DOUBLE-SIDED OIL PAINTING ON IRON PLATE WITH HANGERS - FE ALLOY - SECOND HALF OF 19TH CENTURY

Artefact name Double-sided oil painting on iron plate with hangers

Authors Zala. Uršič (, Ljubljana, Ljubljana, Slovenia) & Nataša. Nemeček (National museum of Slovenia, Ljubljana, Ljubljana, Slovenia)

Url /artefacts/1427/

The object

Credit National museum of Slovenia_NMS, Z.Ursic.

Fig.1: Front side of the oil painting on iron plate before restoration,

Fig. 2: Back side of the oil painting on iron plate before restoration,

Credit National museum of Slovenia_NMS, Z.Ursic.

Description and visual observation

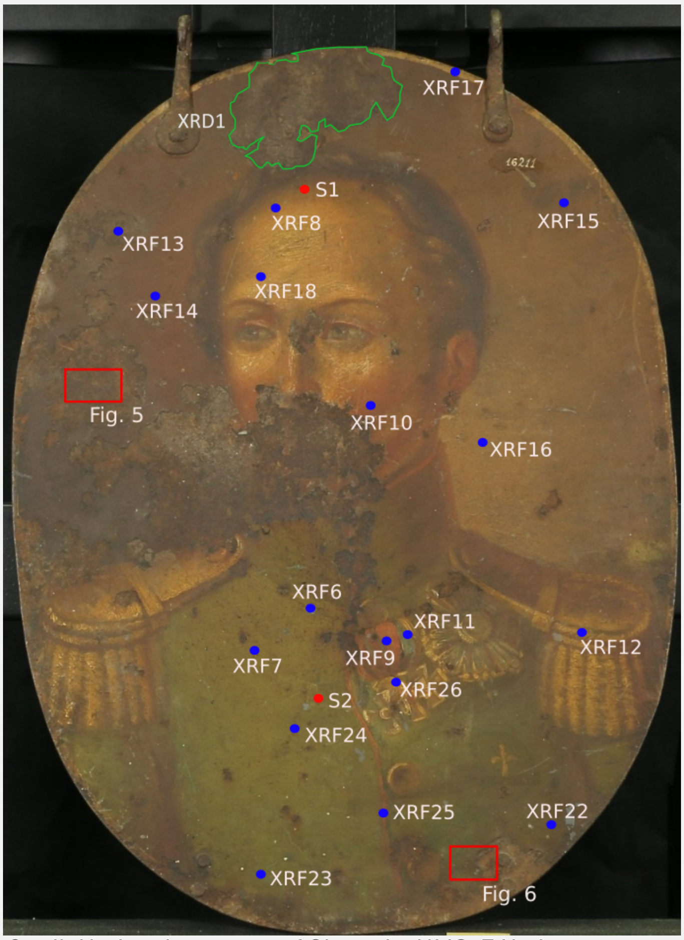
Description of the artefact	The painting is painted on both sides using the technique of oil on iron plate. It has two iron hooks on the upper edge and an oval shape. It measures 55.5 × 41 cm without hooks or 60.5 × 41 cm with hooks.
Type of artefact	Painting
Origin	Unknown
Recovering date	After 1945
Chronology category	Second half of 19th century
chronology tpq	----
chronology taq	----
Chronology comment	
Burial conditions / environment	Outdoor to indoor atmosphere
Artefact location	National museum of Slovenia (NMS), Ljubljana
Owner	National museum of Slovenia (NMS), Ljubljana

Inv. number	N 39363
Recorded conservation data	The painting is currently in process of conservation and restoration.

Complementary information

On both sides of the painting there is a thick layer of dirt (made up of corrosion products, dust, soot and pollutants) and a yellowed thin layer of coating present (presumably oil-resin based). Paint layer on both sides is damaged (missing paint layer to the support due to flaking and corrosion). Areas where iron is exposed are corroded; brown, red and black corrosion products are visible. Orange corrosion products are also locally present on top of the paint layer.

