)*, and yellow lines (meander, lower base; *fig. 35*).

3.2.3 BINDING MEDIA OF THE COATINGS, LACQUER, AND GROUND LAYERS

Before the analysis of the lacquer and ground layers, it was necessary for conservation reasons to determine if, and if so, what coatings are present.
In three samples, the whitish coatings on the carved lacquer side could be identified with GC-MS as ibota wax, an Asian insect wax. Through comparison with a reference sample of the Japanese ibota wax ibota-ro,[23] which is used in certain polishing processes in the lacquer technique, the results of the analysis could be verified. The coating, which was visible under UV illumination, was likewise identified using GC-MS: colophony with traces of shellac and a drying oil were found. This also corresponded with the THM-Py-GC-MS investigations performed at the Getty Conservation Institute (Michael Schilling, Julie Chang): In a sample from the red carved lacquer side, in addition to the lacquer components, colophony (pine resin) with traces of shellac and cedar oil were found. The results suggest that the iboda wax is attributable to historical care in China (as it was not common here) while the colophony coating belongs to the later history of care in Vienna.
Asian lacquers cannot be directly analysed by GC-MS as they are insoluble. The red lacquer of the front and black lacquer of the reverse were thus investigated in the Conservation Science Department of the Kunsthistorisches Museum using THM-Py-GC-MS.
The black lacquer contains urushiol (this was determined from the pyrolysis products of the aged lacquer) and drying oils (possibly a mixture of perilla and linseed oils). The red lacquer shows the same pyrolysis products, hence the same binding media composition, but additionally contains cedar oil.
For comparison, samples were investigated at the Getty Conservation Institute by the same method (THM-Py-GC-MS): The red lacquer of the front shows a very high proportion of an oil, heat bodied tung oil, and *urushi* (Chinese: *daqi*, *Toxicodendron vernicifluum*) as well as mercury sulphide (from its pigmentation with cinnabar). In the black lacquer, perilla oil with *urushi* was determined (Chinese: *daqi*).

[23] Ibota-ro, from the Watanabe company, http://www.urushi-watanabe.net (last accessed: 15 October 2020).

All of the lacquer layers thus contain urushiol[24] and can be assigned to the tree type *Toxicodendron vernicifluum*, native to China, Japan, and Korea.[25] To improve handling and achieve the desired level of gloss, various oils were added to the lacquer[26]: cedar and tung oil in the red layers, perilla oil[27] in the black layers.

The investigation of the binding medium of the ground proved unexpectedly difficult. In the THM-Py-GC-MS investigation at the Getty Conservation Institute, proteins associated with the ground could be determined, suggesting an animal glue as the binding medium. The historical source mentioned above, however, indicates that animal blood was commonly used in the grounds of lacquer works. The GC-MS investigation at the Kunsthistorisches Museum showed the presence of amino acids, suggesting the use of blood, but animal blood could not be unequivocally identified. Only using nano LC-MS/MS was the binding medium clearly identified as pig blood based on the peptide sequences found *(Table 1)*.[28]

Table 1: List of the peptides/proteins determined by nanoLC-MS/MS (taken from the investigation report from the Department of Biochemistry and Microbiology, University of Chemistry and Technology, Prague).

Accession	Protein	#Peptides
HBB_PIG	Hemoglobin subunit beta	5
HBA_PIG	Hemoglobin subunit alpha	4
TRYP_PIG	Trypsin	2
HBB_TARBA	Hemoglobin subunit beta	2

[24] Urushiols, derivatives of catechol, are the main component in tree saps from Eastern and Southeast Asian lacquer trees, at about 60–65%; other components are: 20–30% water, 5–7% plant gums, 2–5% glycoproteins and <1% enzymes. See Nanke Schellmann, *Über die Reinigung ostasiatischer (Urushi-)Lacke*, in: Paul-Bernhard Eipper (ed.), *Handbuch der Oberflächenreinigung*, Munich 2017, 338–460, here: 338.

[25] In Asia, depending on the country and region, different lacquer trees of the family *Anacardiaceae* are used for the production of lacquer. Urushiol is the main component of the tree type *Toxicodendron vernicifluum* (synonym: *Rhus verniciflua Stokes*) used in China, Japan, and Korea. In lacquers from Vietnam (tree type *Rhus succedanea*), laccol is the main component, while in the lacquers of Cambodia, Thailand, and Burma (tree type *Melanorrhoea usitata*) it is thitsiol; see Marianne Webb, *Lacquer. Technology and Conservation*, Oxford 2000, 3–8.

[26] The lacquer master Tatsuya Matsumoto described the advantages of this tradition in a 2005 interview: 'Urushi will harden more slowly and the urushi layer will become thicker so that it feels like carving rubber. And the carved part will become a little lustrous, so there's no need to polish […]. It [the lacquer] will be soft when carving, but then it will harden.' Tatsuya Matsumoto, *History of Choshitsu and Its Terminology*, in: U*rushi 2005. International Course on Conservation of Japanese Lacquer*, Tokyo 2005, 28–33.

[27] Perilla oil, also called egoma oil, is won from the seeds of the perilla plant (*Perilla frutescens*), also called wild sesame or black nettle.

[28] See Silvia Miklin-Kniefacz – Václav Pitthard – Walther Parson – Cordula Berger – Sabine Stanek – Martina Griesser – Štěpánka Hrdličková Kučková, *Searching for Blood in Chinese Lacquerware: ZHŪ XIĚ HUĪ* 豬 血 灰, in: Studies in Conservation 61/3, 45–51.

3.2.4 PIGMENTS OF THE LACQUER AND GROUND LAYERS

The investigation of the pigments using SEM/EDX and XRF revealed the presence of orpiment for the yellow lacquer layers; the greens were coloured using orpiment and indigo, the red with cinnabar, and the black lacquer layers with carbon black.[29]
The thin yellow drawing on the reverse of the screen frame was executed with orpiment and ochre.
Only earth pigments were determined in the ground layers (not pigmenting proper, rather the natural components of the earths used).

3.2.5 METAL PARTICLES AND TEXTILE FIBRES OF THE LACQUER AND GROUND LAYERS

The metal powders and leaves used in the lacquer painting of the reverse were also identified using XRF: depending on the 'gold tone', silver, gold, and silver-gold alloys were detected. For instance, in a cross-section *(see fig. 30)*, over a sprinkling of a fine powder of a silver–gold alloy, a line with red lacquer (cinnabar with some earth pigment) is detectable, onto which very pure gold (only traces of silver and copper detectable) was again sprinkled.
The textile fibres and textiles in both the ground and the overall covering were investigated in Textile Conservation using microscopic investigation. In all samples, ramie-like[30] stem fibres were determined.[31]

[29] Marianne Webb lists orpiment, cinnabar, and carbon black as the pigments historically most commonly used to colour lacquer layers, before the introduction of synthetic pigments; see Webb (cit. n. 25), 8.

[30] Ramie, also called China grass, China plant, or Chinese nettle, is obtained from the inner bark of the stem of the ramie plant. The natural fibre is a bast fibre. See https://en.wikipedia.org/wiki/Ramie (last accessed: 20 November 2020).

[31] Thanks to our colleagues Barbara Pönighaus-Matuella and Lisa Metatla.

Fig. 36: Crack in the middle panel with an adjacent crust of glue over the carved lacquer.

Fig. 37: Glue crust filling the finely carved lacquer relief.

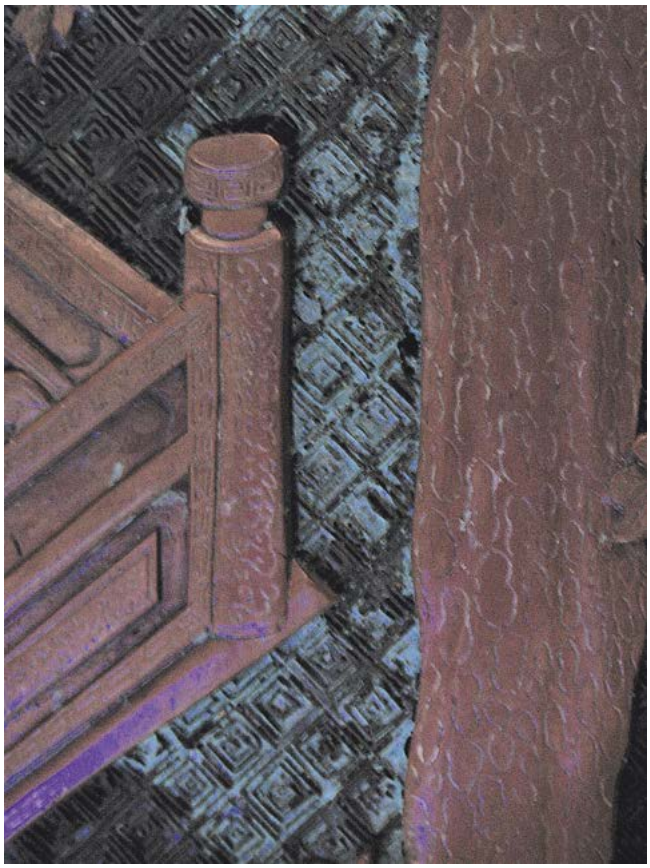


Fig. 38: Glue crust in UV light.

Fig. 39: Secondary coating in UV light, with traces of wiping from the front to the reverse.

Fig. 40: Secondary coating in UV light, with drips.

4. CONDITION AND REASONS FOR CONSERVATION

In preparation for the planned reinstallation of the lacquer screen in the reopened Weltmuseum Wien, the Conservation Department carried out a first evaluation of the object's state of preservation in late 2010. This revealed numerous deep structural cracks in the wood on both the front and the reverse, which had already led to large areas of loss to the ground and lacquer layers (compare the diagram in section 3. Technological Findings).
A vertical crack in the wood of the middle panel displayed traces of old repair with an animal glue that had flooded the surrounding, finely carved lacquer areas, covering and clogging the decoration *(figs. 36 to 38)*.
What was already evident on close observation with the naked eye was clearly visible under UV light: The entire red carved lacquer surface of the front is coated with a non-original, very glossy varnish[32] (see section 3.2.3 on the binding medium analysis), which had partly flowed over the edges to the unvarnished reverse of the object *(figs. 39 and 40)*. Under the varnish on the front, numerous accumulations of a white waxy substance could be observed, which – as already described – were identified as ibota wax and thus probably attributable to maintenance measures at the location of origin.
The reverse also showed tented deformations of large lacquer areas, severe local abrasion, and further superficial damage to the black lacquer layer. Retouching extending far over the original and 'temporary' facings and considerable surface soiling also contributed to the abject appearance of the once splendid object.
This condition suggested that the damages already documented at the beginning of the twentieth century before the shipment to Austria and on cataloguing in the Imperial and Royal Natural History Court Museum had

[32] The coating lies over dirt and other accumulations in the depths.

never been wholly rectified.[33] A lack of written documentation of possible earlier restorations supports this supposition.[34] The decades-long, unprotected exhibition of the humidity- and light-sensitive object in the permanent display of the Museum of Ethnology had doubtless also left clear traces on the lacquer screen.[35]

4.1 SECONDARY COATING

The secondary or really tertiary coating does not appear disturbing on first glance. On closer observation and in comparison with untreated carved lacquers, it is evident, however, that it both falsifies the original, subtle sheen of the carved lacquer surface and includes particles of i.a. dirt. On a number of test cleaning areas, the difference between the glossy, resinous colophony coating and the matte, aged surface of the carved lacquer is evident. Also recognizable are the dirt particles in the cracks and interstices, which are embedded in the coating, as well as the whitish masses in the interstices and at the edges *(fig. 41)*.
The coating was only applied to the fronts, the lateral surfaces at the top of the base, and the backs of the two small lower elements. As already mentioned, the ibota wax was presumably used for care in China, as it is not common in Europe.

4.2 CRACKS, GAPS AND DEFORMATIONS, LOOSE AREAS AND LIFTING LACQUER

In addition to the historically documented vertical crack in the middle panel, there are multiple, sometimes gaping shrinkage cracks between the inset panels and their rail-and-stile frames and at other construction-related joints of the other pieces on the front and the back. These are associated with numerous loose areas and losses on both sides, especially in the yellow carved lacquer (in the sky; *figs. 42 to 44*).

[33] Already in 1901, Count Montecuccoli described a 'large break' in the middle screen element in a dispatch to the Imperial and Royal Imperial War Ministry. During the cataloguing of the screen in 1903 in the Imperial and Royal Natural History Court Museum, damage to the base and a number of cracks in the lacquer were noted. See Baustädter 2013 (cit. n. 4).

