ICOM-CC
18th Triennial Conference
2017 Copenhagen

SCULPTURE, POLYCHROMY, AND ARCHITECTURAL DECORATIONS

Visual and technical study of the Kumla altar (ca. 1439), Swedish History Museum, Stockholm

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KEYWORDS: conservation education, medieval altarpiece, Lübeck, material investigations, public outreach

ABSTRACT

An investigation of the Kumla altar at the Swedish History Museum was undertaken during a collaborative project between conservation education programmes from three Nordic universities. Students from Conservation Studies, University of Oslo examined the materials and techniques used in the altar's paintings to contribute to discussions of changes to this complex object. Analyses and treatments performed within an open gallery encouraged interactions with the public. Comparisons with later analyses of paint cross sections indicated that the materials and their uses are similar to those found in the limited number of contemporary Lübeck objects that have been analysed to date. However, earlier assessments of Lübeck workshop practices are being revised in ongoing research, to which this study is an important contribution.

INTRODUCTION

Conservation of the late-medieval altarpiece from Kumla church at Närke, in south-central Sweden, was the focal point of a cooperative project between three Nordic programmes for conservation education in spring 2015. This project engaged students and their lecturers from Helsinki Metropolia University of Applied Sciences, the University of Oslo and the University of Gothenburg. In addition to the examination and treatment of the altarpiece, the project had two key objectives: to deepen cooperation between Nordic education programmes and to develop innovative practices for public engagement. To achieve the latter, the work was carried out in a temporary studio set up in a museum gallery (Figure 1). Daily blog entries produced during the project made the project accessible by a wider public (see http://kumlaaltar.tumblr.com/).

Students of painting and furniture conservation cooperated for two months, working in small groups and under supervision for two weeks at a time. During practical work, the altarpiece was disassembled to allow for the removal of wax as well as its consolidation, cleaning and retouching. This presented a unique opportunity for the students from Oslo to investigate the painting techniques. The collected data contribute to discussions of

Figure 1. The conservation of the Kumla altar took place in a museum gallery where students could engage visitors (image: Kumla Altar Blog, http://kumlaaltar.tumblr.com)

the materials and methods commonly used in Lübeck for high-quality church commissions during the first half of the 15th century. While this paper mainly focuses on the original materials and the appearance of the altarpiece, it also addresses public engagement, which was essential to the success of the project.

THE ALTARPIECE

The Kumla altar is a double-winged polyptych with sculptures and painted wings that can be set in three different viewing positions (Figures 2–4). A painted scene of the Annunciation is visible when the altar is closed. The first set of wings open to reveal eight scenes from the Passion of Christ. Behind the second set of wings are ten polychrome sculptures, representing the Coronation of the Virgin with Christ, flanked by sculptures of eight saints. When open, the altarpiece measures 358.0 × 203.5 cm. There is also a predella, which shows Christ with the twelve apostles.

The Kumla altar has been dated to 1439–40 based on parish accounts (Rydbeck 1975, 159) and it has been consistently attributed to a workshop in the Hanseatic hub of Lübeck, which was an important centre for artistic production. After its export to Sweden, the altarpiece survived more than

Figure 2. The Annunciation is visible when the altar is fully closed (image © Gabriel Hildebrand, Historiska museet, Stockholm)

Figure 3. Eight scenes from the Passion of Christ are visible when the outer wings are open (image © Gabriel Hildebrand, Historiska museet, Stockholm)

Figure 4. The altarpiece in its open position, with St Gertrud, St Olav, St Petrus, St Eskil, The Virgin, Christ, St Torkel (a local saint), St Paul, St Erik and St Birgitta (image © Gabriel Hildebrand, Historiska museet, Stockholm)

400 winters in the Kumla church, until the late 19th century when it became part of the collection of the Swedish History Museum. It had been restored at least once before 2015, when remedial conservation treatments again were needed to consolidate flaking ground layers, paint and gilding.

METHODS

An aim of the project was to study the ways in which the original materials were manipulated, with the broader goal of obtaining a deeper understanding of both the object itself and the state of painting practices in Lübeck ca. 1440. Visual characterisation of the object, especially the paint, was aided by portable USB-microscopy (60×; 225×) and portable x-ray fluorescence (pXRF). [1] The 13 samples taken from the paint and gilding were embedded as cross sections and studied under an optical microscope, using normal and ultraviolet light (50×–400×).[2] Scanning electron microscopy with energy dispersive x-ray spectroscopy (SEM/EDX) was performed as well.[3]

RESULTS AND DISCUSSION

Wooden constructions

The straight grain of the oak panels and the house marks on the back side of the corpus indicate a Baltic provenance. In the 15th century, wainscot from the Baltic region was preferred and exported to many cities in northern Europe, including Lübeck (Haneca et al. 2005, 262). Guild regulations also dictated the mandatory use of oak for all church art (Zunftrollen Lübeck 1864, 298).

