CENTRO CONSERVAZIONE RESTAURO LA VENARIA REALE

Tecnologie per la Diagnostica e la Conservazione del Patrimonio Culturale:
L'approccio interdisciplinare del CCR "La Venaria Reale"

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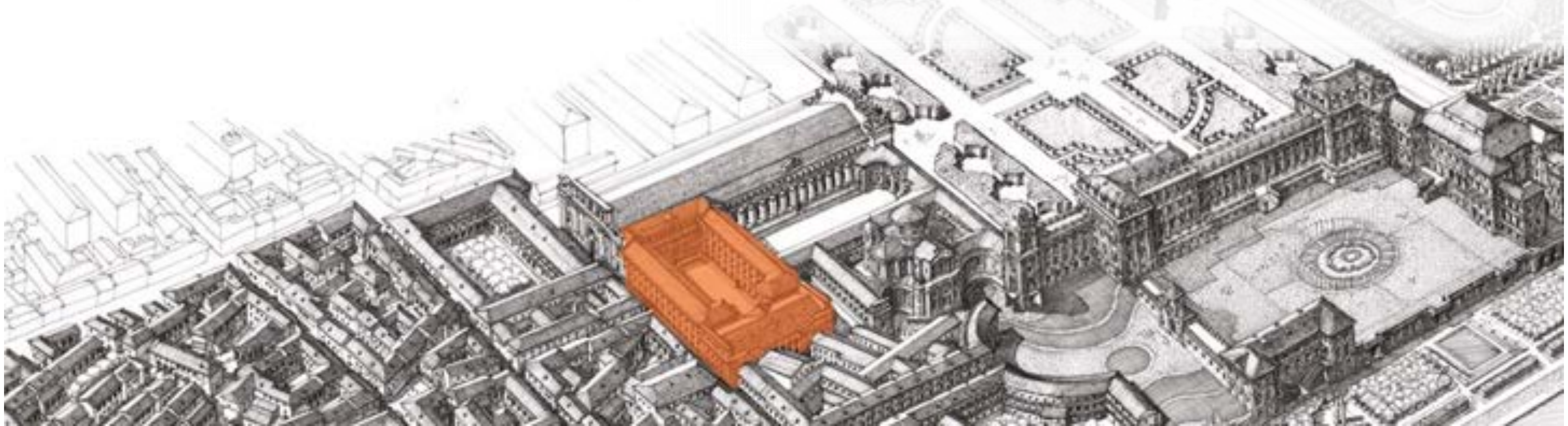
Europe Italy Piedmont Venaria Reale

The **Centro Conservazione Restauro (CCR) «La Venaria Reale»** is one of the three national, strategic poles for the conservation, research, and higher education on cultural heritage.

It is located in the former stables, horse riding tracks, and dog shelters of the Reggia di Venaria, a former royal residence of the House of Savoy and a masterpiece of Baroque architecture, just outside of Turin, Piedmont, North-West of Italy.

The CCR is a no-profit foundation established in 2005 as part of the largest restoration project in European history, involving the Reggia di Venaria, its gardens, and the town's historic center.

The architectural complex - a UNESCO World Heritage Site - has reopened to the public in October 2007, and it has since become a major tourist attraction and exhibition space.



Founded by both public and private institutions, the CCR «La Venaria Reale» acts with flexibility and covers all the main tasks related to the life of cultural heritage artifacts.

Conservation Laboratories

The CCR «La Venaria Reale» hosts nine **Conservation Laboratories**, specializing in the conservation of various types of cultural heritage materials and objects:

- Paintings on canvas
- Paintings on wooden panel
- Wooden sculptures
- Wooden forniture
- Stone materials, wall paintings, and architectural decorated surfaces
- Textiles, tapestries, carpets, leather, and ethnographic materials
- Glass, metal, and ceramic artifacts
- Contemporary art
- Paper, parchment, and photography

Scientific Laboratories

The CCR «La Venaria Reale» hosts fully equipped **Scientific Laboratories** that operate on various fronts, from the scientific analysis of objects of archaeological, historical, and artistic significance to cutting-edge, applied research through grant-based national and international projects.

ANALYTICAL PROTOCOL

Tailored to the questions raised by conservators, curators, or art historians, may involve subsequent analytical steps, such as analysis with non-invasive techniques, removal of microscopic samples, and analysis of samples with micro-invasive techniques.

ANALYTICAL TECHNIQUES

Multispectral imaging, 3D imaging, digital radiography, computed tomography, optical microscopy, colorimetry, FORS, XRF, SEM/EDS, FTIR, Raman, and biological investigations.

Preventive Conservation

The CCR «La Venaria Reale» relies on an interdisciplinary group dedicated to **preventive conservation**, including scientists, conservators and art historians, to define and deliver a series of systematic actions and integrated activities tailored to the specific conditions of each site.

SYSTEMATIC ACTIONS

Scheduled maintenance
Environmental monitoring
Integrated pest management (IPM)
Materials testing

TARGET HERITAGE SITES

Historical residences, including the Reggia di Venaria and many other palaces of the House of Savoy
Museums
Churches

Master’s Degree in Conservation and Restoration of Cultural Heritage – University of Turin

The CCR «La Venaria Reale» hosts a 5-year **Master’s Degree** in Conservation and Restoration of Cultural Heritage launched and coordinated by the University of Turin, with a total of 100-120 students per year.

Main strengths of the Master’s Degree:

- combination of theoretical classes with practical activities in the laboratory and on-site work
- teaching staff includes trained conservators
- professor:student ratio is 1:5
- advanced training in 5 professional fields
- achievement of the professional qualification of Conservator, according to guidelines of the Italian Cultural Heritage and Landscape Code.