[34] According to verbal communication with Norbert Kirchner, M.A., former conservator at the Museum of Ethnology, the folding screen, especially the horizontal surfaces (base), were locally cleaned with rapeseed oil for reinstallation in the Japan/China Hall. Kirchner further confirmed the likelihood of a shellac coating, which he also found on many other objects in the collection, dating from the early years in the Museum of Ethnology. Verbal communication between Silvia Miklin-Kniefacz and Norbert Kirchner, March 2011.

[35] Baustädter documents that during its time in the Imperial and Royal Natural History Court Museum, the screen was presented in various (glass) cabinets; see Baustädter 2013 (cit. n. 4), 141 f. It can be assumed, however, that from its move to the Museum of Ethnology in 1928 until the closure of the permanent collection, the lacquer screen was no longer exhibited in a showcase and was thus exposed over a prolonged period to climatic variations and damage by museum visitors. As already mentioned, Norbert Kirchner, M.A., reported that in the late 1970s the lacquer screen was located in a 'niche' on the mezzanine of the building's Ringstrasse side, and from there was transferred to the raised ground floor for the Japan/China reinstallation in 1987–88.

Fig. 41: Test removal of the coating. The exposed area is lighter and more matte; lower-lying dirt and (whitish) wax remains in the depths.

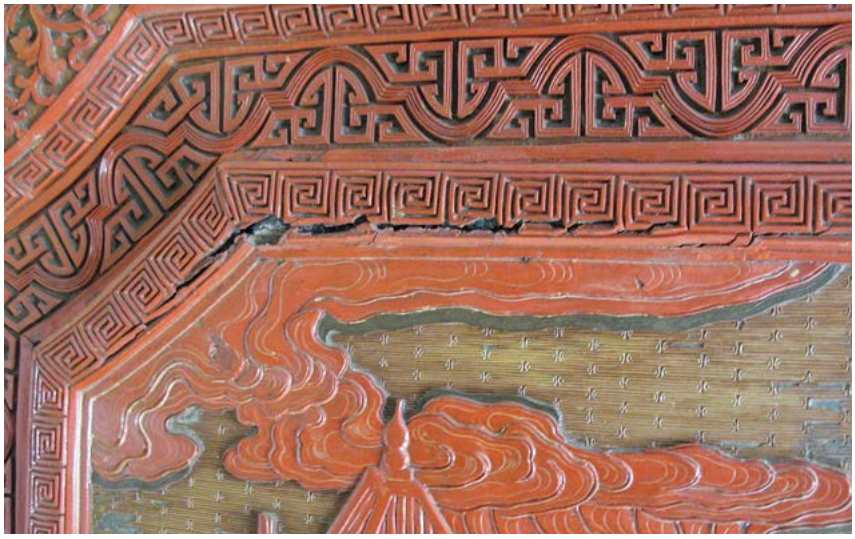


Fig. 42: Cracked joint between the frame and inset panel, front.

Fig. 43: Crack in the carved lacquer extending from a split joint in the support, front.

Fig. 44: Lifting lacquer along a joint in the support, reverse.

Fig. 45: Drips of glue running perpendicular to the vertical crack in the middle panel, UV light.

Fig. 46: Detail of a drip, running horizontally.

Fig. 47: Matte black spots on the surface, reverse.

Fig. 48: Red material transfer on the surface, reverse.

Fig. 49: Scratch in the gold decoration.

4.3 OLD GLUING AND GLUE DRIPS

Along the continuous vertical crack in the middle panel on both the front and the reverse, drips of glue running horizontally are evident, particularly under UV light *(figs. 45 and 46)*. At other early attempts at gluing (e.g. the upper join of the middle panel on the reverse), adhesive likewise usually extends far beyond the area to be secured.

4.4 MATTE, PATCHY REVERSE, SCRATCHES

The originally highly polished black lacquer of the reverse shows a matte, uneven surface. A number of black retouchings and red accretions of colour (probably caused by rubbing against another red object or part of the screen) likewise disturb the appearance of the surface *(figs. 47 to 49)*.

Fig. 50: Loss in the pattern of the sky.

Fig. 51: Large loss on the frame, reverse.

4.5 LOSSES

On the edges of all parts, but particularly at the corners and edges of the base, are numerous mechanical damages and losses, in part reaching to the wood core.
In the area of the sky on the carved lacquer side (brown area), many small relief passages have detached from the ground. The carved lacquer layer is thinnest here, the carving sometimes reaches to the ground, and the tension in the narrow lines of relief is very high. Numerous overpaints and unpigmented wax fills attest to attempts to resolve the persistent problem *(fig. 50)*.
An especially large loss on the reverse, at the lower bottom corner of the frame, is also notable: The lacquer and ground have flaked away, and multiple textile layers and the lower ground remain.
Contiguous to this on the reverse panel and along the long vertical crack, numerous lacquer flakes have been lost that the cracking caused to detach from the lower layers *(fig. 51)*.

4.6 OLD COMPENSATION IN WOOD AND WAX

Loss compensation is found in the form of chalk fills, old wax fills (light red, dark red, light brown, and black; *figs. 52 and 53*) that are partially overpainted (in the sky), and repairs in wood with crude, dark red retouching on the base (back exterior corner and the entire outer/lower meander strip). A number of coarse wood inserts with dark, crude retouching are also found in the carved lacquer area, frame, and top element.

Fig. 52: Old wax fill, black.

Fig. 53: Old wax fill with dark red wax.

Fig. 54: Overpaint of a light wax fill in the pattern of the sky.

Fig. 55: Red-painted wood insert, partially cleaned.

4.7 OVERPAINT

Fills were overpainted, especially old wax fills (brown overpaint for light wax fills in the pattern of the sky, black overpaint for wax fills on the reverse) and wood inserts (dark red) *(figs. 54 to 56)*.

4.8 MISSING HARDWARE AND MISMATCHED REPLACEMENTS

Gilded brass or bronze hardware is present at the twelve feet (replaced with a softwood) and at the upper corners of the base. The originals are cast and the surfaces worked or engraved with chisels and gravers and fire gilded. Four different hardware types are present on the feet of the three bases: on the reverse, five brackets with an engraved cloud pattern (chisel engraved) as well as a later replacement with graver engraving, on the front and sides are six brackets with a relief cloud pattern (cast); six additional areas have cardboard replacements with bronze paint and pencil drawing.
On each of the outer feet of the side panel bases, two brackets were soldered to form one corner: two relief pieces at the front corners and at the back, one relief plate (side) with one engraved plate (back).
Based on the relief hardware present (one left and one right), casts could be produced and the cardboard replacements replaced *(figs. 57 and 58)*.

Fig. 56: Black overpaint on a loss.

Fig. 57: Original cast hardware.

Fig. 58: Softwood foot with cardboard replacement hardware.

Fig. 59: Cleaning of the carved lacquer.

Fig. 60: Cleaning of the back of the base.

5. CONSERVATION TREATMENT

In preparation for the planned reopening of the Weltmuseum Wien, the initial investigations for the cleaning began in January 2011; conservation measures continued with interruptions until February 2015.
The primary goals of the conservation treatment were the stabilization of the construction, cracks, and lacquer layers and the cleaning of the lacquer surfaces, preserving the secondary coatings.

5.1 SURFACE CLEANING

Because to the great effort required and the expected minimal visible impact, it was decided to preserve both the wax accretions (as a historic document) and the later resin coating; only very disturbing drips in transition areas were reduced.

Fig. 61: Cleaning of the black lacquer of the reverse with petroleum spirits (b.p. 140–200°C).

After multiple tests with gels, films, and mouldable pastes, the carved lacquer areas were ultimately carefully cleaned with a mixture of deionized water and isopropanol (8:1): Each application, using cotton swabs or brushes, was limited to a manageable area (5–10 cm^2) and after a short dwell time was blotted with a lint-free cellulose cloth before proceeding to the next location.
The red lacquered reverses (frame and base) could be cleaned with the same method, as the red lacquer of the reverse displayed an astonishing resistance to aqueous cleaning *(figs. 59 and 60)*.
The black lacquered areas (inset panels) of the reverses, however, which also lack secondary coatings, required wholly different measures. From aging, especially through the effects of UV light, these areas show heavy superficial micro-cracking and are thus matte and very water sensitive. They were cleaned with petroleum spirit (boiling point range 140–200°C) *(fig. 61)*. Later paint and old retouching partly had to be removed with acetone and a scalpel. Excess glue residue was softened with locally applied agar-agar compresses and removed with horn spatulas.

5.2 SURFACE CONSOLIDATION OF THE REVERSE: *URUSHIGATAME*

Although the cleaning of the black lacquer areas achieved an improvement in their visual appearance, in order to secure the light damaged surface and the gold decoration it seemed sensible to stabilize the micro-cracks in the longer term. This is traditionally effected for lacquer by rubbing raw lacquer into the damaged surfaces. The colour and gloss of the gold decoration, however, can greatly change as a result.
A method recently developed in Japan – *urushigatame* – seeks to achieve penetration of the lacquer only in the interstices of the cracks, leaving nothing on the surface. Here *urushi* (Chinese: *daqi*), thinned with a slow-evaporating solvent, is introduced into the micro-cracks and carefully removed from the surface using a more quickly evaporating solvent, until no residues are evident on the cloth. Through the mixture of specific lacquer types, hardening and transparency can be optimally adjusted, which is particularly important for the gold decoration.

Fig. 62: Application of the thinned *urushi* mixture in sections.

In the black lacquer areas of the reverse, *urushigatame* was carried out with a 1:1 mixture of *nashiji-urushi*[36] and *kijomi-urushi*[37] diluted with Shellsol A (2 parts). The surface was cleaned first with a dry cloth; after about 15 minutes the remaining *urushi* was removed from the surface with naphtha (petroleum spirits, boiling point range 80–120°C). The hardening took place at ca. 65% RH, for which the humidity in the workroom was slowly increased with humidifiers.

Initial tests showed that this treatment altered neither the matte gilding nor the colour tones of the gold. The process was repeated once after the curing.

For particularly absorptive and matte areas in the black, during the second application the *urushi* was not removed with solvents but only polished clean (this procedure is called *suri-urushi*); in this way, partial differences in the surface gloss could be evened out. Very matte areas were also partially polished with Micro-Mesh cloths before the application of *urushi*.

The alternative to this (admittedly) non-reversible surface treatment would be *no* treatment and an absolute protection from light! Any other coating – even if reversible – would remain in the microcracks and result in unknown changes *(figs. 62 to 68)*.

[36] Very light, transparent *urushi* coloured yellowish with gamboge; minimal adhesive strength.

[37] High-grade raw lacquer with good curing and adhesion properties, darker than *nashiji-urushi*.

Fig. 63: Surface after the *urushigatame* treatment.

Fig. 64: Detail before cleaning and before *urushigatame*.

Fig. 65: Detail after cleaning and *urushigatame*.

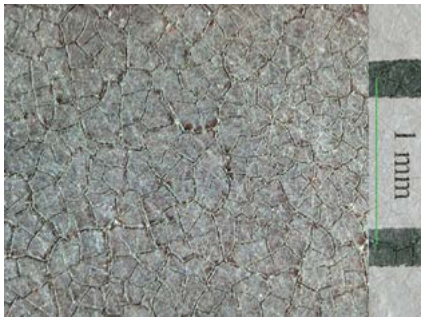


Fig. 66: The micro-cracks before cleaning (USB digital microscope camera eScope DP-M07, 250x imaging magnification).

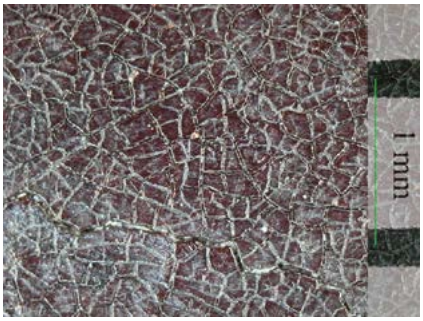


Fig. 67: The micro-cracks after cleaning (USB digital microscope camera eScope DP-M07, 250x imaging magnification).

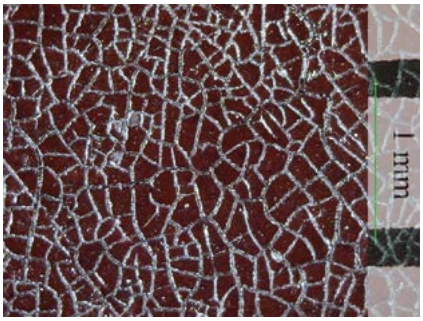


Fig. 68: The micro-cracks after the *urushigatame* treatment (USB digital microscope camera eScope DP-M07, 250x imaging magnification).