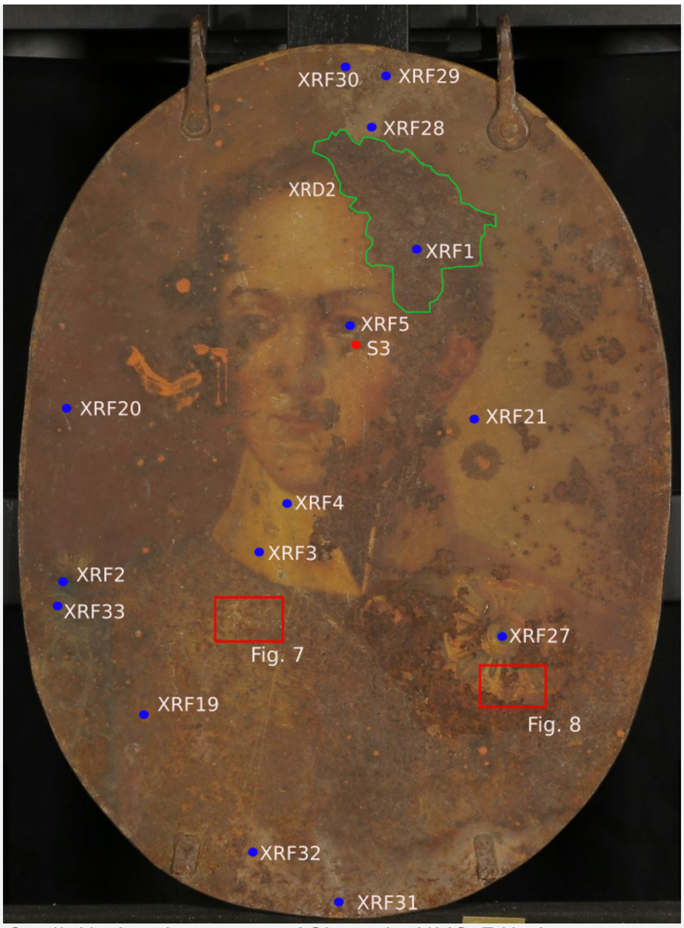
Study area(s)



Credit National museum of Slovenia_NMS, Z.Ursic.

Fig. 3: Front side showing the location of XRF analyses (blue dots), sampling areas for stratigraphy analysis (red dots), sampling area for XRD and SEM-EDS analysis (lined with green), figures 5 and 6 (squares),

Fig. 4: Back side showing the location of XRF analyses (blue dots), sampling area for stratigraphy analysis (red dot), sampling area for XRD and SEM-EDS analysis (lined with green) , figures 7 and 8 (squares),



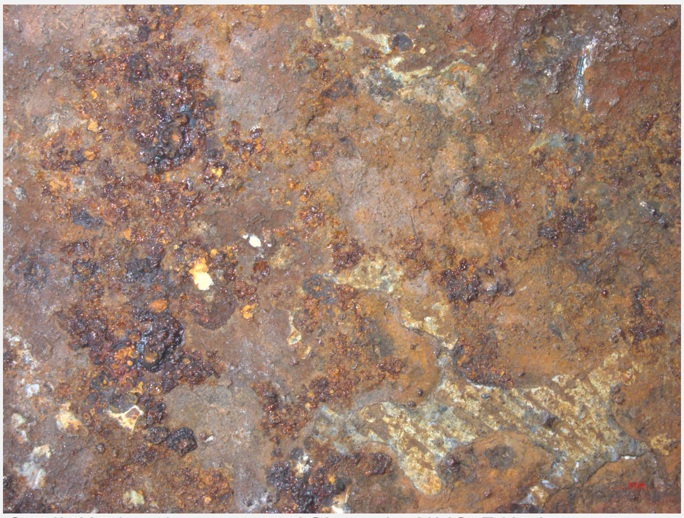
Credit National museum of Slovenia_NMS, Z.Ursic.

Fig.5: Micrograph of corrosion layer on the front side of the painting,

Credit National museum of Slovenia_NMS, Z.Ursic.

Fig. 6: Micrograph of flash corrosion layer on the front side of the painting,

Credit National museum of Slovenia_NMS, Z.Ursic.



Credit National museum of Slovenia_NMS, Z.Ursic.