Interdisciplinarity of the Master’s Degree:

- humanistic disciplines
- scientific and technical subjects
- content on artistic techniques
- materials and methods for conservation

Advanced Training and Study School (SAF)

The CCR «La Venaria Reale» fulfills its mission to provide high education through its **Advanced Training and Study School**, which organizes classes, courses, seminars, and schools, while managing the laboratory sessions and on-site activities for the Master's Degree.

https://www.ccrdigital-lab.it/

Study and Conservation of Polychrome Wooden Sculptures from MAO

CENTRO CONSERVAZIONE RESTAURO LA VENARIA REALE

Historical Context and Aim of the Study

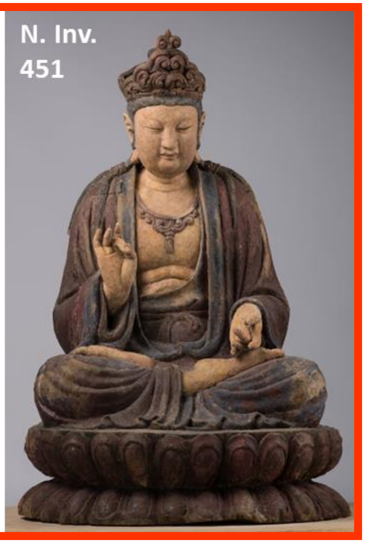
museo d'arte orientale

Politecnico di Torino 1859

UNIVERSITÀ DI TORINO

Selection of 7 Buddhist sculptures from MAO, Turin

Chinese provenance, 16th-18th century (Ming Dynasty)



Bodhisattva:
a person who is on the path towards *bodhi* («awakening») or Buddhahood

Research Questions and Analytical Protocol

Interdisciplinary approach in which analytical protocol is tailored to the research questions formulated by conservators and art historians.

RESEARCH QUESTIONS

- Support an improved, science-informed understanding of sculptures' original context, historical significance, history of transformations as they were transferred to Europe to become trade commodities and pieces for the art market.
- Study the sculptures' materials and techniques, with a special focus on any transformations that might have occurred overtime, especially in terms of later repainting, and assembling technique from multiple wooden pieces.
- Revisit current attribution in terms of provenance and dating in light of the results of scientific analysis.
- Assess the sculptures' conservation state and support the development of suitable treatment strategies taking into account ethical and methodological considerations.

ANALYTICAL PROTOCOL

Photography and Multiband Imaging
Visible diffuse and raking light photography
Multiband imaging (IRR, IRFC, UVF, UVR)

Photogrammetry

Digital Radiography
Computed Tomography

Non-Invasive Point Analysis
Digital microscopy
X-ray fluorescence spectroscopy (XRF)
Fiber optics reflectance spectroscopy (FORS)
Raman spectroscopy

Removal of Microscopic Samples

Micro-Invasive Analysis
Optical microscopy (OM)
Scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM/EDS)
Fourier-transform infrared (FTIR) spectroscopy

Photography and Multiband Imaging

Preliminary information on the presence and distribution of various types of original and conservation materials

Diffuse visible light photography (Vis-D)

Infrared reflectography (IRR)

False color infrared post-processing (IRFC)

Ultraviolet-induced visible fluorescence (UVF)

Photogrammetry

3D information on the object's dimensions and surface texture

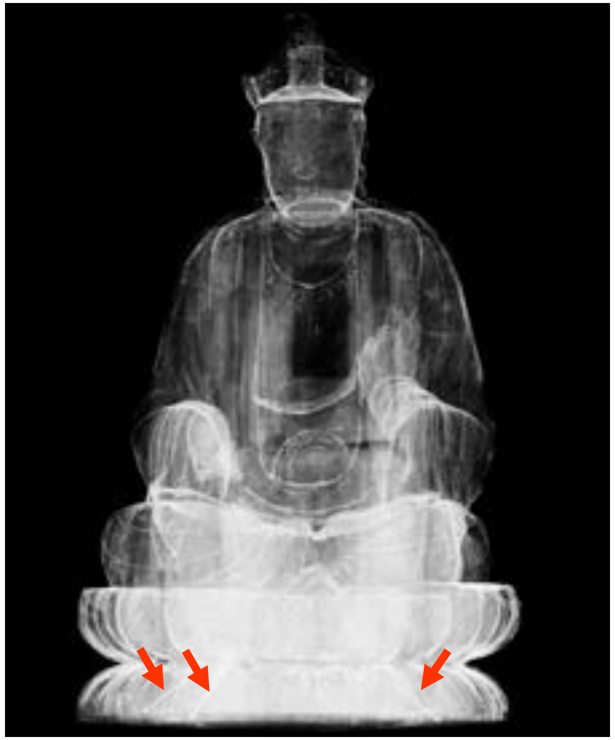
Photogrammetric multispectral 3D model

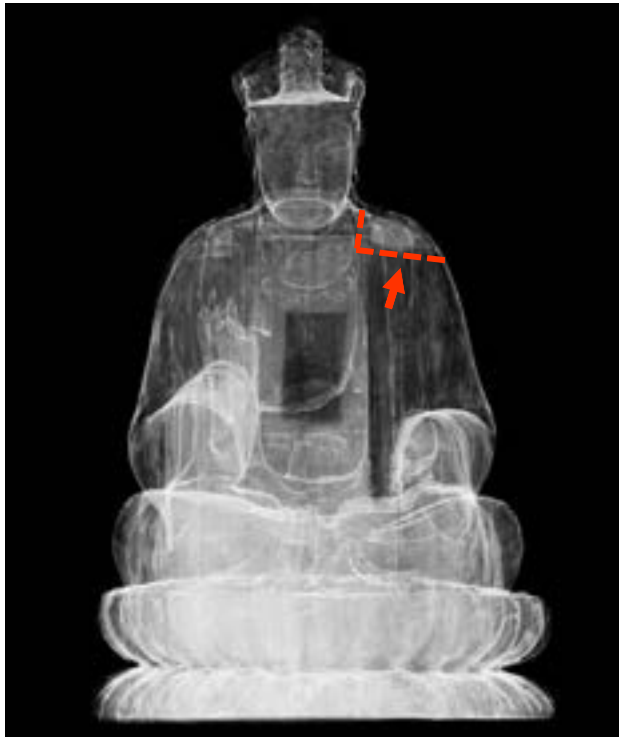
Politecnico di Torino

Digital Radiography and Computed Tomography

2D or 3D information on assembling technique for composite objects, state of conservation, presence of elements from previous conservation treatments

Neu-ART European project (2009-2013) | Collaboration with University of Turin's Department of Physics and National Institute for Nuclear Physics (INFN)