5.3 CONSOLIDATION

The consolidation method for the lifting lacquer areas on the black lacquer reverse also differed from that of the carved lacquer front.
Due to the water sensitivity of the reverse, proteinaceous glues and aqueous emulsions had to be avoided. A similarly traditional gluing technique with *mugi-urushi* was chosen: Wheat flour kneaded with water is mixed with raw lacquer (1:1), resulting in a thick mass with high adhesive strength usually used for joining pieces of wood, textile, ceramic, etc. The adhesive mixture must be thinned to introduce it underneath the cupped lacquer, for which e.g. petroleum spirit (boiling point range 80–120°C) works well. The thinned *mugi-urushi* is fed under the flakes with brushes or thin spring steel spatulas and must then be pressed for several days.
For this, a so-called *shinbari* construction was used: Rods of knot-free beech were spanned against a corresponding frame, allowing pressure to be exerted at precisely the desired location. Depending on the hardness required, different sequences of mylar film and small plexiglass, silicon, and PVC plates served as interlayers *(fig. 69)*.
In the carved lacquer areas, a flexible adhesive was necessary, but due to the coating there was no danger of damage from aqueous adhesives. A mixture of Plextol D 360[38] (3 parts) and Plextol D 498[39] (2 parts) was deemed appropriate as it offered both the necessary adhesive strength and a high flexibility. This was subsequently also used as a binding medium, mixed with ground cork and phenolic resin microballoons, to stabilize and fill (below level) larger cracks in the construction *(fig. 70)*.
In a few areas, detached profiles on the carved lacquer side were reattached with cattle hide glue[40] *(fig. 71)*.

[38] Plextol D 360: a very soft acrylic dispersion based on butyl acrylate and methyl methacrylate, with excellent aging properties and chemical stability.
[39] Plextol D 498: harder than Plextol D 360; an acrylic dispersion based on butyl acrylate and methyl methacrylate, with excellent aging properties and chemical stability.
[40] Cattle hide glue Topaz II, Tanex (CZ), bloom grade 223.

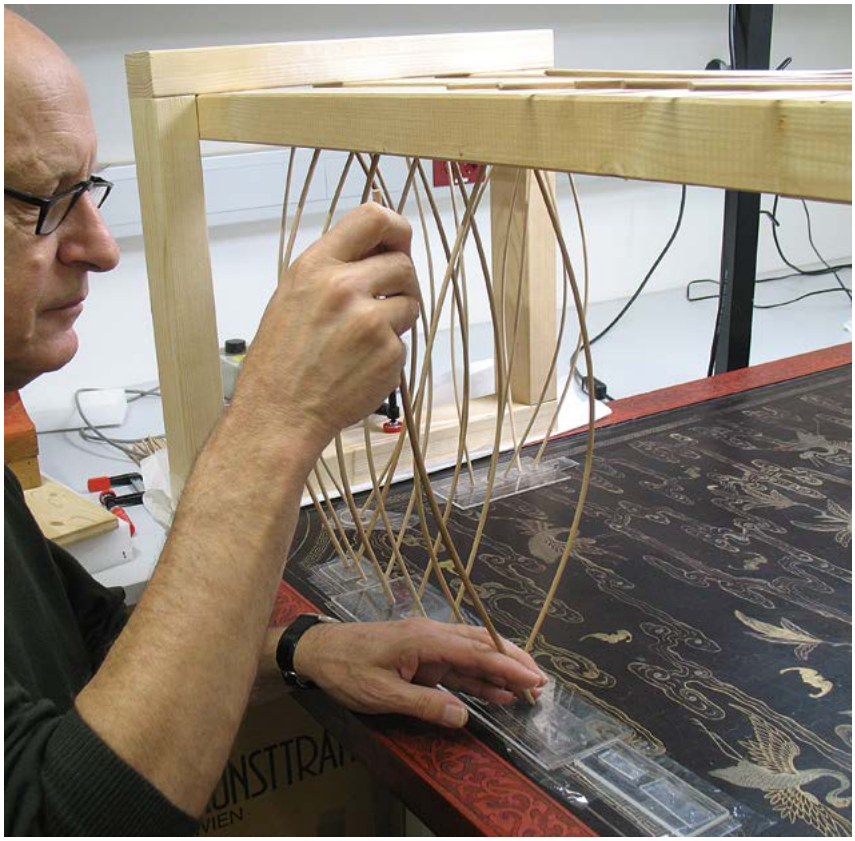


Fig. 69: To apply pressure on the lifting lacquer flakes, a *shinbari* frame with spanned beech dowels was used.

Fig. 70: Filling of larger gaps with ground cork and Plextol dispersion.

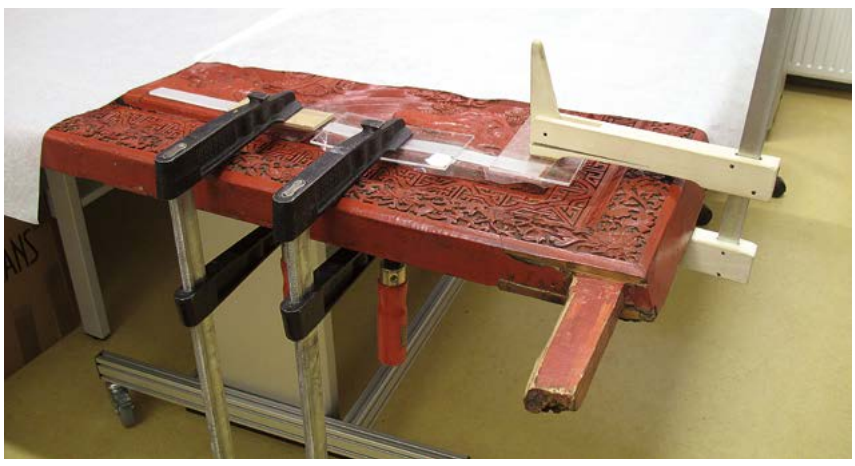


Fig. 71: Gluing of detached wood mouldings with cattle hide glue.

Fig. 72: Loss at the lower right corner of the base (compensation has already begun for the lower meander and brown layer, c.f. *fig. 24*).

Fig. 73: Compensation in the corner with red and brown pigmented microcrystalline wax.

5.4 LOSS COMPENSATION AND RETOUCHING

Very disturbing losses in the carved lacquer were filled with pigmented microcrystalline wax (TeCero 30222/TeCero 30201, 1:1).[41] For this, mixtures were prepared in six different red tones, pigmented with English red, iron oxide red, and ochre in various proportions. After the application of a Plextol separation layer on the lacquer surface or the gaps stabilized with Plextol and cork, the matching wax mixture was applied with a heated spatula, shaped with warmed bamboo skewers and carved and polished on cooling; cold working was sometimes also achieved using a cloth or cotton swabs moistened with petroleum spirits or acetone, with final polishing done using a dry cotton cloth *(figs. 72 and 73)*.

Losses in the brown ('yellow') lacquer of the patterned sky of the background were filled in a similar manner: After the removal of overpainting and old wax fills and consolidation of lifting lacquer layers with the above-mentioned Plextol mixture, the losses were filled with brown-pigmented wax (ochre, sienna, umber). The wax was warmed and kneaded with the hand and then pressed into the loss and formed with small bamboo and steel spatulas. Sometimes a final acrylic glaze (Golden Fluid Acrylics) was applied *(figs. 74 and 75)*.

Plextol inserts were applied to two large losses in the sky area. The carved pattern was cast from an intact area with kneadable silicon, a mixture of Plextol and phenolic resin microballoons and pigments (ochre and others) cast in the mould, and the positives thus produced were trimmed to fit the losses. Reversible attachment was achieved using Canadian fish glue; transitions and air bubbles were smoothed with a brown-pigmented wax mixture; final retouching was carried out with acrylics (Golden Fluid Acrylics) *(figs. 76 to 78)*.

[41] TeCero 30201 microcrystalline wax is obtained from heavy fractions of petroleum, solidification point 70–75°C, drop point 76–80°C, Tromm (acquired from Deffner & Johann, DE); TeCero 30222, microcrystalline wax, solidification point: 80–85°C, hard, good ability to be polished, gloss similar to lacquer.

Fig. 74: Loss to the carved lacquer pattern of the sky.

Fig. 75: Compensation of the missing carved lacquer with modelled, brown-pigmented wax.

Fig. 76: Large old fills with overpainting in the sky.

Fig. 77: Inserts made by moulding and casting with a Plextol mixture.

Fig. 78: Inserts adhered and further filled with wax, with retouching.

Fig. 79: Old wood insert, loss at the edge (reverse framing).

Fig. 80: Filling of losses at the edge with red pigmented wax, smoothing of the wood insert with acrylic spackle and retouching with acrylic paints.

Fig. 81: Old wood insert with old retouching.

Fig. 82: Retouching removed and adjustment of the wood insert.

Fig. 83: Retouching in acrylics.

Fig. 84: Compensation with microcrystalline wax, with *urushi* application on the right side.

Fig. 85: Compensation in wax with the hardened *urushi* coating (*suri-urushi*).

Losses to the edges and corners of the red frame on the reverse were likewise filled with red wax; losses to the surface, however, were closed with an acrylic spackle (Ecofiller[42]) and multiple layers of acrylic glazing (Golden Fluid Acrylics[43]). To match the surface gloss, the acrylic layers underwent intermediate and final polishing with Micro-Mesh 2400.
The black and yellow lines of the decoration were realized on both the wax and the acrylic fills with acrylic paints *(figs. 79 and 80)*.
Nearly all of the old wood fills had to be adjusted: Darkened old retouching was removed (usually with acetone), mismatched forms were levelled with a scalpel and sandpaper and filled with acrylic spackle if necessary; retouching was done with acrylic paints *(figs. 81 to 83)*.
Losses to the black lacquer on the reverse were filled with black-pigmented microcrystalline wax (ivory black, Indian red). After consolidation of loose areas, the application of the wax was done with a heated spatula, and the wax fills were then smoothed with bamboo and horn spatulas or with cork, cotton cloths, or petroleum spirits and finally dry polished to achieve the desired gloss.
The wax fills were partly isolated with raw lacquer (*ki-urushi*), and only thereafter was *urushigatame* performed on the entire surface. No problems were found with the adhesion or hardening of the *urushi* on the wax *(figs. 84 and 85)*.

42 Ecofiller water-based acrylic wood filler, Borma Wachs (available in wood colours from Neuber's Enkel, Vienna).

43 Golden Fluid Acrylics consist of an acrylic polymer binding medium and concentrated, high-quality pigments, with no fillers. They are lightfast, permanent, and flexible. Golden Fluid Acrylics have a low viscosity, which allows a smooth application while maintaining colour intensity.

Fig. 86: Application of linseed oil mordant over a wax fill.

Fig. 87: Reduced (blotted) application of the oil mordant.

Fig. 88: Dusting with gold powder (*aokin*, 'blue gold').

Fig. 89: Scratched gold decoration.

Fig. 90: Retouching with thinly applied and reduced oil mordant and dusting with gold powder (*kin*, 'pure' gold).

5.5 GOLD RETOUCHING

The bulk of the gold retouching was carried out imitating the original technique, however using the reversible and easier to use (with respect to humidity) 3-hour linseed oil mordant instead of Chinese lacquer.[44]
The abraded or missing decoration was applied in the unpigmented linseed oil mordant using a brush and carefully blotted; after a short drying time (5–10 minutes), gold (*keshifun kin* and *aokin*[45]), silver, or tin powder was dusted on with a dry brush. The metal powder adheres only on the areas predrawn with the mordant *(figs. 86 to 90)*.
Smaller losses could i.a. also be closed with pearlescent watercolours (Kremer[46]).

5.6 HARDWARE

All of the hardware described in section 4.8 is mounted with brass brads. The foot hardware was removed for cleaning and casting. Cleaning was done with fine brass brushes and more serious corrosion pustules were reduced with a scalpel. Green copper corrosion on the backs was reduced with radial brass brushes.
The missing metal hardware was cast using the spin casting process.[47] One left and one right original piece was cast and two casts produced of each respectively; one of each side was soldered together to form a corner bracket.