The back panel of the corpus consists of seven boards, while the four wings have three each. The boards were joined together and glued before being integrated into wooden frameworks. The additional use of dowels will have to be confirmed using x-ray, which was not available at the time of this study. The framework around the painted panels is shallower than the frameworks surrounding the saint sculptures, with painted wooden traceries providing polygonal canopies above each sculpture.

The saints were carved roughly, probably with an axe, from half sections of oak trunks and then refined with chisels to further elaborate the forms. The backsides were hollowed out, which was standard practice to reduce the likelihood of splitting. At the top of each sculpture, head holes were drilled and pegs inserted to allow for easier handling and rotation while the sculptures were attached to an adjustable workbench (Truyer and Seymour 2013). Except for the hands and attributes, which were separately attached with dowels, each of the sculptures was for the most part carved from one piece of oak. Several of the attached elements have, however, been lost.

Preparation layers

The wood was probably glue-sized to make the surface less absorbent in preparations for application of the ground layers. Canvas strips bridged the panel joins to produce a continuous smooth surface and to reinforce the ground (Skaug 2008, 23). The latter consists of chalk bound in glue, which was applied pragmatically to some elements, but not others, and was prepared differently for subsequent layers depending on their location.

Figure 5. Discoloured copper-green glaze on tarnished silver leaf (image: Conservation Studies, University of Oslo)

Figure 6. Well-preserved copper-green glaze over silver leaf, showing black lines that create the shape of the ceiling (image: Conservation Studies, University of Oslo)

For example, no ground was applied to the traceries. The ungilded areas of the back walls in the wing boxes were left with a rough texture and evident drips behind the sculptures, while the back wall of the corpus was sanded and polished even in areas not covered by gilding. A final pink (priming?) layer of chalk mixed with red iron oxide was applied only to the corpus in sectors behind the sculptures and presumably under the gilding. The function of this colour remains unclear, as these pink areas were no longer visible after the sculptures had been installed.

On the corpus and wings, incisions outline the shapes of sculptures in the gilded background, which ensured that the gilding was applied only to visible areas. Incisions in the ground layers were made in gilded areas, and when the use of wet/dry mediums was impractical. Infrared reflectography was not available at the time of our investigation and thus underdrawings in the painted panels were not assessed.

Metal work, tooling and glazing

Burnished gold leaf was used in the background in the paintings and behind the sculptures. The leaf was applied over a red iron oxide preparation layer, after which the metal was burnished. The dimensions of the gold leaf were reported by Tångeberg to be 93 mm^2, which in that author's opinion was larger than average (Tångeberg 1986, 229). Halos behind the sculptures and features in the background in the paintings were partially incised and partially punched, resulting in detailed decorative effects.

Distinct passages with either gold or silver leaf were identified in halos on the paintings as well as in clothing details and architectural elements. Analysis with pXRF indicated that the armour was formed of silver leaf, which was probably covered with a glaze that has since worn away in some places, where the silver has oxidised. While this was confirmed in the analysis of a cross section from one sample of armour by SEM/EDX; the strongest signal of the elements analysed by this technique using a sample of another piece of armour was zinc. It might be that this sample, from a fragmented surface, lacks the silver leaf from the surrounding area, or that zinc was a component in a past conservation treatment. While it is possible that the metal contains zinc, at present this cannot be confirmed. Furthermore, because no preparation layer was observed underneath the metal in either of these two cross sections, it is clear that the gilding here was applied directly onto the ground (ground gilding).

Various glazes and scumbles originally created rich decorative effects. On the rib vaults in the scene of *The Trial*, the copper-green-glazed silver is now heavily discoloured (Figure 5). However, something closer to the original vibrancy can be viewed on the vaults in the scene of *The Flagellation*, as well as in details on clothing, where the copper-green-glazed silver is much better preserved (Figure 6). Again, no bole or preparatory layer can be seen under the metal.

On the red framework, stencils of metal leaf in the shape of flowers were applied either with a very thin mordant (not detected in available cross sections) or directly onto the sticky glaze before it had dried (Figure 7). The flowers alternate between what is thought to be gold- and yellow-glazed silver. The latter is now tarnished. However, SEM/EDX of a cross section confirmed that the glazed flowers were created with a yellow-glazed part-gold or *Zwischgold* (thin silver and gold sheets beaten together).