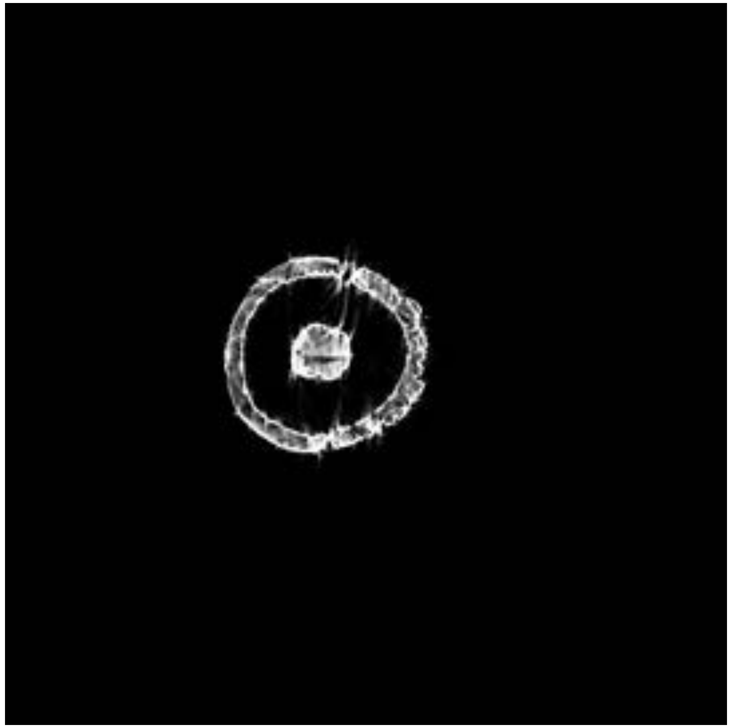
Digital radiography

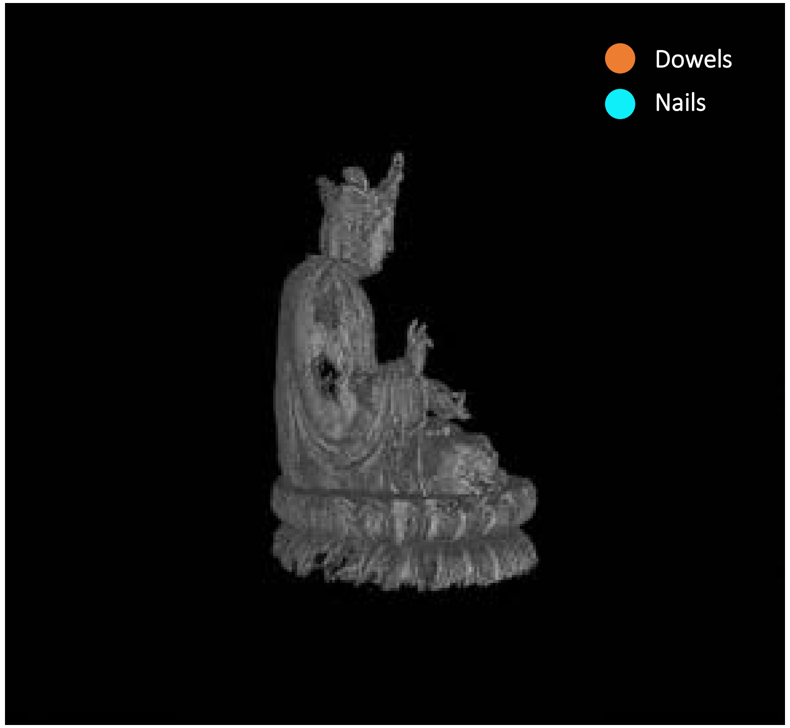
CENTRO CONSERVAZIONE RESTAURO LA VENARIA REALE

UNIVERSITÀ DI TORINO

Digital Radiography and Computed Tomography

2D or 3D information on assembling technique for composite objects, state of conservation, presence of elements from previous conservation treatments





Computed tomography

Volume segmentation to visualize the assembling of different wooden elements:
the relevant number of wooden elements suggests a 19th-century production!

Non-Invasive Point Analysis

Elemental, electronic, and molecular characterization of pigments and dyes featured in the object's color palette