44 Oil mordant (mixtion) is a mordant for gold leaf and metal powder based on linseed oil; 3-hour mordant dries in about three hours, depending on the thickness of the application, ambient temperature, surface, etc.
45 Finest Japanese gold powder in different alloys: *kin*, gold (97.6%); *aokin*, 'blue gold' (80% gold, 20% silver). http://www.urushi-watanabe.net/en/index.html (last accessed: 15 October 2020).
46 Kremer watercolour palette for gold retouching.
47 Johannes Ghezzi, M.A., Teesdorf/Baden bei Wien.

Fig. 91: Top: two pieces of original hardware; below, two reproductions (untreated).

Fig. 92: Top: two pieces original hardware; lower right: polished reproduction; lower left: polished and gilded reproduction.

The casts were partly galvanically gold plated on the fronts, hand polished, and abraded with fine brass brushes to match the surfaces of the aged originals.
All of the hardware was remounted using the historic brass nails; missing nails were replaced and the nail heads partially galvanically gold plated.
In order that the screen not rest on the hardware and cause this to exert pressure on the lacquer layers immediately above, all feet were underlaid with 3 mm thick oak shims *(figs. 91 and 92)*.

Fig. 93: Assembly of the multi-part lacquer screen in the new, environmentally controlled showcase.

6. REDISPLAY IN THE WELTMUSEUM WIEN

Since the reopening of the Weltmuseum Wien in October 2017, the lacquer screen, in its own protective showcase, is again presented in the China Hall on the mezzanine. The freestanding case, constructed of steel with the imposing dimensions of 4 m (W) × 3.5 m (H) × 1.2 m (D), is equipped with two large Prosorb drawers to stabilize the environment of the interior and an additional air diffusion system (without a fan). The glazing is 8 mm, 2-layer laminated glass. The showcase can be opened by two large doors on the front. The illumination of the object is achieved with LED lights positioned outside of the case *(figs. 93 and 94)*.

Fig. 94: New presentation of the lacquer screen in the Weltmuseum Wien.

7. THANKS

The successful completion of this major project would not have been possible without the help of many colleagues. The authors extend their heartfelt thanks to all those employees of the Weltmuseum Wien and the KHM-Museumsverband who were involved, whether briefly or for longer periods, in the research and conservation of the screen. Our particular thanks also go to our external colleagues and advisors Julie Chang, Norbert Kirchner, Štěpánka Hrdličková Kučková, and Michael R. Schilling.

SUMMARY

The technical study and conservation treatment of the imperial Chinese carved lacquer screen from the Qianlong Period (1736–1796), created in the 1770s, was one of the largest projects undertaken as part of the reopening of the Weltmuseum Wien in 2017. Imposing and of great artistic value, the screen was removed in 1900 by Austrian troops during the so-called Boxer Rebellion from the imperial hunting park Nan hai-tze (Nanhaizi) near Beijing and transported via Pula to Vienna where – after its presentation in the Imperial and Royal Natural History Court Museum – it was continuously exhibited in the Museum of Ethnology from its opening in 1928 until 2004. The depiction, spanning all three panels of the screen, shows the mythical Pantao Feast, the birthday festivities of Xiwangmu, the Queen Mother of the West. The reverse, executed in gold lacquer and gold painting, also relates to this.

The cracks and losses in the carved lacquer were consolidated and secured with Plextol D 360 and Plextol D 498 (3:2), with the addition of ground cork and organic phenolic resin microballoons for large gaps. Lifting lacquer on the reverse was set down traditionally using *mugi-urushi*, for which a so-called *shimbari* construction was also frequently employed. The secondary colophony coating on the reverse was retained, as was the presumably historic protective layer containing ibota wax. The carved lacquer surface was cleaned with a mixture of deionised water and isopropanol; the reverse largely with petroleum spirits. Losses in the carved lacquer areas and on the reverse were filled with pigmented microcrystalline wax. For the final surface consolidation on the reverse, the *urushigatame* method, developed in Japan, was applied. Nearly all old wood inserts had to be adjusted, and old retouching and overpaint was removed. New gold retouching on the reverse was achieved using a linseed oil mordant and gold powder. Missing metal hardware was cast and gilded galvanically.

Protected in an environmentally controlled glass showcase, the restored lacquer screen has been a centrepiece in the redisplayed collection of the Weltmuseum Wien since autumn of 2017.

ZUSAMMENFASSUNG

Die Erforschung und Restaurierung des kaiserlichen chinesischen Schnitzlackstellschirms aus der Qianlong-Zeit (1736–1796), entstanden in den 1770er Jahren, war eines der größten Projekte im Zuge der Neueröffnung des Weltmuseums Wien im Jahr 2017. Der imposante und künstlerisch hochwertige Stellschirm war im Zuge des sogenannten »Boxeraufstands« 1900 von österreichischen Truppen aus dem kaiserlichen Jagdpark Nan hai-tze (Nanhaizi) bei Peking entwendet und über Pula nach Wien transportiert worden, wo er – nach seiner Präsentation im k. u. k. Naturhistorischen Hofmuseum – im Museum für Völkerkunde von dessen Eröffnung 1928 bis 2004 durchgehend ausgestellt war. Die alle drei Tafeln des Paravents übergreifende Darstellung zeigt das mythische Pan-Tao-Fest, die Geburtstagsfeier von Xi Wangmu, der Königinmutter des Westens. Auch die mit Schwarzlack und Goldbemalung ausgeführte Rückseite nimmt darauf Bezug.

In Vorbereitung der Restaurierung wurden sowohl Aufbau und Zusammensetzung aller Grundierungs- und Lackschichten als auch die textilen Fasern der Grundierung und die verwendeten Metallpartikel des Golddekors der Rückseite untersucht. Der schon historisch belegte senkrecht verlaufende Riss in der Mitteltafel sowie mehrere teils klaffende Schwundrisse hatten zu zahlreichen losen Stellen und Fehlstellen im Lack auf der Vorder- und Rückseite geführt.

Die Risse und Fehlstellen im Schnitzlack wurden mit Plextol D 360 und Plextol D 498 (3:2) gefestigt und gesichert, bei großen Fugen unter Zusatz von Korkgranulat und organischen Phenolharzkügelchen. Die auf der Rückseite aufstehenden Lackschollen wurden in traditioneller Weise mit *mugi-urushi* niedergelegt, wobei vielfach auch eine sogenannte *shimbari*-Konstruktion Verwendung fand. Der sekundäre Kolophoniumüberzug auf der Vorderseite wurde belassen, ebenso die vermutlich historische Pflegeschicht mit Ibotawachs. Die Schnitzlackoberfläche wurde mit einer Mischung aus deionisiertem Wasser und Isopropanol gereinigt; die Rückseiten großteils mit Siedegrenzbenzin. Alle Fehlstellen im Schnitzlackbereich und auch auf der Rückseite wurden mit pigmentiertem, mikrokristallinem Wachs gefüllt. Für die abschließende Oberflächenkonsolidierung der Rückseite wurde die in Japan entwickelte *urushigatame*-Methode angewendet. Fast alle alten Holzergänzungen mussten angepasst sowie alte Retuschen und Übermalungen entfernt werden. Neue Goldretuschen auf der Rückseite erfolgten mit Leinöl-Mixtion und Goldpulver. Fehlende Metallbeschläge wurden nachgegossen und galvanisch vergoldet.

Geschützt von einer klimatisierten Glasvitrine, stellt der restaurierte Lackschirm seit Herbst 2017 ein Prunkstück in der neuen Schausammlung des Weltmuseums Wien dar.

a

The Restoration of the Fortepiano by Nannette Streicher Opus 961, Vienna 1813 (SAM 844)

Ina Hoheisel and Alfons Huber

1. INTRODUCTION

The Collection of Historic Musical Instruments is not only world-famous for its exceptional cimelia of the Renaissance and early Baroque, it also chronicles, among other things, the history of Viennese piano production from its origins until the first half of the twentieth century on the basis of selected pieces. With the restoration of the fortepiano by Nannette Streicher *(fig. 1)*, built in 1813, a longstanding gap in the exhibition concept could be closed.

The restoration was supported by a generous donation from the TANA Trust, London, and by Saskia van der Wel and Fritz Heller.

2. WHO WAS NANNETTE STREICHER?

Nannette Streicher (1769–1833), born Anna Maria Stein in Augsburg, was the oldest of the four surviving children of Johann Andreas Stein (1728–1792), perhaps the most famous German piano builder of the Mozart period. Already early on, she worked in her father's workshop and there from a young age learned the craft of piano making. She was a talented pianist, and already as an eight-year-old played the Triple Concert of Wolfgang Amadé Mozart together with her father and the composer, when in 1777 the latter visited the Stein workshop in Augsburg on his journey to Paris. In 1794 she married Andreas Streicher (1761–1833), a childhood friend of Schiller, with whom she moved to Vienna in the same year, and here,

Figs. 1a and b: Fortepiano by Nannette Streicher, Vienna 1813, after restoration. Vienna, Kunsthistorisches Museum, Collection of Historic Musical Instruments, inv. no. SAM 844.

Fig. 2: Portrait of Nannette Streicher, anonymous. Vienna, Kunsthistorisches Museum, Collection of Historic Musical Instruments, inv. no. SAM 734.

The piano builder family Stein-Streicher

Johann Georg Andreas Stein 1728–1792	⚭	Maria Regina Burkhard1742–1800

4 children: Anna Maria, Matthäus Andreas, Johann Heinrich, Andreas Friedrich

Anna Maria Stein 1769–1833	⚭	Johann Andreas Streicher 1761–1833

2 children: Johann Baptist, Sophie

Johann Baptist Streicher 1796–1871	⚭ ⚭	1st marriage Auguste André 2nd marriage Friederike Müller

together with her seven-year-younger brother Matthäus Andreas Stein (1776–1842), founded a piano building workshop. The siblings separated in 1802, however. Around this time Nannette Streicher, in her early thirties, had already made a reputation in her trade and has since been considered the first female piano builder in history *(fig. 2)*. Ten years later, the firm exported on a grand scale to all lands of the monarchy, to Germany, and to Italy. Pianos of the same construction type as that presented here were also owned by Carl Maria von Weber (1786–1826) and Johann Wolfgang von Goethe (1749–1832). Nannette Streicher was befriended with Ludwig van Beethoven (1770–1827) and later saw to his household.
Her son Johann Baptist (1796–1871), who received a broad education and cosmopolitan upbringing, led the company to an international reputation that lasted until the mid-nineteenth century (see family tree above).

3. THE NANNETTE STREICHER PIANO

The fortepiano SAM 844 with the opus number 961 was donated to the Collection of Historic Musical Instruments in 1991 by the Bösendorfer company, which had previously possessed a small collection of historic keyboard instruments. The provenance before this period with Bösendorfer can unfortunately no longer be traced due to a lack of documentation. In the spring of 2013, on the occasion of the 200-year jubilee of its production, the restoration of the Nannette Streicher fortepiano was declared a focus project.[1]

[1] Through the unforeseen turbulence around the House of Austrian History, the completion of the extensive restoration project was delayed until 2017, however. Because of the renovation works in the Collection of Historic Musical Instruments, which were divided into two phases, the conservation report could only be submitted in 2019.

Fig. 3: Condition before treatment 2013.
a. Compression crack in the long wall.
b. Inhomogeneous appearance with corroded and broken strings.