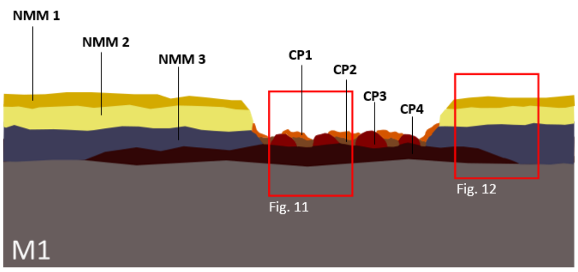
Fig. 7: Micrograph of corrosion layer on the back side of the painting,

Credit National museum of Slovenia_NMS, Z.Ursic.

Fig. 8: Micrograph of corrosion layer on the back side of the painting (lower area). Individual pits from pitting corrosion are visible,

Binocular observation and representation of the corrosion structure

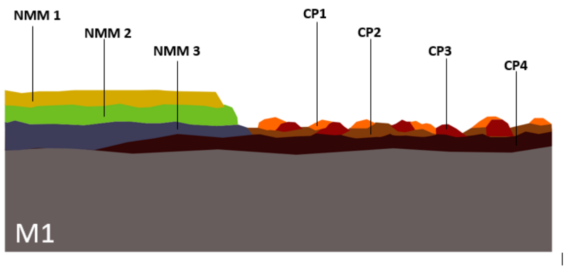
None.



LAYER	DESCRIPTION
NMM1	Varnish or protective coating layer, yellowed/darkened due to aging, transparent, slightly glossy or silky in appearance, mostly very thin but thicker locally, strong adhesion to bottom layer, present on all remaining paint layer, hard to remove with steel scalpel.
NMM2	Paint layer, various thickness depending on the location, stable and hard but can be removed with steel scalpel, very damaged by pitting corrosion.
NMM3	Ground layer, thin, metallic blue gray in appearance, consists of lead oxides and maybe zinc oxides (composition is not determined yet, could be metallic layer), strong adhesion to bottom layer, very hard to remove with steel scalpel, very damaged by pitting corrosion.
CP1	Orange thin layer, active corrosion, powdery in appearance, can be easily removed with steel scalpel, present on top of the paint layer and locally on exposed metal surface.
CP2	Reddish brown thin layer, powdery in appearance, poor adhesion to bottom layer, can be easily removed with steel scalpel, hard to distinguish from other corrosion layers, present discontinuously on much of the paint layer and exposed metal surface.
CP3	Dark red to black wart-like structures, glossy in appearance, localized but present on the whole surface of corroded metal, poor to medium adhesion to bottom layer, can be easily removed with steel scalpel, texture reminds of dry brittle resin.
CP4	Very dark (almost black) stable corrosion layer, hard, thin, strong adhesion to underlying metal, can be partially removed with strong action with steel scalpel, is present on the whole surface of exposed metal and under the edges of paint layer. It is not present under larger areas of paint where metal underneath did not oxidize.
M1	Dense, stable, hard, cannot be scratched with steel scalpel, not visible under layer of corrosion products.

Credit National museum of Slovenia_NMS, Z.Ursic.

Fig. 9: Stratigraphic representation based on visual observation and visualization of the stratigraphies of the lower back side of the painting (damaged by extensive pitting corrosion). Red squares correspond to stratigraphies in Fig. 11 and 12,