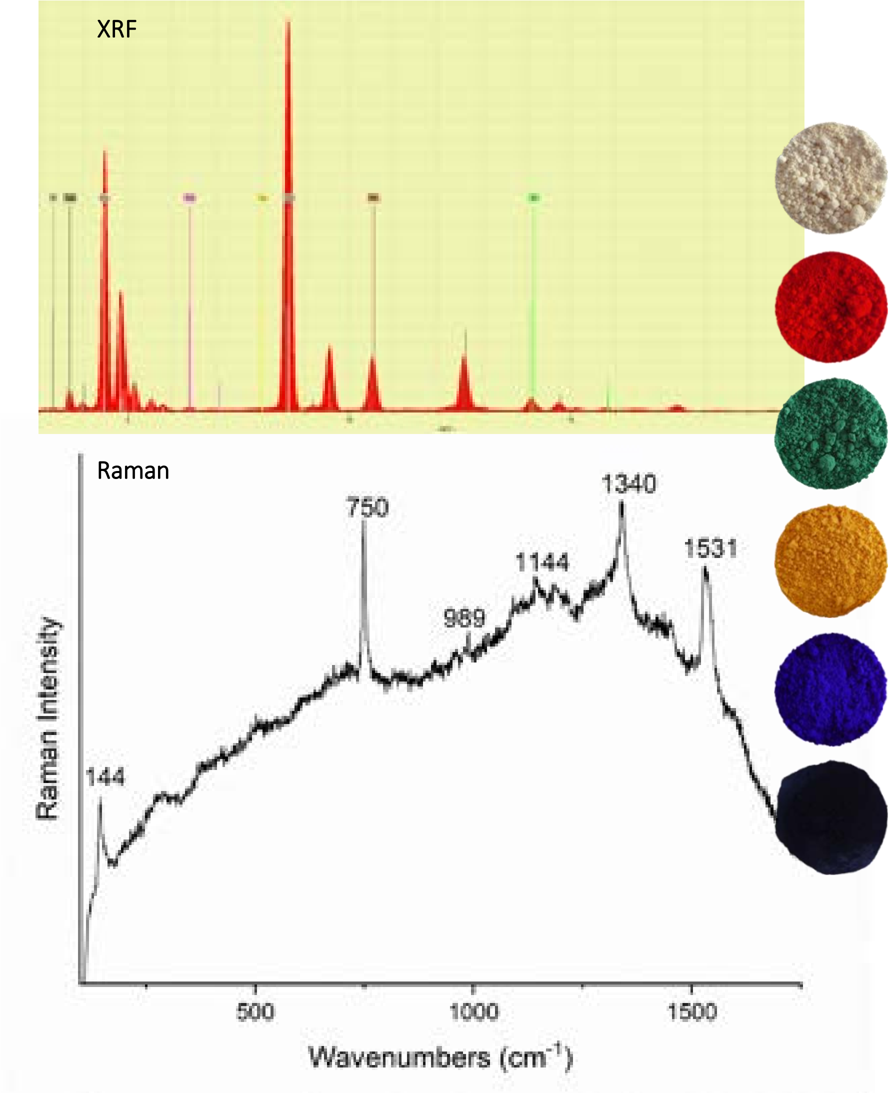
X-ray fluorescence (XRF) spectroscopy

Fiber optics reflectance spectroscopy (FORS)

Raman spectroscopy

Non-Invasive Point Analysis

Elemental, electronic, and molecular characterization of pigments and dyes featured in the object's color palette



Lithopone
Titanium white

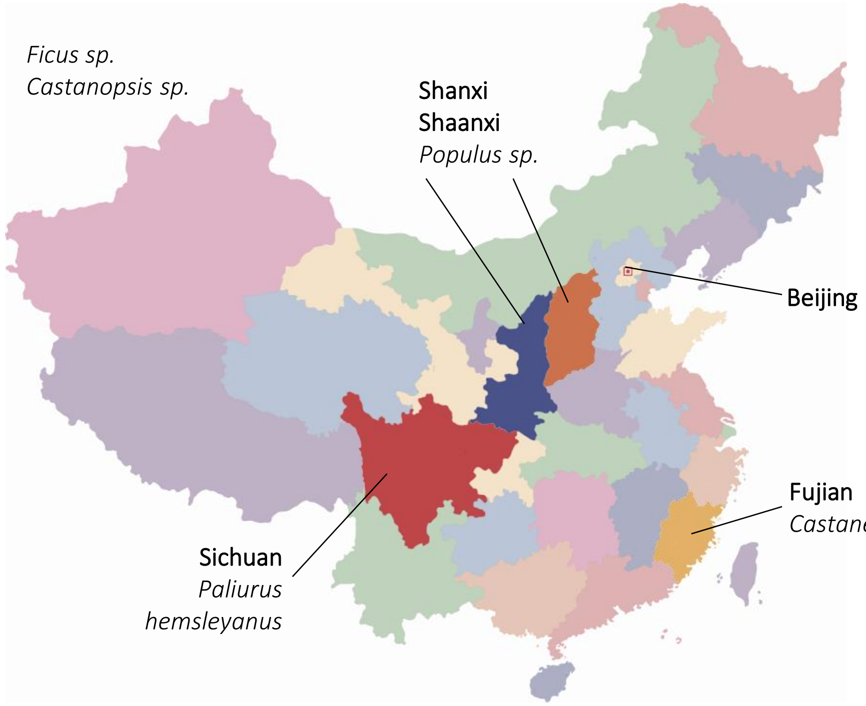
Red lead
Iron oxides
Organic red lakes
Cadmium red

Green earth
Chromium oxide

Iron hydroxides

Ultramarine blue
Phthalocyanine blue

Carbon-based black



While all wood species identified are compatible with a Chinese provenance, the color palette is not indicative of either an Asian or European provenance of the sculptures.

The identification of lithopone as a ground layer in some sculptures indicates a **mid-19th century *terminus post quem***. These sculptures are likely of Chinese provenence and were repainted at a later date to appeal to European collectors.

Micro-Invasive Analysis

In-depth characterization of pigments and binders within paint stratigraphy, information on degradation processes

Visible and ultraviolet light optical microscopy (Vis-UV OM)

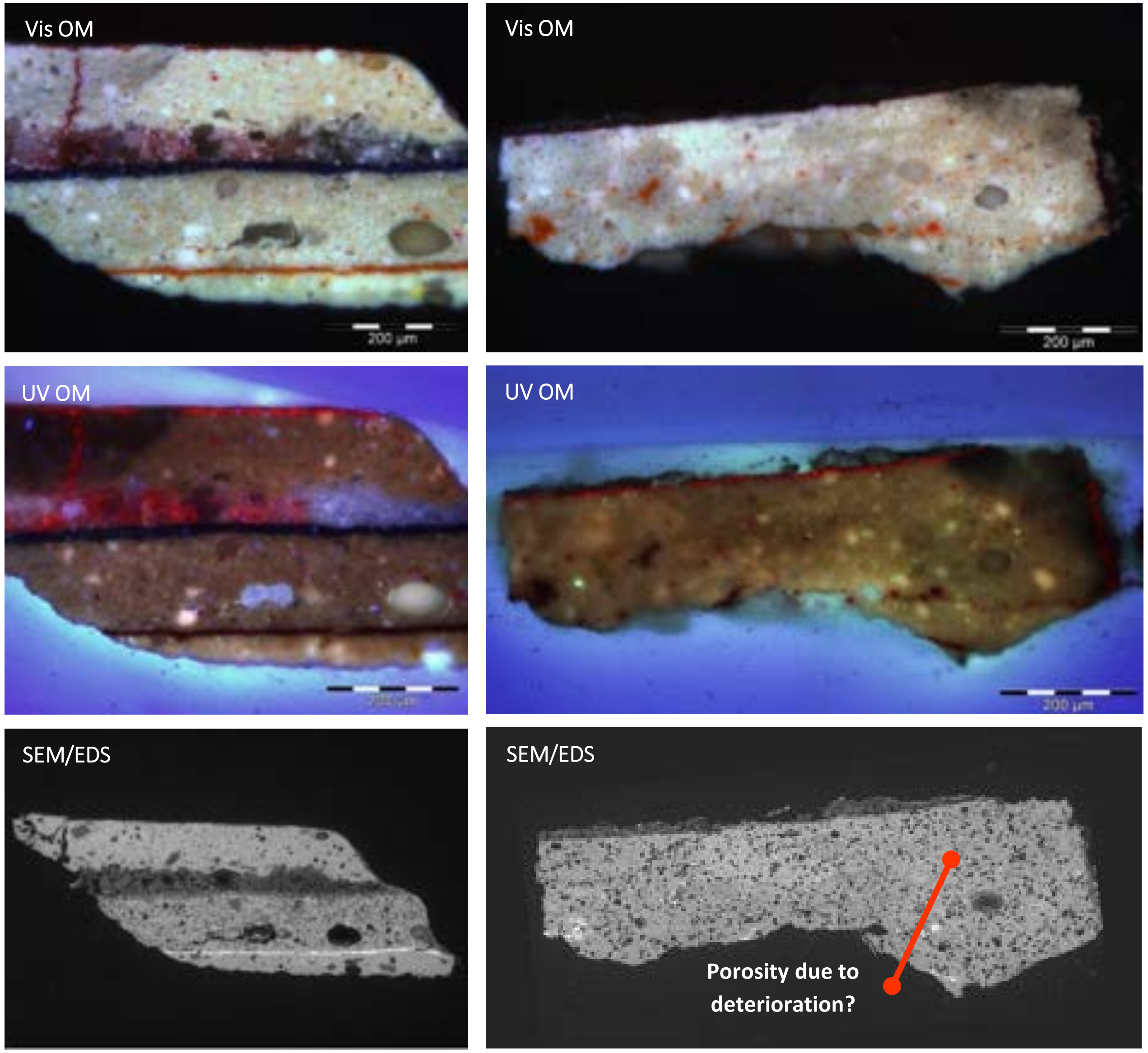
Scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM/EDS)