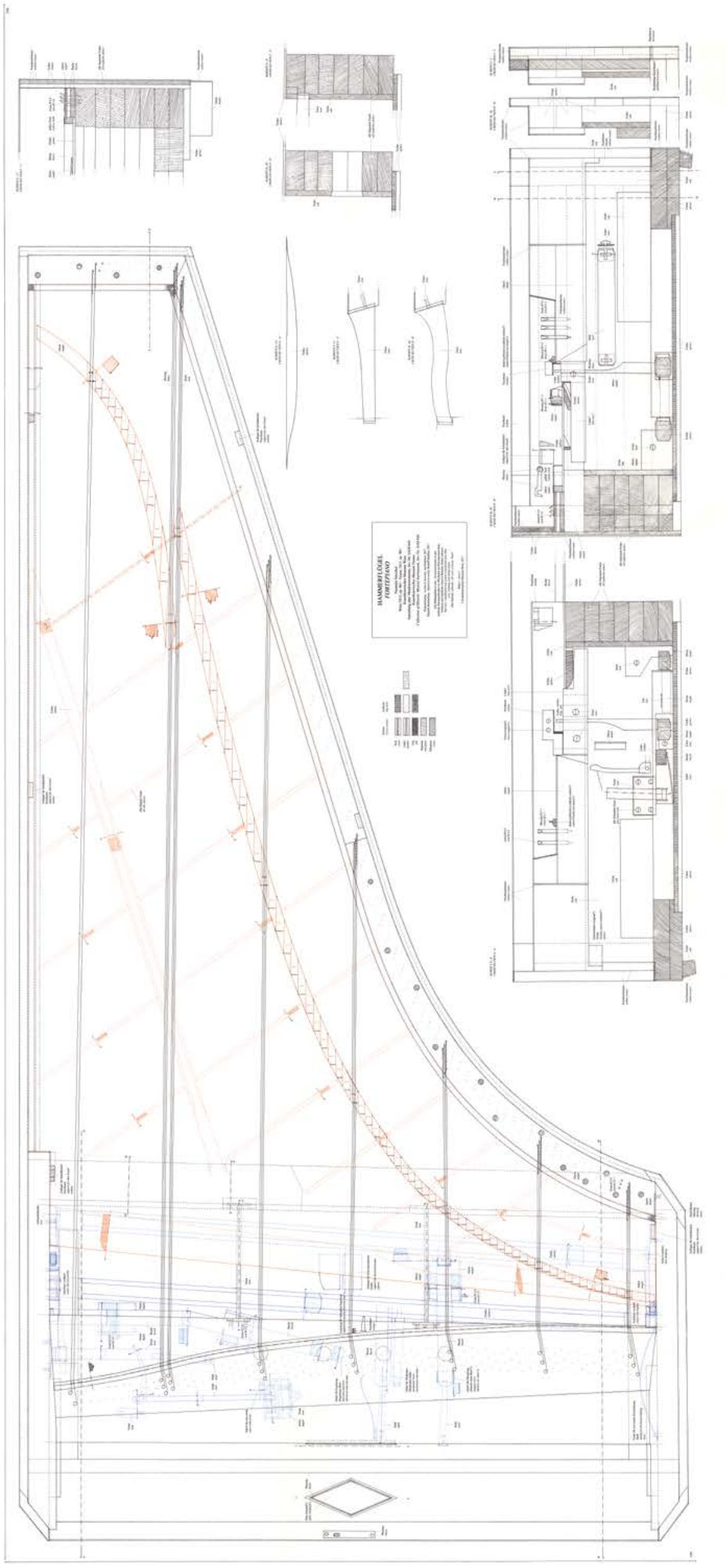
3.1 CONDITION BEFORE TREATMENT

In 2013, the instrument was in a badly damaged, partially altered and modified, unplayable state *(fig. 3)*. The goal of the conservation and restoration measures was only partially clear at the start, so that for documentation purposes and in-depth examination a technical, 1:1 hand drawing of the entire instrument was first made *(fig. 4)*.[2]

The resulting intensive engagement with the condition allowed the possibility of gradually formulating a restoration concept. The question of re-establishing playability at first remained open, however, as ca. 25% of the preserved string set consisted of historic but heavily corroded strings. Following a comprehensive measurement study and in comparison with preserved instruments from the same workshop, the historic string material was finally found to not be original, on the basis of its larger diameters and damage-related tension.

Ultimately, it was decided unanimously as a team to completely restore the fortepiano – with the goal of also being able to play it again. The primary arguments for this were the intact statics of the instrument, the string material assessed as not original, the renewed hammer leather, as well as two further, collection-specific reasons: As our didactics emphasize the history of Viennese piano production, but the display collection lacked a playable instrument from this prominent workshop, a sort of 'gap closing' was to be achieved through the project. Additionally, although the availability of financial resources was not tied to conditions from the sponsors, the recovery of playability nonetheless appeared desirable as a 'happy side effect'.

[2] This hand drawing can be acquired by instrument builders or restorers from the Image Reproduction Department of the Kunsthistorisches Museum.



Figs. 4a and b: Technical drawing.

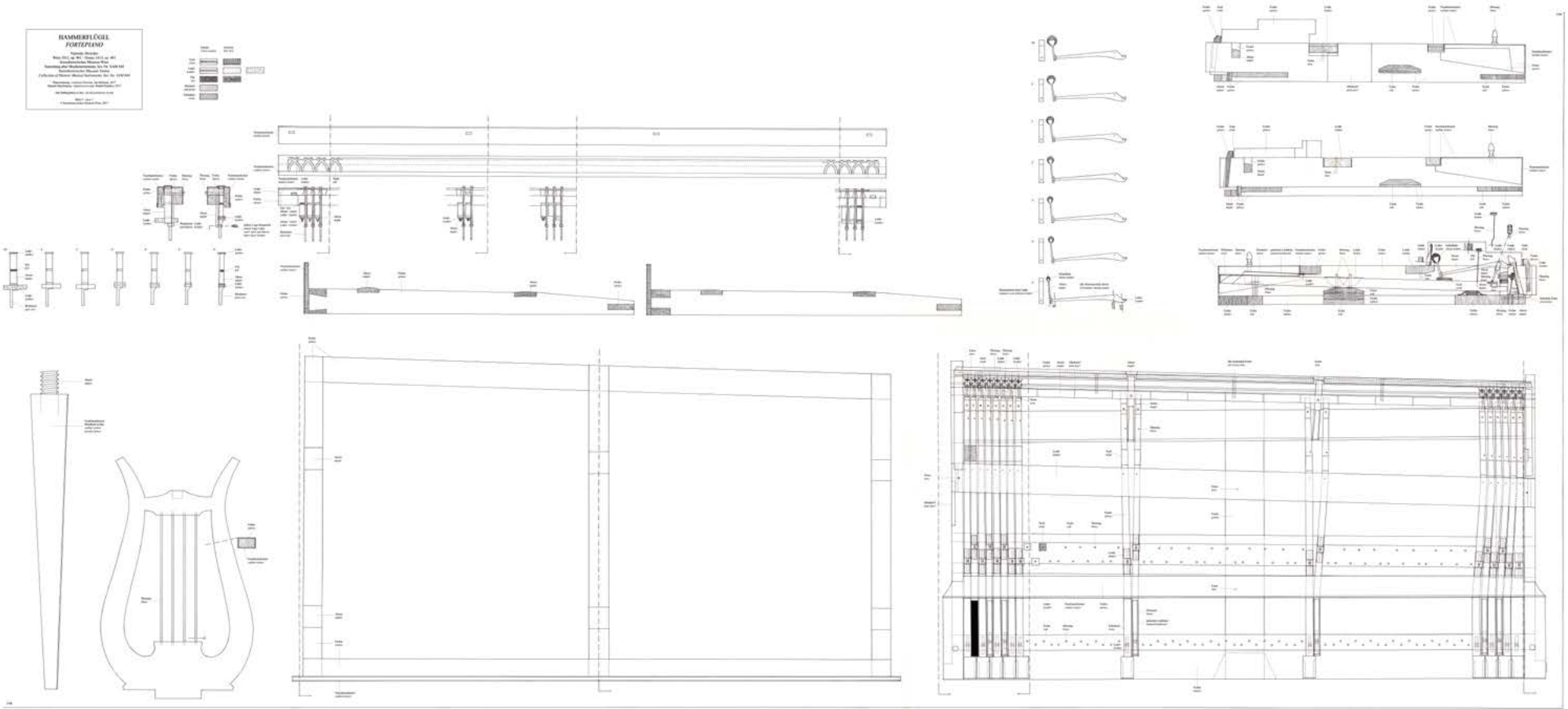

HAMMERFLÜGEL
FORTEPIANO

Fig. 5: Rebuilt pedal system (2nd half of the 19th century).
a. Original lyre on new pedal bar.
b. Traces of the original mounting of the lyre.

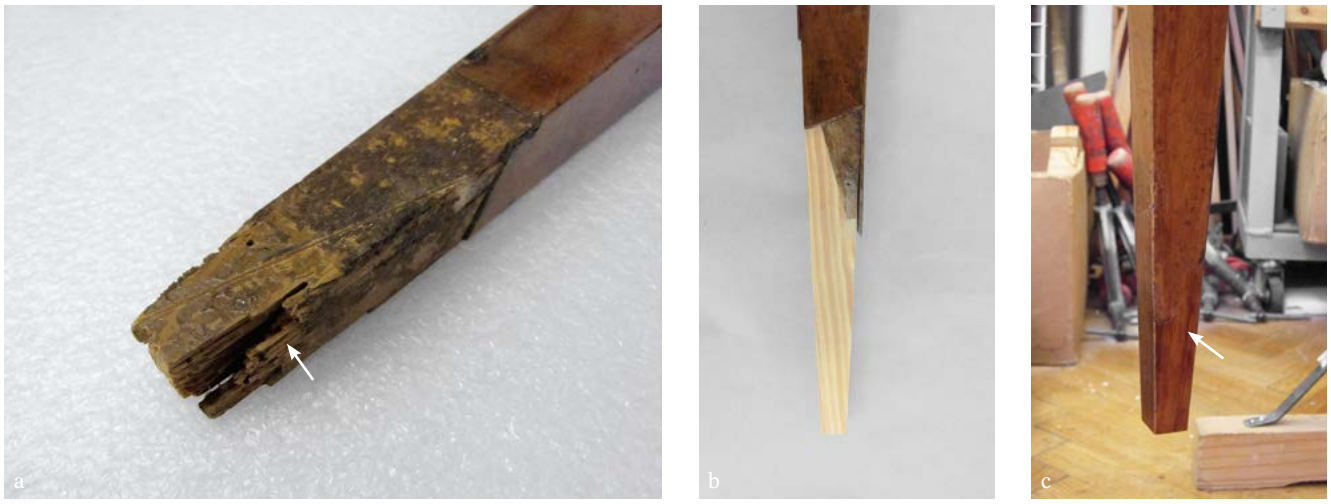


Fig. 6: Creating stability.
a. Leg damaged by furniture beetle activity.
b. Repair of the worm-damaged foot.
c. Veneer compensation with old veneer.

3.2 RECONSTRUCTION OF THE PEDAL SYSTEM

One of the at first glance most visibly disturbing changes lay in the alteration of the original pedal system, in which, likely in the second half of the nineteenth century, the original lyre was screwed to a new construction. The original wooden pedals were replaced by pedals of brass and screwed with a new mounting to the underside of the piano, where the traces of the original lyre attachment were still visible *(fig. 5)*.
Due to the fact that one leg was missing and two legs were damaged by furniture beetle activity, the piano could not be placed on its feet. That, however, was a prerequisite for the reconstruction of the pedal system, or rather of the length of the activating wires. As the wood core of one leg was crushed and broken away through insect holes, this had to be replaced with new wood. The visible surfaces were closed through loss-free compensation using old, already lacquered veneer, which proved advantageous as the

Fig. 7: Comparison instruments for the reconstruction of the pedal bridge.
a. Fortepiano Nannette Streicher, Vienna 1814. Stockholm, Swedish Museum of Performing Arts, inv. no. F332. (© Image by Sofi Sykfont, Swedish Museum of Performing Art. https://creativecommons.org/licenses/by-nc-sa/4.0/).
b. Fortepiano Nannette Streicher, Vienna 1819. Vienna Museum of Technology, inv. no. 15 276. (© Technisches Museum Wien.)

surface was aged and bore traces of use, and thus matched the overall appearance of the instrument *(fig. 6)*. The piano surely had a curved pedal bar originally. Two sibling instruments were found for comparison, in the Swedish Museum of Performing Arts in Stockholm from 1814 *(fig. 7a)* and the Vienna Museum of Technology from 1819 *(fig. 7b)*. Two facts are evident from these comparison instruments:

1. Within a company, there were (presumably always) multiple models with differences in features, pitch range, and price.
2. Our six-octave fortepiano op. 961 was obviously a proven standard model, which was still in demand almost unchanged six years later.

In June 2015, the instrument in Stockholm could be measured, a 1:1 scale sketch made, and a series of detail photos taken. However, the Stockholm instrument displayed a greater pitch range from CC to f^4 and is equipped with five pedals, whereas the Streicher piano SAM 844 was built from FF to f^4 and with only four pedals. The construction thus had to be adjusted. The connection points were plumbed from the case bottom to the drawing. This allowed the determination of the midpoint of the pedals, giving a distance of exactly 12 Viennese inches[3] between the first and the fourth midpoints.

[3] 1 Vienna foot (at 12 inches) = 316 mm.

Fig. 8: Damage to the soundboard.
a. Compression crack on the long wall.
b. Detached ribs.
c. Shrinkage cracks in the treble.

Fig. 9: Restoration of the soundboard, securing cracks with pieces of parchment.