Paint underlayers

Most cross sections of samples from painted areas without gilding show an underlayer made of lead white, often mixed with orange-red particles of red lead. The function of this layer was most likely to fix underdrawings, but since the red-orange particles also were applied under blue and green passages, the layer may have had an optical function as well.

Paint

The palette was limited to the typical colours available to painters working in Northern Europe in the 15th century (Table 1). However, with this limited palette, painters achieved considerable variation in hues and tones through wet-in-wet blending, which enhanced the illusion of volume in the figures, draperies and architectural forms. In general, paint was applied in layers from dark to light. Mid-tones were created in flesh-tones by leaving a base-tone exposed. Clothes were painted with long brushstrokes in different shades that follow the shapes of the draperies. Diluted black paint was used to indicate the deepest shadows, while viscous white paint was applied in broad brushstrokes for the highlights. Hair was painted with curved lines in uniform thickness and colours, to indicate strands of hair, over a uniform base colour. Semi-translucent contours in black and brown paint delineate parts of the figures in relatively broad brushstrokes, and thinner contours outline the features of the faces. The overall appearance is rather stylised, with broad contours and generic modelling, but the variations mentioned point towards an extensive knowledge of the oil medium and how to prepare it for different purposes.

For the sake of brevity, data from pXRF and SEM/EDX are summarised according to colour in Table 1, but since it is the green and red passages that are the most significantly altered, these are further discussed in the following.

Green

Green glazes and opaque greens were used in clothing, vegetation and architectural elements. In these, copper was detected overall with pXRF and SEM/EDX. The copper-based glaze applied on the now-tarnished silver leaf is heavily degraded (Figure 5). Now brown and clouded, the silver no longer reflects through the glaze, meaning that the current appearance of these areas is considerably duller than originally intended. By contrast, the opaque copper-green-containing passages are much better preserved, containing lead-tin yellow and possibly also green earth. In a cross section of an opaque green drapery, particles of iron, along with silicon, aluminium, magnesium and potassium, were detected by SEM/EDX. Among other pigments, this suggests the presence of green earth. The relatively thick application of yellow-green paint in double layers might explain the retention of the vibrant green colour. Further investigations will focus

Figure 7. Frame (inner wings) with a faded red glaze over red lead (image: Conservation Studies, University of Oslo)