Fourier-transform infrared (FTIR) spectroscopy

Micro-Invasive Analysis

In-depth characterization of pigments and binders within paint stratigraphy, information on degradation processes

Object No. 450 | **Object No. 451**

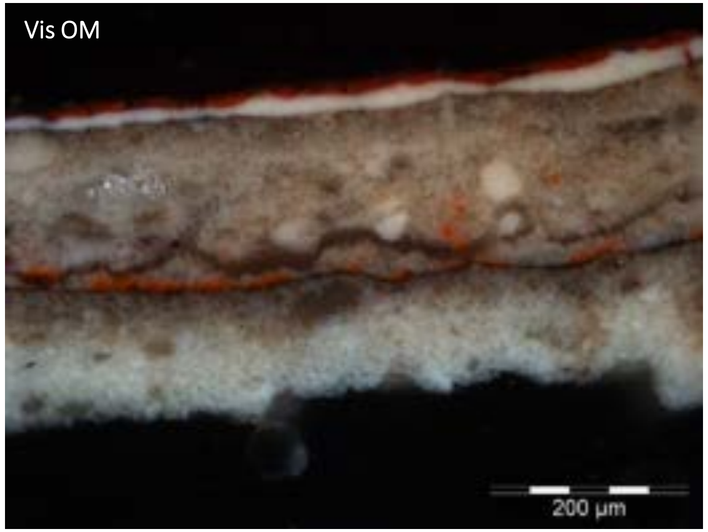


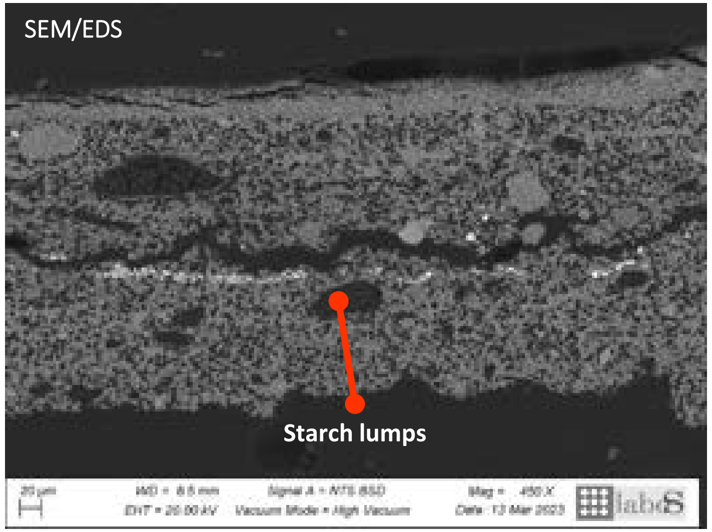
Study and Conservation of Polychrome Wooden Sculptures from MAO

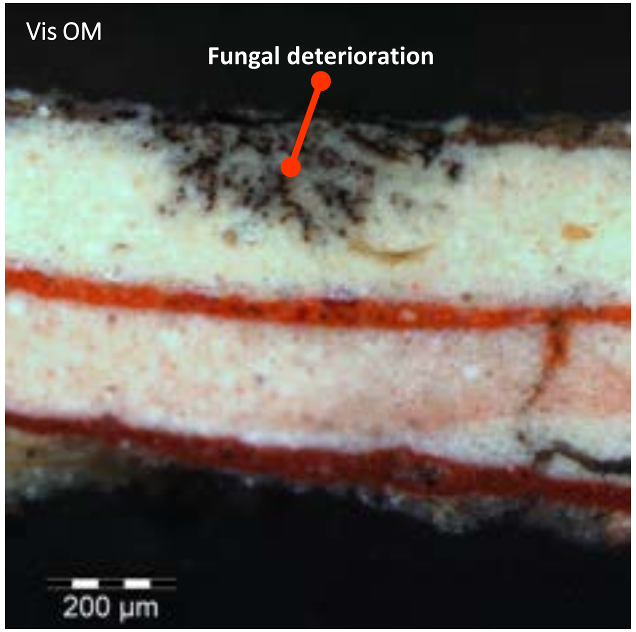
CENTRO CONSERVAZIONE RESTAURO LA VENARIA REALE