On the basis of the adapted drawing, the core planks and cross pieces were cut, with the Stockholm instrument serving as a model for the dimensions and design. Matching the new connecting brace between the lyre and case bottom to the existing gluemarks revealed that the brace was not positioned exactly symmetrically to the middle axis of the instrument. In order to avoid the brace sitting crookedly on the lyre, whereby the pedal wires would not run parallel to the lyre 'strings', this was shifted slightly off of the middle axis and the pedals had to be secured slightly asymmetrically.
The veneering of the pedal bar likewise occurred using the detached veneer with its aged surface including traces of use. The reconstruction of all missing pieces was done following the Stockholm model, the feet and all of the brass decorations were oriented on the Streicher piano in the Vienna Museum of Technology. Moulding and casting of the brass appliqués was done by the metal restorer Martin Klobassa.

3.3 RESTORATION OF THE SOUNDBOARD

The soundboard displayed multiple shrinkage cracks, loose ribs, deformations, and a typical compression crack along the long wall, which was caused by excessive tension and the detached bass hitchpin rail *(fig. 8)*.
To allow the lasting repair of the damage, the soundboard was removed from the instrument, which thanks to the thinness of the glue layer was achieved within an hour aided by some ethanol and warmth.

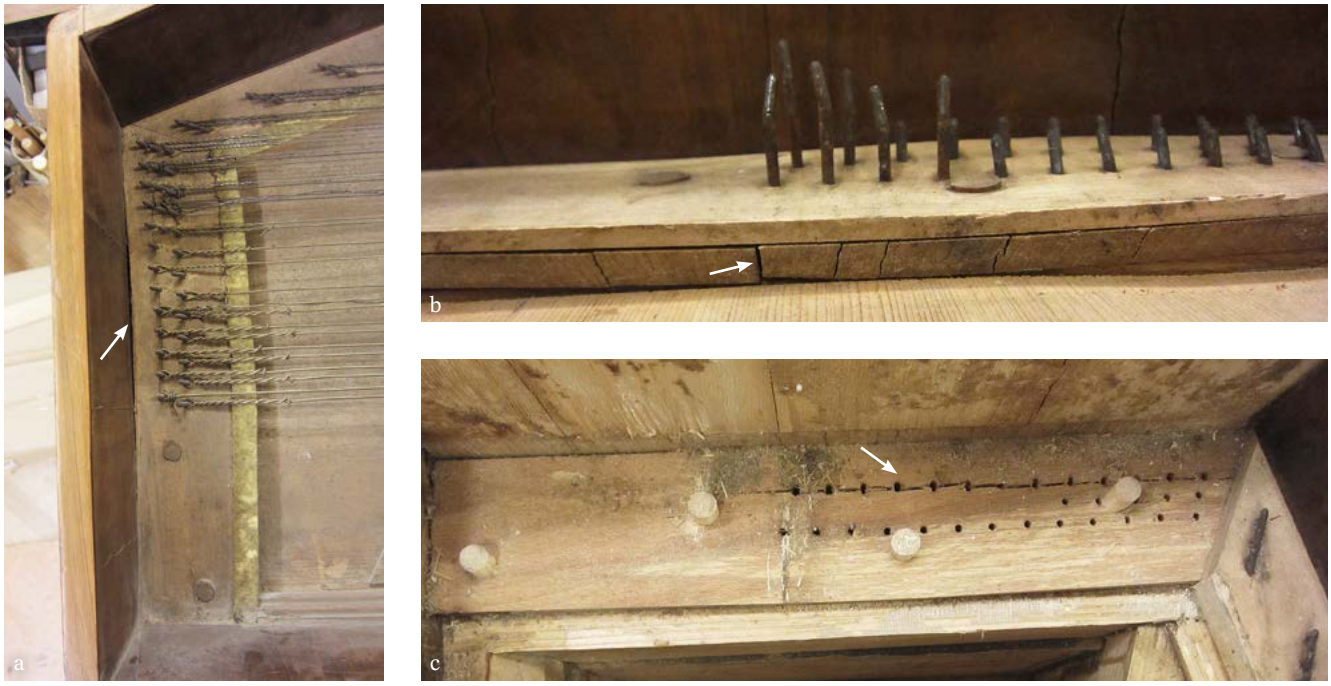


Fig. 10: Damage to the bass hitchpin rail.
a. Detached, deformed bass hitchpin rail.
b and c. The wood of the second and third layers is incorrectly oriented and cracked along the main cleavage direction.

A plywood sheet was prepared with holes cut for the bridges to be able to lay the soundboard upside down. The ribs – if the adhesion had not already failed in the past – were 2/3 detached to relax the soundboard. Through underlaying the outer edges of the soundboard with strips of fabric and placing warm sandbags on the distorted areas, a return to plane could be achieved. Further, all open cracks were repaired and the considerable shrinkage compensated for through the insertion of strips of new soundboard wood in the treble area. The long crack along the long wall was glued in stages.
After the reduction of deformations to the soundboard and gluing of all ribs to the pre-dried soundboard, the joins and crack edges were secured from the bottom with small pieces of pre-dried parchment *(fig. 9)*, before the soundboard was glued back into the instrument.

3.4 RESTORATION OF THE BASS HITCHPIN RAIL

Through the later restringing of the instrument with strings that were much too strong – this will be discussed later in more detail – a tension of around 6,000 N (equivalent to about 600 kg) bore on the bass hitchpin rail alone. This hence detached from the back wall and distorted. On the hitchpin rail, constructed in three layers, the layers had separated, which due to the inauspicious wood choice in its creation were multiply cracked and thus no longer functional *(fig. 10)*.

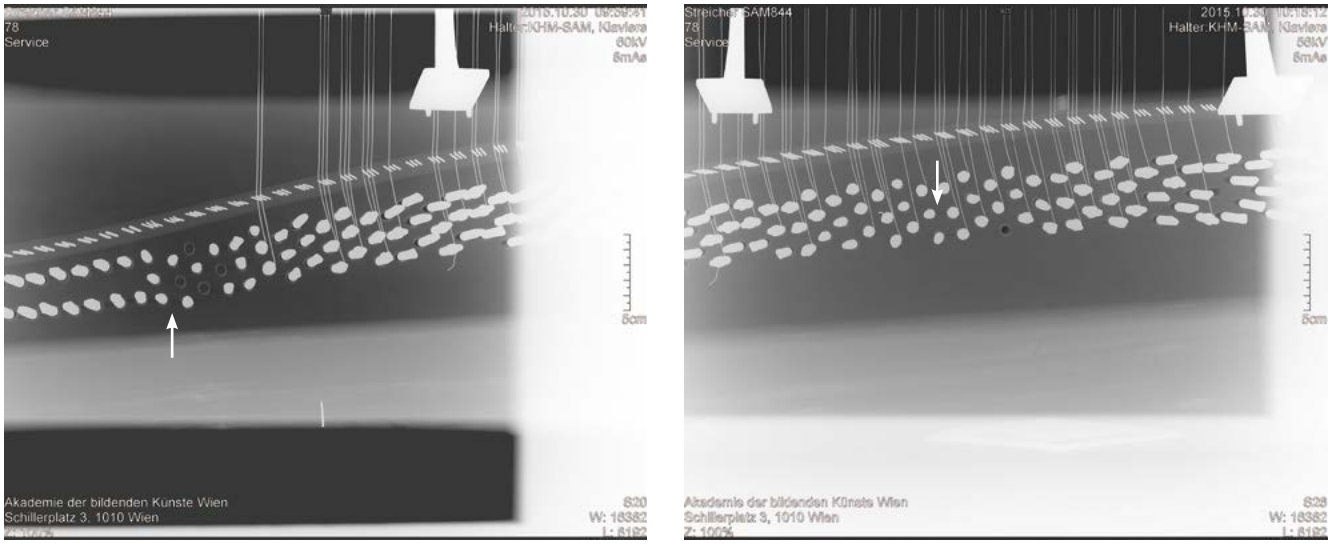


Fig. 11: X-radiographs of the wrest plank identified a crack. (Photo: Manfred Schreiner, Academy of Fine Arts Vienna.)

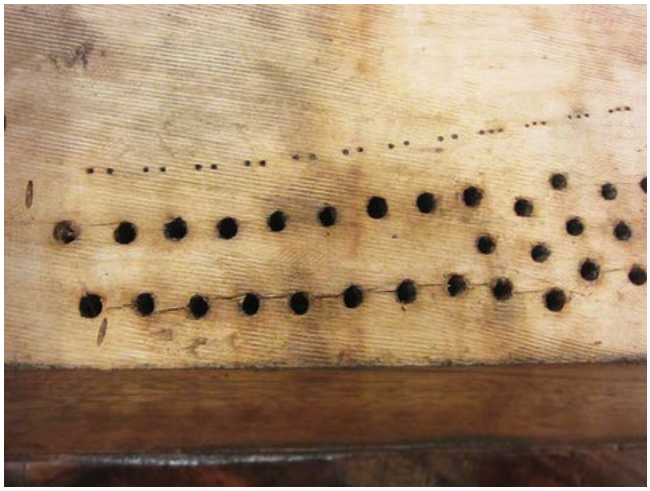


Fig. 12: The extent of the wrest plank crack was revealed on removal of the veneer.

As for layers 2 and 3, the main split direction of the wood lay parallel to the plate pins – which caused the present crack formation and would have resulted in further cracks – it was decided, against usual museum conventions, to replace these two layers for static reasons. With the removal of deformations and adhesion of the upper layer, the original appearance was preserved.

3.5 RESTORATION OF THE WREST PLANK

Although there was initially no strong suspicion of a crack in the wrest plank for the Streicher piano, it was prophylactically decided to have an x-radiograph of the critical component made. Manfred Schreiner of the Academy of Fine Arts Vienna was commissioned to do this *in situ*. It was thus revealed that the wrest plank showed cracks of varying widths in multiple places. As to be expected the bass area, where the highest tensile forces occur, was most effected *(fig. 11)*.

Fig. 13a: Introduction of synthetic resin.

Fig. 13b: Securing the crack with fiberglass fleece.

Following the diploma thesis by Markus Brosig,[4] which already seven years before had provided orientation in the restoration of the fortepiano by Johann Schantz, where the method discussed therein could be successfully realized,[5] the decision was made unanimously with the collection curators to also repair the cracks with Araldite® epoxy resin in this case. After removal of the wrest plank bridge, the covering veneer could be removed with a minimum of damage using damp sponge cloths and an infrared heater, upon which the suspicion of a compound crack in the wrest plank was confirmed *(fig. 12)*.

Before gluing, dowels were inserted into the pinholes to prevent their filling with epoxy resin. Altogether, only 5 ml Araldite® was introduced into the wrest plank *(fig. 13a)*. Due to good prior experience, the pin block was next secured with a fibreglass fleece *(fig. 13b)*. After a test on a mock-up, the fleece was adhered using bone glue to the pin block, with the warp and weft threads placed at a 45° angle to the cracks to increase stability. Earlier experiments showed that the highest possible pressure is decisive for adhesion. A 10 mm thick prewarmed acrylic sheet proved a good interlayer. Through swelling the pieces of veneer facing, these could finally be precisely glued into their old locations before the dowels in the pinholes were drilled open.

4 Markus Brosig, *Restaurierung von Stimmstockrissen an flügelförmig besaiteten Tasteninstrumenten*, in: Friedemann Hellwig (ed.), *Studien zur Erhaltung von Musikinstrumenten. Teil 2: Besaitete Tasteninstrumente, Orgeln* (Kölner Beiträge zur Restaurierung und Konservierung von Kunst und Kulturgut, vol. 17), Munich 2006, 9–89.

5 Ina Hoheisel – Alfons Huber, *Ein Hammerflügel, der Joseph Haydn hoffentlich Freude gemacht hätte*, in: Restauratorenblätter 29, 2010, 179–186.

Fig. 14: Restoration of the action.
a. Necessity of replacing eleven non-original hammer shanks.
b. Comparison of original (below) and non-original (above) hammer shanks.
c. Hammer shank reconstructed after the original.
d. Comparison of original underlying leather and non-original playing leather.

3.6 ACTION

Eleven non-original hammer shanks, which differed from the originals in form and material, had to be replaced in the mechanism *(figs. 14a and b)*. The new hammer shanks were reconstructed following the original model *(fig. 14c)* and acoustically tuned to the neighbouring hammers through plucking and thinning, following the method discovered by Paul McNulty.[6] The extant inhomogeneous intoning leather, that is, the uppermost leather layer on the hammerheads, obviously derived from later repairs on the basis of its appearance, thickness, tanning method, and quality of application (*fig. 14d*). In the search for the optimal striking points, it was revealed that multiple hammers became stuck on the front edge of the wrest plank due to the excessive thickness of the renewed leather in the descant. To solve this problem, it was decided to remove the non-original leather and attach a thin vegetable-tanned leather from the same animal (sheep) as a so-called 'sacrificial layer' to protect the original core leather. The adjustment and regulation of the mechanism alone – parallel to the breaking-in phase – required several weeks.