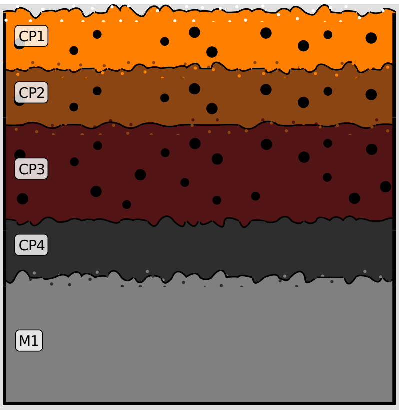
LAYER	DESCRIPTION
NMM1	Varnish or protective coating layer, yellowed/darkened due to aging, transparent, slightly glossy or silky in appearance, mostly very thin but thicker locally, strong adhesion to bottom layer, present on all remaining paint layer, hard to remove with steel scalpel.
NMM2	Paint layer, various thickness depending on the location, stable and hard but can be removed with steel scalpel.
NMM3	Ground layer, thin, metallic blue gray in appearance, consists of lead oxides and maybe zinc oxides (composition is not determined yet, could be metallic layer), strong adhesion to bottom layer, very hard to remove with steel scalpel.
CP1	Orange thin layer, active corrosion, powdery in appearance, can be easily removed with steel scalpel, present on much of the exposed metal surface.
CP2	Reddish brown thin layer, powdery in appearance, poor adhesion to bottom layer, can be easily removed with steel scalpel, hard to distinguish from other corrosion layers, present on much of the exposed metal surface.
CP3	Dark red to black wart-like structures, glossy in appearance, localized but present on the whole surface of corroded metal, poor to medium adhesion to bottom layer, can be easily removed with steel scalpel, texture reminds of dry brittle resin.
CP4	Very dark (almost black) stable/passivated corrosion layer, hard, thin, strong adhesion to underlying metal, can be partially removed with strong action with steel scalpel, is present on the whole surface of exposed metal and under the paint layer. It is not present under larger areas of paint where metal underneath did not oxidize.
M1	Dense, stable, hard, cannot be scratched with steel scalpel, not visible under layer of corrosion products.

Credit National museum of Slovenia_NMS, Z.Ursic.

Fig. 10: Stratigraphic representation based on visual observation and visualization of the stratigraphies of the front side and upper back side of the painting,

MiCorr stratigraphy(ies) – Bi

Fig. 11: Stratigraphic representation of lower area of the back side (pitting corrosion) of the object observed macroscopically under binocular microscope using the MiCorr application. This statigraphy shows a corroded area and is parallel to painted areas. CP4 in this statigraphy corresponds to CP1 in Fig. 12. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation, credit NMS, Z.Ursic.



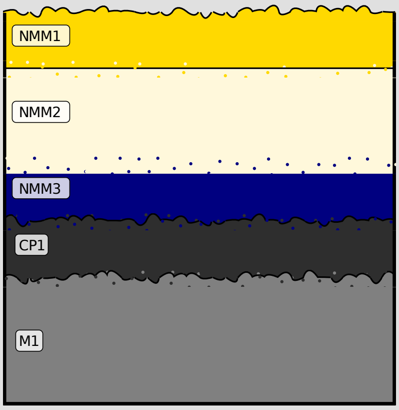
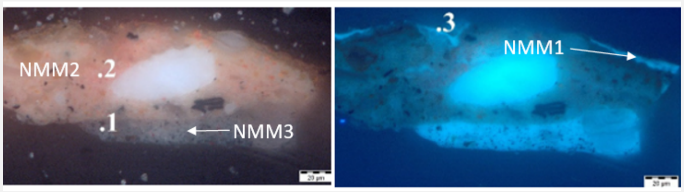


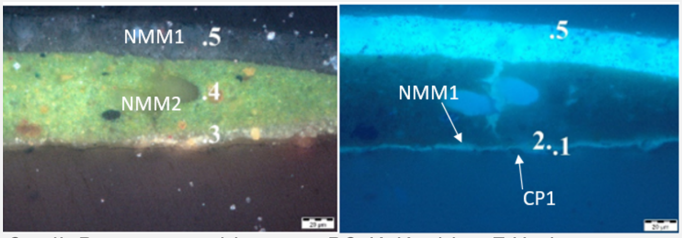
Fig. 12: Stratigraphic representation of lower area of the back side (pitting corrosion) of the object observed macroscopically under binocular microscope using the MiCorr application. This statigraphy shows a painted area and is parallel to corrosion structures in Fig. 11. CP1 in this statigraphy corresponds to CP4 in Fig. 11. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation, credit NMS,Z.Ursic.

Sample(s)



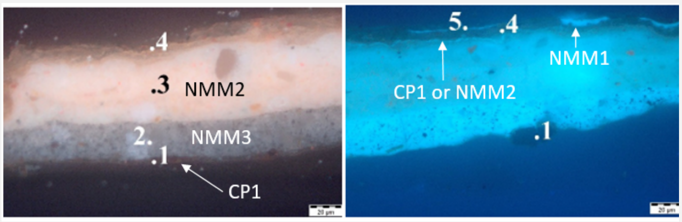
Credit Restavratorski center_RC, K. Kavkler, Z.Ursic.