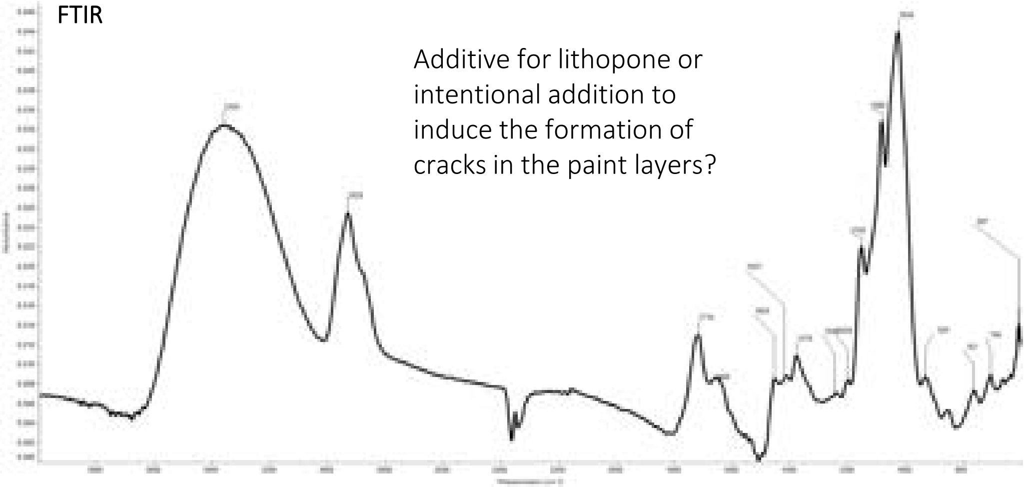
Micro-Invasive Analysis

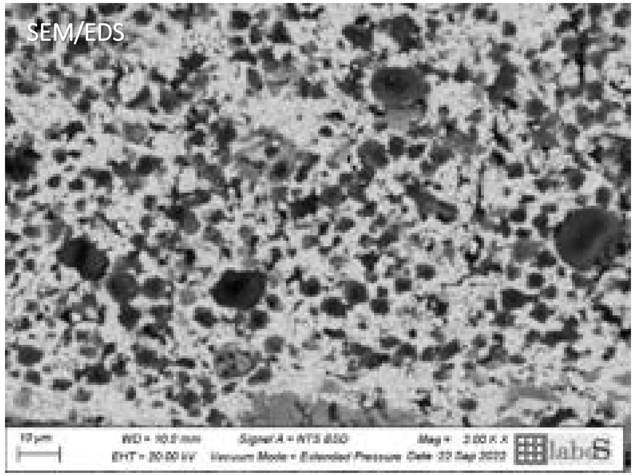
In-depth characterization of pigments and binders within paint stratigraphy, information on degradation processes











Study and Conservation of Polychrome Wooden Sculptures from MAO

Conservation Treatment

Systematic comparison of cleaning methods:

- dry cleaning and solvent mixtures
- mechanical removal with scalpel blades
- Nd:YAG 1064-nm and 532-nm lasers used in Q-Switching (QS) and Long Q-Switching (LQS) modes

Study and Conservation of Polychrome Wooden Sculptures from MAO

Exhibition and Acknowledgments

Centro Conservazione Restauro «La Venaria Reale»

Chiara Ricci
Paola Buscaglia
Debora Angelici
Anna Piccirillo
Daniele Demonte
Federico Di Iorio
Sara Croci
Valentina Tasso
Noemi Sanna
Francesca Zenucchini
Paola Manchinu
Federica Pozzi

Politecnico di Torino

Paola Buscaglia
Sara Croci
Federico Di Iorio
Leila Es Sebar
Luca Lombardo
Sabrina Grassini

Università di Torino

Alessandro Re
Ludovica Pia Cesareo

Museo d'Arte Orientale

Davide Quadrio
Laura Vigo
Anna Musini

Thank you for Your Kind Attention!

CENTRO
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Visible diffuse and raking light photography

For visible diffuse light photography, lighting was carried out with 2 Elinchrom RX1200 strobes to the right and left of the object, at an angle of approximately 45° to the normal to the surface, and with the aid of softboxes to diffuse the light. Photographs were taken with a Nikon D810 DSLR Full Spectrum camera, modified to extend its spectral sensitivity in the 350-1000-nm range and providing a resolution of 7360 x 4912 pixels, equipped with a complementary metal oxide semiconductor (CMOS) silicon sensor as well as Madatec UV-IR Cut and BG40 filters. Image processing, carried out by means of Adobe Photoshop, included a color correction conducted by inserting a 24-color X-Rite ColorChecker Classic reference in the field of view.

Infrared reflectography (IRR) and false color processing (IRFC)

Lighting was carried out with 2 Elinchrom RX1200 strobes to the right and left of the object, at an angle of approximately 45° to the normal to the surface, and with the aid of softboxes to diffuse the light. Photographs were taken with a Nikon D810 DSLR Full Spectrum camera, modified to extend its spectral sensitivity in the 350-1000-nm range and providing a resolution of 7360 x 4912 pixels, equipped with a complementary metal oxide semiconductor (CMOS) silicon sensor as well as Madatec IR 850 filter. Image processing was carried out by means of Adobe Photoshop. Infrared false color images were obtained in the RGB color space of Adobe Photoshop by using two reflection images acquired in the visible and NIR spectral ranges. In particular, the green (G) and red (R) components of the visible image are transferred into the blue (B) and green (G) channels, while the red (R) component is replaced with the NIR image. This methodology yields false color images of the NIR-R-G (RGB) type.

Ultraviolet-induced visible fluorescence (UVF)

Lighting was carried out with 2 Elinchrom RX1200 strobes equipped with a B+W 403 filter by moving the lights at different angles at a constant distance. The acquisition procedure involved taking several shots on the same frame by setting the camera to 'Multiple Exposure' to merge illuminations from different positions. Photographs were taken with a Nikon D810 DSLR Full Spectrum camera, modified to extend its spectral sensitivity in the 350-1000-nm range and providing a resolution of 7360 x 4912 pixels, equipped with a complementary metal oxide semiconductor (CMOS) silicon sensor as well as Madatec UV-IR Cut and BG40 filters. Image processing, carried out by means of Adobe Photoshop, was conducted by inserting a non-fluorescent reference in the field of view.