[6] Paul McNulty, *Shaping Hammer Shanks by Ear – A Common Practice*, in: Beatrix Darmstädter – Ina Hoheisel (eds.), *Unisonus. Musikinstrumente erforschen, bewahren, sammeln,* Vienna 2014, 600–604.

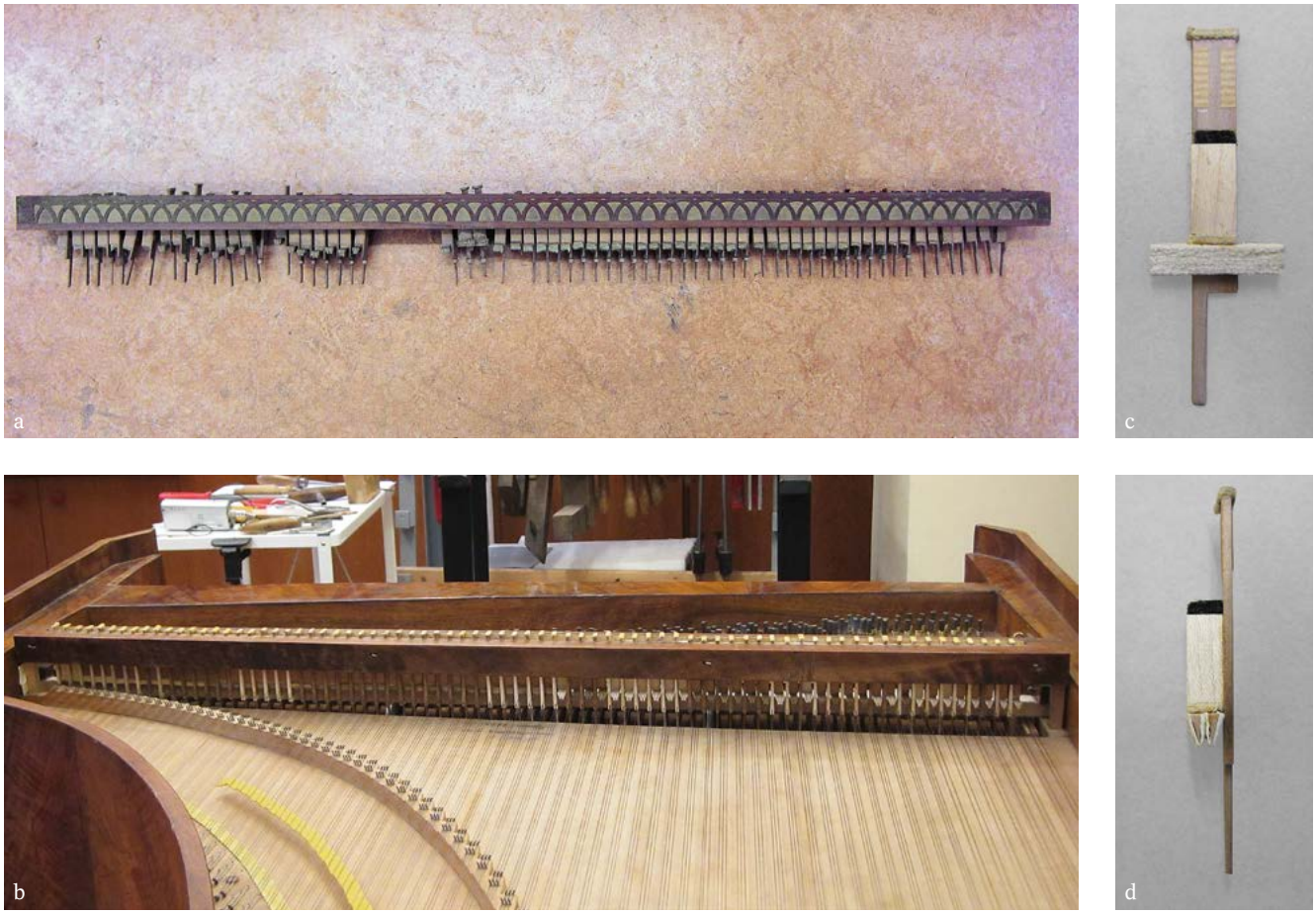


Fig. 15: Restoration of the damper.
a. Condition before treatment.
b. Replacement of missing pieces.
c and d. Reconstructed wedge-shaped damper.

3.7 RESTORATION OF THE DAMPER

The damper action showed serious mechanical damages *(fig. 15a)*. Numerous damper guiding rods and lost dampers had to be reconstructed, and finally the entire damper action in the instrument reconfigured *(figs. 15b to d)*.

3.8 STRINGING

The sound of a piano is the result of a very complex vibration system – consisting of the mass and elasticity of the soundboard, the mass and striking dynamics of the hammers, and not least the mass, tension, elasticity, and capacity of the strings – that is, a system with at least eight variables, in part unknown parameters, among them also the intended pitch. Precisely in consideration of the rapid development in piano construction in this period, it was first not excluded that some original stringing remained within the extant, very inhomogeneous set of strings. The extant stringing was thus first reconstructed by interpolation and the tension calculated. With brass bass strings of 1.25 mm and steel strings up to 0.49 mm in the treble (this corresponds approximately to the period around 1830), the result was a total string tension of around 34,000 N, corresponding to an equivalent of ca. 3,400 kp. Comparison with other,

in part somewhat earlier Streicher pianos with original strings and string numbers and an almost identically constructed instrument from 1819, which likewise displayed original string numbers, revealed that, versus the presumed original strain of ca. 2,260 kp-equivalent, the later stringing lay around 12,000 N or 1.2 tons higher – a convincing explanation for the described damage. The tension of the string set finally chosen, somewhat thinner especially in the tenor and bass (with 0.90 mm brass strings in the bass and 0.36 mm iron strings in the treble) lays, at a pitch of a^1 = 435 Hz, about 7% deeper than the original strain. The conservational 'trick' of exploiting the sound potential of the instrument with lower strain lies in choosing thinner strings but achieving the full capacity of the strings through the selection of an adequate pitch.
The missing bassoon stop was reconstructed using a soft, old handmade paper and toned thin raw silk, following the original model in the Vienna Museum of Technology. The same was done for the moderator bar with the fabric strips that on activation of the pedal could be slid between the hammerheads and the strings to modulate the tone toward the piano *(fig. 16)*.

3.9 SURFACE OF THE REAR WALL

The veneer of the long wall had severe mechanical damage and showed numerous deep scratches, dents, and injuries to the lacquer. The different character of the veneer, differences in the colour of the lacquer, and a different wood structure of the marquetry suggested that the veneer in the last third of the long wall had been replaced *(fig. 17a)*. The appearance of the replacement indicated a coating containing cellulose nitrate. Investigation under UV illumination confirmed this assumption through the observation of differing fluorescence at the interface of the two veneer types *(fig. 17b)*. As the differences in colour were very disturbing, the colour of the repaired surface was matched to the original.
After cleaning the entire surface of the instrument, a mixture of methoxy-2-propanol and tung oil was prepared and the colour matched to the original lacquer using Orasol® dyes. With the help of a fine grit sanding paper, the non-original surface was polished with the addition of this mixture. The long-chain alcohol allows a retarded dissolution of the lacquer, while the oil could penetrate thanks to the slight sanding, resulting in an increase in saturation. The damages to the original veneer could be retouched using Orasol® dyes dissolved in shellac. A more uniform appearance of the long side could thus be realized *(fig. 18)*.

Fig. 16: Completion of the bassoon stop and moderator ('bassoon' = vibration strip of paper and silk; the moderator is made of cloth strips).

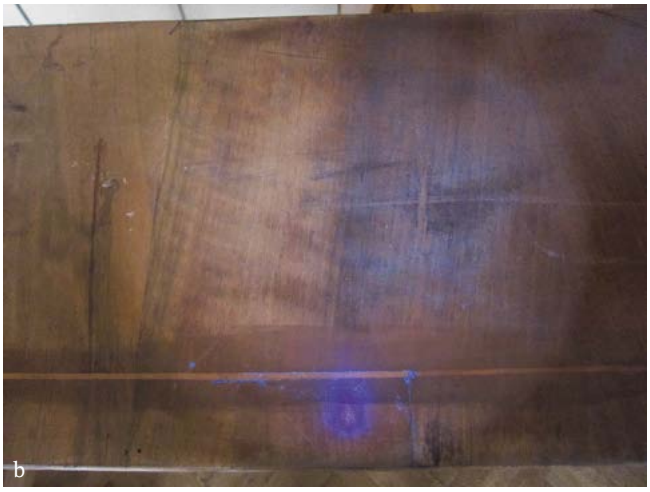


Fig. 17: Condition of the rear wall before treatment.
a. Non-original veneer with recent lacquer.
b. Differing fluorescence at the interface seen under UV light.

Fig. 18: Surface of the rear wall after retouching.

Fig. 19: Surface of the lid.
a. Condition before treatment with remains of the original lacquer.
b and c. Intermediate stage during removal of the overpaint.

3.10 SURFACE OF THE LID

The exterior of the lid had been carelessly overpainted at a later date with a dark brown lacquer, presumably pigmented with soot. The coating was so unaesthetic that at no point was there doubt about removing it rather than leaving it as an 'organic condition' *(fig. 19)*. As the original lacquer was previously sanded off except for a small area, there was no concern about removing the black layer with solvents, which was easily achieved using a mixture of ethanol and acetone. To match the exposed veneer surface to the appearance of the adjacent original surfaces, a ground of toned modified linseed oil varnish was applied, and finally a mixed polish based on a contemporary recipe[7] was put on with a pad.

3.11 FACSIMILE OF THE NAMEPLATE

As the original nameplate over the keyboard was either replaced by a sheet of matte glass or the original ink signature had been effaced *(figs. 20a and b)*, the decision was made to attach a reproduction plate to this prominent place. This was adjusted from the model in the Vienna Museum of Technology using Photoshop *(fig. 20c)* and – printed in reverse on a transparency – laid reversed on the glass in the original frame so that the lettering on the back of the transparency would be properly legible. The facsimile is indicated through a small dated annotation *(fig. 20d)*.

7 Mixed polish of 150 g lemon shellac, 80 g purified sandarac, 50 g gum elemi dissolved in 1 L ethanol and filtered. From: Jean-Paul Coutrait, *Trucs et procédés du bois*, Paris 1993, 254.

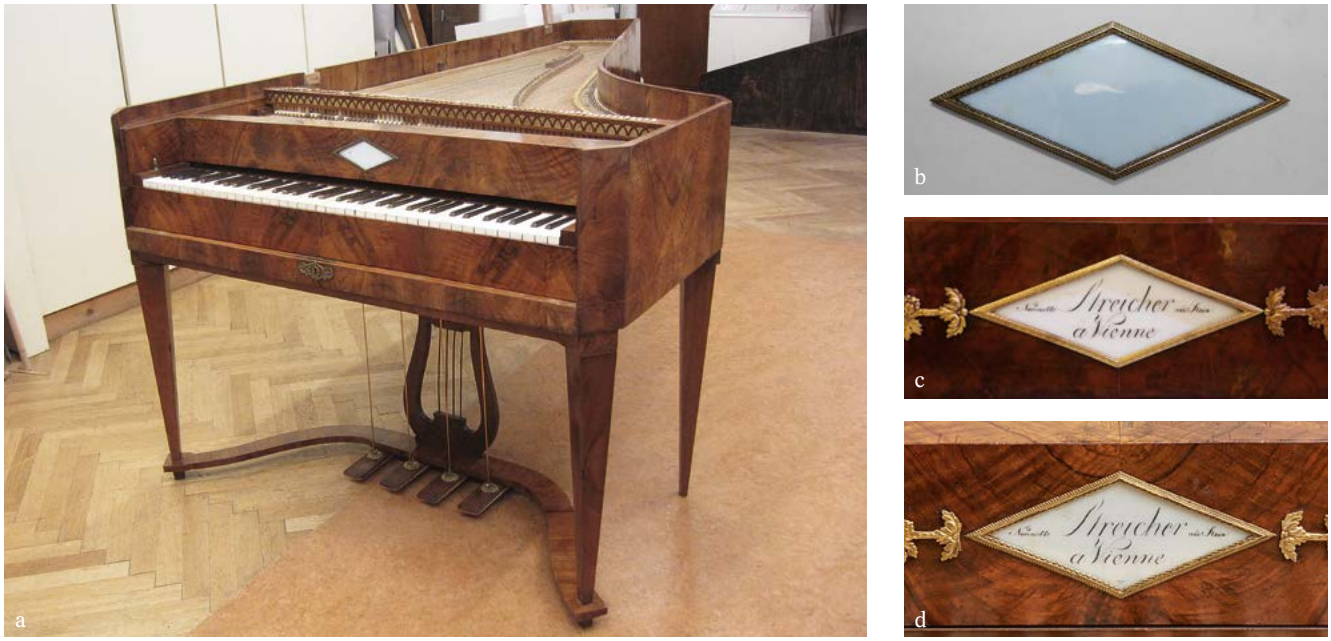


Fig. 20: Facsimile of the nameplate.
a. Condition before treatment.
b. Matte glass without signature.
c. Original plate, Streicher piano, Vienna Museum of Technology. (© Michael Kirchweger.)
d. Signature facsimile on the old matte glass. (Photo: Rudolf Hopfner.)