Fig. 13: Sample S1 (see fig. 3 for precise area of sampling) showing statigraphy of paint layer under visible light (left) and UV light (right): ground layer (.1), paint layer (.2), varnish (.3),



Credit Restavratorski center_RC, K. Kavkler, Z.Ursic.

Fig. 14: Sample S2 (see fig. 3 for precise area of sampling) showing statigraphy of paint layer under visible light (left) and UV light (right): corrosion (.1), ground layer (.2), paint layer (.3 and .4), varnish (.5),



Credit Restavratorski center_RC, K. Kavkler, Z.Ursic.

Fig. 15: Sample S3 (see fig. 4 for precise area of sampling) showing statigraphy of paint layer under visible light (left) and UV light (right): corrosion (.1), ground layer (.2), paint layer (.3), another paint layer or corrosion products (.4), varnish (.5),

Description of sample

Samples (flakes) of paint layer were taken with a scalpel on various areas on both sides of the painting (see Fig. 3-4). Samples were embedded in polystyrene resin and grinded down to get a visible cross-section of paint layer.

Two 0.5 g samples for XRD analysis of corrosion products were taken from corroded area on each side of the painting (see Fig. 3-4). Samples were taken mechanically with a scalpel and were in powder form. Collected samples in powder form were also used for additional SEM-EDS analysis.

Alloy Fe Alloy

Technology Unknown

Lab number of sample 1-2 (XRD, SEM-EDS), 1-3 (paint statigraphy).

Sample location Faculty of Natural Sciences and Engineering, Ljubljana

Responsible institution Faculty of Natural Sciences and Engineering, Ljubljana

Date and aim of sampling March 2022 (statigraphy of paint layers), January- April 2023 (XRD and SEM-EDS identification of corrosion products).

Complementary information

Microscopic analysis of paint statigraphy showed that ground layer is very thin and has blue-gray metallic appearance. Additional XRF analysis of ground layer showed that it consists mainly of lead oxides, possibly with addition of zinc. The colour of ground layer is very unusual (metallic blue) and has not been explained yet.

Paint layer consists of different inorganic pigments with linseed oil as a binder. With additional XRF analysis we identified various pigments, such as lead white, emerald green, Naples yellow, chrome red, vermillion, various iron oxide pigments... With identification of those pigments and their historic use we were able to date the painting to the second half of 19th century.

The protective varnish layer consists of thin layer of organic yellowed material, most likely drying oil (linseed oil) or some type of resin.

Analyses and results

Analyses performed:

Non invasive approach:

-XRF with handheld handheld portable ED X-ray fluorescence spectrometer (Hitachi X-MET 8000), calibration Alloy LE FP, 2 scans for each measurement; at 8 kV and 40 kV.

Invasive approach:

-XRD (no info for equipment yet)

-SEM-EDS

Microscopic analysis of paint statigraphy: sample was embedded in polystyrene resin and polished to get a cross-section, then observed with Olympus BX-60 optical microscope with Olympus SC50 digital camera under visible and UV light.

Non invasive analysis

Metal was analysed with portable XRF machine (XRF1 in fig. 4) on a corroded area on back side of the painting where there was no visible paint flakes or other surface materials present. The analysis confirmed that the metal is an iron (Fe) alloy with high content of silicon (Si) and trace elements of aluminium, magnesium and sulphur (Table 1). We could not determine the specific type of alloy as the carbon content was not analysed. Most likely all present elements except Fe and maybe Si and S are trace elements from pigment residue or atmospheric pollution.

Element (mass%)	Fe	Si	Al	Mg	S	Pb	P	Zn	Cu
Area 1	88.7	4.4	2	1.5	1.4	1	0.5	0.3	0.2

Table 1: Chemical composition of iron plate. Sample XRF1 on Fig. 4. Method of analysis: handheld XRF, Dr. Eva Menart,

National Museum of Slovenia.

Extensive XRF analysis was also made on various locations on both sides of the painting (see fig. 3 and 4) with a goal of identifiying inorganic pigments and composition of the ground layer. Identification of pigments such as emerald green, lead white, Naples yellow, chrome red, vermillion helped us to date the painting.