Visible-induced infrared luminescence (VIL)

Lighting was achieved by means of 1 Nikon SB-910 portable speedlight, equipped with 3 Hoya UV-IR Cut filters. The acquisition procedure involved taking several shots on the same frame by setting the camera to 'Multiple Exposure' to merge illuminations from different positions. Images were acquired in the 850-1000-nm spectral range (near infrared, NIR) with a Nikon D810 DSLR Full Spectrum camera, modified to extend its spectral sensitivity in the 350-1000-nm range and providing a resolution of 7360 x 4912 pixels, equipped with a complementary metal oxide semiconductor (CMOS) silicon sensor as well as a Madatec IR 830 filter. Image processing was carried out by means of Adobe Lightroom and Adobe Photoshop software. A pure Egyptian blue tablet was included in the frame to obtain the right image exposure.

Photogrammetry

Tridimensional photogrammetric data was acquired with a Fujifilm X T-30 APS-C mirrorless camera equipped with a complementary metal oxide semiconductor (CMOS) sensor, providing a resolution of 26.1 megapixels, and with a Schneider 50 mm lens. The statues were positioned on a rotating platform and a photograph was shot every 10° of rotation and at different heights. Lighting of the object in different spectral bands was achieved by means of several light sources. This technique entails the acquisition of a series of images that must overlap by at least 66%. Image processing, carried out by means of Meshroom software, includes the following steps: identification of analogous points in the images acquired, determination of the camera's relative positions, generation of a sparse cloud, followed by a dense cloud that describe the object's morphology, triangulation of the collected points to produce an object made of polygons (mesh), and application upon the morphology of the color directly resulting from the overlapping of the acquired images. Image processing also includes a color correction and precise measurement of the object under examination, conducted by inserting a 24-color X-Rite ColorChecker Classic reference and a metric scale in the field of view.

Visible diffuse light photography

For visible diffuse light photography, lighting was carried out with 2 800-W Ianiro Varibeam Halogen lamps pointed to a light gray ceiling to diffuse the light. Photographs were taken with a Fujifilm X T-30 APS-C mirrorless camera equipped with a Madatec UV-IR Cut and BG40 filters. Image processing, carried out by means of Adobe Photoshop, included a color correction conducted by inserting a 24-color X-Rite ColorChecker Classic reference in the field of view.

Ultraviolet-induced visible fluorescence (UVF)

Lighting of the object was achieved by means of two 5-W Madatec LED UV lamps with emission peak at 365 nm. Photographs were taken with a Fujifilm X T-30 APS-C mirrorless camera equipped with a Madatec UV-IR Cut and BG40 filters. Image processing, carried out by means of Adobe Photoshop, was conducted by inserting a Labsphere Spectralon 99% Wavelength Calibration Standards in the field of view.

Ultraviolet reflectography (UVR)

Lighting of the object was achieved by means of two 5-W Madatec LED UV lamps with emission peak at 365 nm. Photographs were taken with a Fujifilm X T-30 APS-C mirrorless camera equipped with a Baader Venus UV-pass filter. Image processing, carried out by means of Adobe Photoshop, was conducted by inserting a Labsphere Spectralon 99% Wavelength Calibration Standards in the field of view.

Ultraviolet false color processing (UVFC)

Ultraviolet false color images were obtained in the RGB color space of Adobe Photoshop by using two reflection images acquired in the visible and ultraviolet spectral ranges. In particular, the blue (B) and green (G) components of the visible image are transferred into the green (G) and red (R) channels, while the blue (B) component is replaced with the UVR image. This methodology yields false color images of the G-B-UVR (RGB) type.

Infrared reflectography (IRR) and false-color processing (IRFC)

Lighting was carried out with 2 800-W Ianiro Varibeam Halogen lamps, pointed on the ceiling to diffuse the light. Photographs were taken with a with a Nikon D810 DSLR Full Spectrum camera, modified to extend its spectral sensitivity in the 350-1000-nm range and providing a resolution of 7360 x 4912 pixels, equipped with a complementary metal oxide semiconductor (CMOS) silicon sensor as well as Madatec IR 850 filter. Image processing, carried out by means of Adobe Photoshop, was conducted by inserting a Labsphere Spectralon 99% Wavelength Calibration Standards in the field of view. Infrared false color images were obtained in the RGB color space of Adobe Photoshop by using two reflection images acquired in the visible and NIR spectral ranges. In particular, the green (G) and red (R) components of the visible image are transferred into the blue (B) and green (G) channels, while the red (R) component is replaced with the NIR image. This methodology yields false color images of the NIR-R-G (RGB) type.

Digital radiography

Digital radiography was carried out using a tailor-made system equipped with a General Electric Eresco 42 MF4 X-ray source with a tungsten anode and a 0.8-mm beryllium window, providing an adjustable voltage of 5-200 kV, a maximum current of 10 mA, and a maximum power of 900 W. The emission of X-rays takes place within a cone of elliptical section (40° vertical and 60° horizontal), with focal spot diameter of 3 mm, while a 2-mm aluminum slab is placed in front of the tube exit window to absorb the less energetic X-rays that are not useful for the radiographic investigation, thus limiting any beam hardening effects. The detector is a Hamamatsu C9750-20TCN X-ray Line Sensor Camera with a gadolinium scintillator coupled with a linear array of vertically arranged charge-coupled devices (CCD), resulting in a measurement area of 2560 pixels with 200-μm^2 size and 4096 gray levels (12 bit). Image acquisition, performed by means of HiPic proprietary software, is carried out by moving the detector horizontally along a motorized axis. In the present case, radiographs were collected using 180-kV voltage, 5-mA current, and 1.15-m/min scan speed. Images were corrected using white (X-ray source on, no object) and dark (X-ray source off) references. Image processing was conducted with a tailor-made software operating on the National Instruments' LabVIEW platform.