Table 1. Portable XRF and SEM/EDX results

Colour	Area	Elements detected by XRF	Elements detected by SEM/EDX	Possible interpretation
Violet	Headscarf of St Anne	Fe, Pb, Ca		Iron-containing pigment, like hematite, mixed with lead white.
	Sample 5 Greyish-violet tone, Christ's garment	Cu, Pb, Ca, Fe, Sr	Pb, Al, Cu, Ca, Mn, Fe, Zn, Cl, K, Si, Na, S	At least two layers of azurite mixed with lead white and an organic red lake. The absence of phosphorous in the red lake suggests that the glaze originated from a plant source, like madder. The blue colour consists of one lighter and one darker shade. All elements associated with lapis lazuli (aluminium, sodium, silicon, sulfur) are present, though they seem not to be associated with the blue particles based on elemental mapping (SEM/EDX). Bright orange particles of red lead are present in the underlayer, along with lead white. Ground layers consist of chalk.[1]
	Sample 11 Violet-glazed silver leaf on Olav's dragon		Ca, Al, Ag, Cl, K, Na, Si, S, Pb, Zn, Fe, Mg	Silver leaf applied directly onto the ground layer (no bole).
Blue	Tunic of man present in *The Trial*	Cu, Pb, Ca, Fe		Azurite mixed with lead white.
	Sample 4 Virgin's blue garment	Cu, Pb, Se, Sr	Cu, Si, Pb, Ca, Na, Al, Cl, K, S	Azurite over an organic red lake mixed with lead white. See interpretation for Sample 5. In addition, two yellow underlayers consist of lead white/lead-tin yellow with bright orange particles of red lead.
Yellow	Man's hat in *The Crucifixion*	Pb, Sn		Lead-tin yellow
	Sample 9 Angel's cross		Pb, Ca, Sn, Al, K, Na, Cl, Si, Fe, Mg, P	Lead-tin yellow on top of a thin layer of lead white. Based on elemental mapping, the iron is evenly dispersed throughout the area and in a very small amount.
Orange	Brocade of judge in *The Trial*	Pb, Ca, Cu, Zn, Sr,		Possibly red lead mixed with lead-tin yellow. The source of the copper content is unclear.
Green	**Sample 12** Green drapery, the Angel Gabriel		Ca, Pb, Cu, Sn, Si, Zn, K, Al, Cl	Four colour-layered structure: azurite over a copper green glaze, which were laid over a red glaze, over lead-tin yellow mixed with lead white. A lead-white underlayer, mixed with red lead.
	Deep green, on tree	Pb, Cu, Ca, Fe, Zn, S, Cl		Copper green, probably mixed with carbon black and/or an ochre colour.
	Sample 2 Midtone, yellow-green garment	Cu, Pb, Fe, Sn	Ca, Pb, Al* Cu, Si, Zn, Fe, Cl, K, Mg, Br, Sn	Two layers of copper green mixed with lead-tin yellow, over a lead-white underlayer with large particles of red lead. All the elements associated with green earths earth (potassium, aluminium, iron, manganese, silicon) were identified. The source of bromine is unclear.
	Sample 10 Dark grey-green, Gabriel's wing	Pb, Cu, Se, Fe, Zn, Sr, Cd	Ca, Pb, Al*, Cu, Si, Cl, Zn, S, K, Fe	Fragmentary greenish-grey: azurite with lead white over an organic red lake. The source of cadmium is unclear.
	Green glaze over metal leaf	Ca, Cu, Ag, Fe, Zn, Sr, Rh		Copper-green glaze on silver leaf.
Red	Red ground behind sculptures	Ca, Fe, Si		Probably an iron-containing red pigment.
	Faded red frame	Pb, Ca, Fe, Cu		Degraded red glaze over red lead. Source of iron and copper is unclear.
	Sample 13 Red shadow on Gabriel's sleeve		Ca, Pb, Al*, Cl, K, Na, Si, Zn?, S?, Fe, Mg?, P?	Red glaze over red lead, possibly mixed with an iron-containing red pigment.
	Sample 3 Mid-tone, pink-red garment	Pb, Hg, As, Sr, Ni	Pb, S, Ca, Hg, Al*, Zn, Si, Mg, K, Fe	Vermilion mixed with red lead over lead white with bright orange particles of red lead.
	Faded border around Gabriel, outer wing	Pb, Ca, Cu, Fe		Red lead with a degraded red glaze. The source of the copper and iron content is unclear, while calcium probably relates to the ground layers.
Black	**Sample 6** Black, originally under gilded metal flower ornament		Pb, Al*, Cl, Ca, Si, Zn, K, Na, Fe, P?, Si	Black over an orange-red layer of red lead mixed with an iron-containing red pigment. The underlayer is lead white mixed with red lead.
Grey	Greyish-violet tone on tunic	Cu, Pb, Ca, Fe, Sr		Lead white mixed with a black pigment. Source of copper is probably azurite, while source of iron is unclear
Silver	**Sample 1** Armour	Ca, Ag, Zn, Sr, Fe, Sb, Zr	Ca, Zn, Na, Si, Al*, Mg, Al, Cl, K, Au	No silver was detected by SEM/EDX. Inconclusive.
	Sample 7 Armour	Ca, Ag , Pb, Cu, Sr	Cl, Al*, Fe, Na, S, P, Ag, Mg, Si, Cl, K	Silver leaf applied directly onto the chalk ground. The silver is oxidised probably because a glaze has worn away in places.
Zwischgold	**Sample 8** Golden stencil, large flower	Pb, Au, Ag, Fe, Zn	Ca, Pb, Al, Cl, Ag, S, K, S, Na, Si, Au, Zn, Ge, Mg, P, Mn	Part-gold applied onto the red glaze (while tacky?), over red lead.
Gold	Gilding, background behind sculptures	Ca, Au, Fe, Sr		Gold leaf over iron-oxide preparation layer

[1] This applies to all measured areas

* Aluminium was detected by SEM/EDX in all samples, including the embedding material. Al is marked with a star (*) when Al is most likely present in the sample itself due to higher concentrations in certain areas.

Figure 8. Well-preserved glaze over vermilion; punch-marks on the halo are seen (image: Conservation Studies, University of Oslo)

on establishing the precise nature of the green pigment(s), the preparation methods and the binding medium.

Red

The painters of the images and wooden frames used a full range of reds in all their variety: red lakes, vermilion, red lead and red iron oxide. With these, they could produce sophisticated nuances in clothing, architectural elements and on the decorative frames. Predictably, some reds (both glazes and opaque passages) are well preserved while others are less so. The absence of phosphorus in some red glazes on the paintings suggests a plant-based lake, like from madder root (Kirby et al. 2005). However, the red glaze on the frames contains phosphorus, which is associated with red lake originating from an insect. Given the known date of the altar, cochineal is unlikely, but the results remain inconclusive.