3.12 RECONSTRUCTION OF THE SECOND SOUNDBOARD

A characteristic component of Viennese pianos of the Biedermeier period after ca. 1810 is the so-called *Schalldeckel* (second soundboard). This regulates the sound balance between the treble and bass ranges, especially when playing with the main lid open. The development in the course of the nineteenth century toward ever greater volumes, however, led to its removal from many older instruments – as on our Streicher piano. The second soundboard was reproduced following the model in the Vienna Museum of Technology.

4. THANKS

In conclusion, it is emphasized that all of these complex and in part contradictory circumstances were discussed amongst the entire collection team and decisions made unanimously. Our thanks go to all our colleagues who helped us in word and deed and material.
Not least, since September 2016 many musician friends made their time available during the adjustment phase. This feedback played a decisive role in the development of the sound potential of the finished instrument *(fig. 21)*. The pianist Birgit Streicher, additionally a direct descendent of the builder, gave us the most time.

Fig. 21: Condition after treatment with reconstructed pedal system and soundboard.

5. MATERIALS USED

Acetone: Neubers Enkel, 1060 Vienna
Araldite® AY 103/ HY 951 (Bodo Möller Chemie): produced by CIBA Geigy
Watercolours (Schmincke): Otto Kummer Artists' Materials, 1070 Vienna
Ethanol: Neubers Enkel, 1060 Vienna
Fibreglass textile (fibre composites): Composit Technology
Skin and bone glue: Beck, Koller & Fischer, 1010 Vienna
Natural resins: Kremer-Pigmente, D-88317 Aichstetten
Intonation leather: Maximilian Hauser, 1020 Vienna
Linseed oil: Kremer-Pigmente, D-88317 Aichstetten
Methyl cellulose: Kremer-Pigmente, D-88317 Aichstetten
Orasol® dyes: Kremer-Pigmente, D-88317 Aichstetten
Strings: Marc Vogel, D-79795 Jestetten
Shellac: Kremer-Pigmente, D-88317 Aichstetten
Petroleum benzine 100–140°C: Kremer-Pigmente, D-88317 Aichstetten
Turpentine: Kremer-Pigmente, D-88317 Aichstetten
Wishup (dry cleaning sponge – Akemi): Deffner & Johann, D-97520 Röthlein
(All other materials from respective specialist stores or from the holdings of the Conservation Department of the Collection of Historic Musical Instruments).

SUMMARY

On the occasion of the 200th anniversary of its production year in 2013, the fortepiano op. 961 (inv. no. SAM 844) by the famous and first female piano maker Nannette Streicher, part of the Collection of Historic Musical Instruments (*Sammlung alter Musikinstrumente*) of the Kunsthistorisches Museum Vienna, was selected as the collection's main conservation project. At that time, the instrument was highly damaged, partially altered and rebuilt, and in unplayable condition.

Before defining the aim of the project, a hand drawn 1:1 engineering detail drawing of the whole instrument was made for documentation purposes. The time consuming close examination of the instrument's existing state allowed the goals of the conservation to be developed gradually.

The question of playability remained unanswered, since 25% of the preserved strings appeared to be contemporary with the piece. After a detailed analysis of the scaling and stringing and comparison with period instruments from the same workshop, it became clear that not only was the present heavy stringing not original, it was also responsible for the serious damage to the wrest plank, hitchpin rail, and soundboard. The suspicion of a cracked wrest plank was confirmed by x-ray examination.

After weighing the pros and cons, the whole collection team decided by mutual agreement to realize a complete restoration including playability.

The entire project took about four years. The main steps of the process are presented, including the reconstruction of the pedal rail; the restoration of the wrestplank, hitchpin rail, soundboard, and the action; and the treatment of the surface. Reflections on the scaling and an invisible method to restore a cracked wrestplank while preserving the historic material [Brosig, 2006] are also discussed.

The project was funded by the TANA Trust London, Saskia van der Wel, and Fritz Heller.

ZUSAMMENFASSUNG

Im Frühjahr 2013, anlässlich des 200-Jahr-Jubiläums seiner Herstellung, wurde die Restaurierung des Hammerflügels (op.-Nr. 961; Inv.-Nr. SAM 844) von Nannette Streicher, der ersten Klaviermacherin der Geschichte, zum Schwerpunktprojekt der Sammlung alter Musikinstrumente des Kunsthistorischen Museums Wien erklärt. Zu diesem Zeitpunkt befand sich das Instrument in einem stark beschädigten, teils veränderten und umgebauten, unspielbaren Zustand.

Zu Beginn war das Ziel der konservatorischen und restauratorischen Maßnahmen nur teilweise klar, so dass zu Dokumentationszwecken und zu einer vertiefenden Befundung zunächst eine technische 1:1-Handzeichnung des gesamten Instruments angefertigt wurde. Die damit verbundene intensive Auseinandersetzung mit dem Bestand eröffnete die Möglichkeit, schrittweise ein Restaurierungskonzept zu formulieren.

Jedoch blieb die Frage nach der Wiederherstellung der Spielbarkeit zunächst offen, da ca. 25 % des erhaltenen Saitenbezugs aus historischen, jedoch stark korrodierten Saiten bestand. Nach einer umfangreichen Mensuranalyse und im Vergleich mit erhaltenen Instrumenten der gleichen Werkstatt wurde das überlieferte Saitenmaterial jedoch letztlich aufgrund der größeren Durchmesser und schadensrelevanten Zugkräfte, die zu erheblichen Beschädigungen des Stimmstocks, des Anhangs und des Resonanzbodens führten, als nicht original eingeschätzt. Der Verdacht auf einen vorliegenden Stimmstockriss konnte durch eine Röntgenuntersuchung bestätigt werden.

Schlussendlich wurde vom wissenschaftlichen Team der Sammlung einvernehmlich entschieden, den Hammerflügel komplett zu restaurieren – mit dem Ziel, ihn auch wieder spielen zu können.

Im vorliegenden Beitrag werden die wesentlichen Punkte des vierjährigen Restaurierprojekts vorgestellt, wie die Rekonstruktion des Pedalstegs, die Restaurierung des Stimmstocks, des Anhangs, des Resonanzbodens und der Mechanik sowie die Regenerierung und Behandlung der Oberfläche. Überlegungen zur Mensurierung sowie eine unsichtbare, materialschonende Methode zur Klebung gerissener Stimmstöcke werden ebenfalls besprochen und diskutiert.

Das Projekt wurde mit einer großzügigen Spende durch den TANA Trust London sowie Saskia van der Wel und Fritz Heller unterstützt.

Authors

Francesca Del Torre Scheuch
Studied art history at the Ca' Foscari University, Venice. Researcher at the Museo Civico Treviso and the Prints and Drawings Cabinet of the Biblioteca Correr, Venice. Curatorial Assistant at the Museo Archeologico Provinciale in Torcello (Venice). Research assistant to the management of the Istituto di Storia dell'Arte, Fondazione Giorgio Cini, Venice. From 2003, researcher for exhibition projects at the Picture Gallery, Kunsthistorisches Museum; member of a research project on paintings by the Bassano family in the Picture Gallery of the Kunsthistorisches Museum. From 2011, curator for Italian painting before 1600, Picture Gallery, Kunsthistorisches Museum.

Elfriede Haslauer
Studied Egyptology and classical archaeology in Vienna. Participated in Austrian excavations at Tell el-Daba and Asasif/Upper Egypt, 1968–1976. From 1971 to 1976, appointed assistant at the University of Vienna, Institute for Egyptology excavation in Egypt. From 1976, research staff member in the Egyptian and Near Eastern Collection of the Kunsthistorisches Museum, and its director from 2004 to 2006.

Ina Hoheisel
Studied conservation at the University of Applied Sciences, Erfurt, 2003–2008, with a thesis project at the Collection of Historic Musical Instruments, Kunsthistorisches Museum, advised by Alfons Huber. Remote study of *Protection of European Cultural Heritage* at the European University Viadrina in Frankfurt/Oder from 2009 to 2011, culminating in an M.A. Since 2009, conservator at the Collection of Historic Musical Instruments; likewise from 2019, adjunct lecturer in the main artistic subjects (*Zentrales Künstlerisches Fach, ZKF*) at the Academy of Fine Arts Vienna.

Ingrid Hopfner
Studied from 1985 to 1990 in the master class for restoration and conservation at the Academy of Fine Arts Vienna under Prof. Helmut Kortan and Prof. Gerald Kaspar. Employed since 1990 in the Paintings Conservation department of the Picture Gallery, Kunsthistorisches Museum Vienna with a focus on the conservation of panel paintings. From 1991 to 1994, adjunct lecturer at the Academy of Fine Arts Vienna; from 2005 to 2007, thesis advisor at the University of Applied Arts Vienna. 2011–2017, participation in the Bruegel Project of the Kunsthistorisches Museum, *The panels by Pieter Bruegel the Elder at the Kunsthistorisches Museum, Vienna: Technical Study and Survey of their Structural Condition*, supported by the Getty Foundation in the context of the *Panel Paintings Initiative*.

Alfons Huber
Completed studies at the Academy of Fine Arts Vienna (1981) followed by work in private practice; from 1983 to 2019, conservator in the Collection of Historic Musical Instruments, Kunsthistorisches Museum. Habilitation (qualification as lecturer) at the Academy of Fine Arts, 1996. Numerous publications on the conservation–restoration of musical instruments, organology, and questions of preventive conservation and climate stabilization in museums. Reconstruction of historical string keyboard instruments. Dissertation (Museum Ecosystem / *Ökosystem Museum*) at the Academy of Fine Arts Vienna in 2012.

Christiane Jordan
Studied art conservation from 1999 to 2005 at the Academy of Fine Arts Vienna and Queen's University, Canada. Thesis in 2005 in the conservation of ethnographic objects. Conservator of organic objects at the Weltmuseum Wien since 2005; from 2020, project coordination for construction and installation projects in the KHM-Museumsverband. From 2009, adjunct lecturer at the Academy of Fine Arts Vienna.

Richard Miklin
Studied German literature and history at the University of Vienna. Lecturer in German literature at the Nihon University, Tokyo, from 1988 to 1990; thereafter freelance author in Vienna. Since the 1990s also associate in the conservation practice of Silvia Miklin-Kniefacz. In this context, research on provenance, history, and art historical aspects of conservation objects, including the *Vieux-laque* room and the two Chinese cabinets in Schönbrunn Palace.

Silvia Miklin-Kniefacz
Studied objects conservation (specializing in metal objects) at the University of Applied Arts Vienna, in the master class of Prof. Hubert Dietrich, followed by postgraduate lectureship for the master class (1982–1988). Study of the technique and conservation of *urushi* lacquer and *kintsugi* from 1988 to 1990 at the TNRICP (Tokyo National Research Institute for Cultural Properties, with Nakasato Toshikatsu), Japan. Conservator in private practice since 1990.

Sabine Stanek
Completed studies in technical chemistry at the Vienna University of Technology in 2001 with a thesis in the field of archaeometry; thereafter lecturer at the Institute for Natural Sciences and Technology in Art at the Academy of Fine Arts Vienna. Employed as a conservation scientist in the Conservation Science Department, Kunsthistorisches Museum, from 2002; specialization in investigations addressing questions relating to paintings, materials, production techniques, and preventive conservation.

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