Metal

The metal is iron alloy, but the specific type of alloy and microstructure of the metal could not be determined without metallographic analysis.

Microstructure	None
First metal element	Fe
Other metal elements	

Complementary information

None.

Corrosion layers

The iron support is in satisfactory condition and is stable and solid. In places where the paint layer has fallen off, there is a fairly thick layer of passivated corrosion present, except on small local areas of fresh damage, where the paint peels to the ground layer. Corrosion is mostly inactive and stable, there are local smaller active corrosion areas. Corrosion products from the support locally penetrate the paint layer where they cause discoloration. If the paint layer is removed, thin layer of dark brown (almost black) corrosion products can be seen underneath it. Locally, underlaying thicker deposits of corrosion products are causing paint layer to swell.

On the front side of the painting, corrosion products are heterogenous and form multiple layers. Statigraphy of corrosion products is similar on most areas and can be divided by four main layers: outer layer of localized brittle, powdery orange products (CP1), followed by reddish brown powdery layer (CP2), followed by dark red (almost black) shiny brittle wart-like structures of different sizes that appear indvidually but cover most of the surface (CP3). The lowest layer consists of dark brown, almost black thin hard layer that covers original metal surface (CP4).(Fig. 5) Paint surface on the bottom part of the painting was cleaned with cleaning systems that contained water (rigid agarose gels with chelators) that locally came into contact with exposed corroded metal; on those areas bright orange active corrosion (flash corrosion) formed almost immidiately after removal of rigid gels (CP1). (Fig.6).

On the back side, corrosion on the upper area of the painting are the same type as on the front side. (Fig. 7) On the lower area, corrosion type is slightly different: extensive pitting corrosion appears that forms deep individual pits across the whole surface of that area. Corrosion statigraphy is similar as on the front side of the painting: orange, brittle corrosion products (CP1) are located mainly around the pits and inside them on top of other corrosion layers, but also on top of the remaining paint layer - this is probably because of cleaning of the remaining paint layer with agarose gels which contain water (same problem as on the front side of painting). Inside the pits underneath CP1 is a layer of brownish-red brittle corrosion products (CP2), which is hard to distinguish from other layers. Next layer are dark red (almost black) shiny brittle wart-like structures (CP3) and underneath a thin, hard layer of very dark brown products (CP4). (Fig. 8).

Based on the type and colour of corrosion products we can assume that they are mostly iron oxides, with iron hydroxides appearing locally where the surface was in contact with water. This description is based solely on visual analysis. We can assume that the corrosion is atmospheric since the layer is thin and stable and the object was originally kept outside. A sample of corrosion products was taken for XRD analysis in hopes of more precise identification or confirmation of these assumptions (currently awaiting results).

Corrosion form None

Corrosion type None

Complementary information

None.

MiCorr stratigraphy(ies) – CS

Synthesis of the binocular / cross-section examination of the corrosion structure

None.

Conclusion

The painting is made from iron alloy plate. Precise microstructure of the metal has not been analysed since metallographic analysis was not executed. Based on the pigments used for the paint layer the object dates to late 19th century. Areas with missing paint layer appear heavily corroded but the layer of atmospheric corrosion is thin and the metal underneath is in good and stable condition. Various layers of corrosion can be observed visually, mostly iron oxides and hydroxides. Corrosion products are also present on top of the paint layer.

References

References on object and sample

References object

1. Milič, Z., 'Konserviranje in restavriranje železa 3.1.1', Skupnost muzejev Slovenije, 2001, p. 1-8, http://www.sms-muzeji.si/ckfinder/userfiles/files/udatoteke/publikacija/netpdf/3-1-1.pdf (accessed 1 September 2023).
2. H. Pucelj Kranjc, Konserviranje-restavriranje oljne slike na železni pločevini Požar v Kranju iz Narodnega muzeja Slovenije, MA diss., University of Ljubljana, 2018, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=105959&lang=slv (accessed 1 September 2023).
3. D.A. Scott and G. Eggert, Iron and steel in art, London, Archetype Publications, 2009, p. 107-122.

References on analytic methods and interpretation

4. D.A. Scott and G. Eggert, Iron and steel in art, London, Archetype Publications, 2009, p. 35-52.