Where organic red was applied over a mixture of vermilion and red lead, the glaze remains intense and well preserved (Figure 8). Red glazes over red lead, particularly on the frames, have faded to a pale-yellow tone (Figure 7). This is most likely related to UV exposure (Saunders and Kirby 1994, 83, 93) in combination with high relative humidity (RH). In this case, the altarpiece was exposed to sunlight from windows at the sides and back, and to the high RH in the church. As the fading of red lead under damp conditions (RH > 75%) has been well documented (Saunders et al. 2002, 461), this would explain why the frames of the outer wings and portions of the outer-wing paintings have faded significantly, in contrast to the better-preserved interior surfaces. The doors would have been closed during large periods of the liturgical year, opened only on feast days, which naturally protected these parts from environmental degradation. Differences in layering and levels of finish on the interior and exterior might have contributed as well.

CONTEXT

The Kumla altar offers a fascinating window onto practices that seem to have been common for the production of high-quality church objects at the time. Given that there is a documented provenance for the Kumla altar, various parts of this complex object can be related to other securely dated objects produced in Lübeck. However, there are relatively few technical studies aimed at comparing these findings broadly with others of direct relevance. The Schleswig-Holstein catalogues for Lübeck and the St. Annen museum have started to fill this gap, by providing access to limited technical information (Albrecht 2009; 2012), and in time so will research connected to objects that have long been attributed to Lübeck workshops that are now in Norway (Pawel 2015; Streeton 2016). In short, this study of the Kumla altar is an important contribution to the body of research that aims to revise earlier assessments of Lübeck workshop practices.

Communication

Several platforms were used to raise awareness of the Kumla project (Kumla Altar Project 2017). Radio interviews and newspaper articles were essential for public outreach and to attract visitors to the museum. Facebook and a blog were used to communicate with interested individuals, while the open atelier enabled students to engage museum visitors in conversations about the work. The atelier approach was even more efficient when visitors were met by assigned students and encouraged to ask questions, allowing the rest of the group to focus on the practical work. The interactions allowed visitors to become more familiar with conservation, regardless of their level of existing knowledge. Feedback was positive, although there were some visitors who avoided the working station. The diverse visitor groups included several young individuals who encountered conservation for the first time, which is a reminder that communicating conservation to young audiences facilitates greater visibility for the profession in the long term.

CONCLUSION

Given its age and history, parts of the altarpiece are in an exceptional state of preservation. However, the current appearance of the object as a whole is far from the original, which requires some interpretation for the general public. Findings related to the degradation of pigments, especially those that have discoloured (namely copper greens and reds), will be included in educational materials available in the gallery where the altarpiece is on display. They will also be reported on the Kumla Altar Project webpages. The project offered motivational training opportunities for treatment, material research and public outreach for those involved, and thus a distinct advantage for conservators at the start of professional careers. The material research continued after the student authors completed the Conservation Studies programme, which helped to maintain collaboration between newly educated conservators and experienced conservation professionals. The success of the collaborative study might be seen as a model for other educational programmes.

ACKNOWLEDGEMENTS

Special thanks to Tannar Ruuben at Helsinki Metropolia University of Applied Sciences and to Håkan Lindberg at Historiska Museum, Stockholm for initiating and coordinating the project and gaining funding. The authors are grateful to Calin Constantin Steindal (Saving Oseberg Project, Museum of Cultural History, University of Oslo); Duncan Slarke, Francesco Caruso, Tine Frøysaker, Margrethe Rudjord and Christine Løvdal (Conservation Studies, Department of Archaeology, Conservation and History, University of Oslo); and Aura Colliander and Laura Karoniemi (Metropolia University).

NOTES

[1] Portable Thermo Scientific Niton XL3-t Goldd+ equipped with an Ag anode target x-ray tube (6–50 kV, 0–200 µA) and a geometrically optimised large area drift detector. Measurements were carried out in mining mode.

[2] Leica DM LM, equipped with Leica objectives (5×, 10×, 20×, 50×).

[3] Oxford Instruments SEM/EDX was operated at an accelerating voltage of 20 kV. The embedded cross sections were wrapped with carbon tape and imaging performed in low-vacuum mode.

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How to cite this article:
Sæter, L., T.E. Skaaland, L.P. Stoveland, O. Grønnesby, and N.L.W. Streeton. 2017. Visual and technical study of the Kumla altar (ca. 1439), Swedish History Museum, Stockholm. In *ICOM-CC 18th Triennial Conference Preprints, Copenhagen, 4–8 September 2017,* ed. J. Bridgland, art. 1707. Paris: International Council of Museums.