Computed tomography

CT analysis was carried out using a tailor-made system equipped with a General Electric Eresco 42 MF4 X-ray source with a tungsten anode and a 0.8-mm beryllium window, providing an adjustable voltage of 5-200 kV, a maximum current of 10 mA, and a maximum power of 900 W. The emission of X-rays takes place within a cone of elliptical section (40° vertical and 60° horizontal), with focal spot diameter of 3 mm, while a 2-mm aluminum slab is placed in front of the tube exit window to absorb the less energetic X-rays that are not useful for the tomographic investigation, thus limiting any beam hardening effects. The tube is air cooled and it has been used with cycles of 40-min irradiation and 20-min cooling to avoid overheating. The detector is a Hamamatsu C9750-20TCN X-ray Line Sensor Camera with a gadolinium scintillator coupled with a linear array of vertically arranged charge-coupled devices (CCD), resulting in a measurement area of 2560 pixels with 200-μm^2 size and 4096 gray levels (12 bit). Image acquisition, performed by means of HiPic proprietary software, is carried out by moving the detector horizontally along a motorized axis and rotating it around a vertical axis to maintain orientation toward the focal spot of the X-ray source. The detector is shielded by a lead plate to reduce Compton scattering, thus improving image quality. The rotating platform, designed to carry large objects, is connected to a Newport RV350PE high-precision rotary stage providing 0.25° angular steps within a 270° overall range. In the present case, tomographs were collected using 180-kV voltage, 5-mA current, and 1.15-m/min scan speed. Images were corrected using white (X-ray source on, no object) and dark (X-ray source off) references. Image processing was conducted with a tailor-made software operating on the National Instruments' LabVIEW platform and with the Imgrec software, developed by the Lawrence Livermore National Laboratory.

Fiber optics reflectance spectroscopy (FORS)

FORS analysis was conducted using an Ocean Optics HR2000+ spectrophotometer, an Ocean Optics HL-2000-FHSA halogen lamp, and a Labsphere Spectralon Wavelength Calibration Standards white reference. The system includes two fiber optics, one single and one bifurcated, with a 400-µm diameter, that are equipped with an Ocean Optics RPH-2 anodized aluminum fiber support, enabling reflection measurements at a 90° or 45° angle to the bearing surface. Spectra were acquired in reflectance mode, within a 360-1000 nm spectral range, with 45°/0° optical geometry.

X-ray fluorescence (XRF) spectroscopy

XRF analysis was performed using a Micro-EDXRF Bruker Artax 200 spectrometer equipped with a fine focus X-ray source including a molybdenum anode and a Si(Li) silicon drift detector (SDD) with an 8-µm beryllium window, providing an average resolution of approximately 144 eV for the full width at half maximum of the manganese Kα line. The system includes a 4096-channel analog to digital converter (ADC), a series of interchangeable filters, as well as two 0.65-mm and 1.5-mm collimators to adjust spot analysis size. Maximum voltage and current are 50 kV and 1500 µA, respectively, for a maximum power of 40 W. In the present case, measurements were carried out using 30-kV voltage, 1300-µA current, 60-s acquisition time, 1.5-mm collimator, with no filter, by fluxing helium gas onto the measurement area to improve the technique's detection limits (corresponding, with a helium flux, to Z=11, sodium).

Raman spectroscopy

Raman analysis was performed with a Bruker Bravo handheld spectrometer equipped with a charge-coupled device (CCD) detector. Two lasers emitting light at 785 and 852 nm (Duo LASER™) were used as the excitation sources, enabling the acquisition of data in the 170-3200 cm^{-1} spectral range and at a spectral resolution of 10-12 cm^{-1}. The output laser power was ≈ 50 mW for both lasers, while the number of scans and integration time were adjusted according to the color and Raman response of the different areas examined. With this system, spectral acquisition exploits a sequentially shifted excitation (SSE) algorithm that allows for automatic fluorescence removal.

Optical microscopy (OM)

Multi-layered samples were observed and photographed under visible light using an Olympus SZX10 stereomicroscope equipped with an Olympus Color View I digital camera. After being mounted as cross sections, such samples were observed and photographed under visible and ultraviolet light using an Olympus BX51 minero-petrographic microscope equipped with an Olympus DP71 digital camera. In both cases, image acquisition and processing were performed by means of analySIS FIVE proprietary software.

Scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM/EDS)

Cross sections were observed and analyzed with a Zeiss EVO60 scanning electron microscope equipped with a lanthanum hexaboride (LaB6) cathode and a silicon drift detector (SDD), and coupled with a 40 mm^2 Oxford Ultim Max EDS microprobe for semi-quantitative elemental analysis. Samples were coated with a thin layer of carbon and analyzed in high vacuum mode, using an accelerating voltage of 20 kV and a pressure of 10^{-5} Pa.

Fourier-transform infrared (FTIR) spectroscopy

FTIR analysis was performed with a Bruker Vertex 70 FTIR spectrometer coupled with a Bruker Hyperion 3000 infrared microscope and equipped with a mercury cadmium telluride (MCT) detector. Scrapings were analyzed as a bulk in transmission mode through a 15x objective, upon compression in a diamond cell. The instrument is also equipped with an attenuated total reflection (ATR) attachment with a 20x objective featuring a germanium crystal. Data were collected in the 4000-650 cm^{-1} spectral range, at a spectral resolution of 4 cm^{-1}, as the sum of 64 scans. In addition to spot analysis, imaging on select areas of the sample surface can be performed using an MCT focal plane array (FPA) detector in the 4000-900 cm^{-1} range.

Laser Nd:YAG EOS 1000 – 1064 nm
Durata impulso 60-120 µs
Energia massima impulso 1 J
Range di energia 50-500 mJ con incrementi di 50 mJ e 600-1000 mJ con incrementi di 100 mJ
Frequenza di ripetizione 1-10, 15, 20 Hz
Dimensione spot 1,5-6 mm
Fibra ottica 600 µm a focale variabile con fascio guida (laser HeNe 1mW)

Laser Nd:YAG VARIO LQS – 1064 nm
Durata impulso 60-120 ns
Energia massima impulso 380 mJ
Range di energia 75, 100, 150, 200, 250, 300, 350, 380 mJ
Frequenza di ripetizione 1-10, 15, 20 Hz
Dimensione spot 1,5-6 mm
Fibra ottica 600 µm a focale variabile con fascio guida (laser HeNe 1mW)

Laser Nd:YAG Thunder Art – 1064, 532, 355, 266 nm
Durata impulso 8 ns (1064 nm), 6 ns (532 nm), <5 ns (355 nm), 4 ns (266 nm)
Energia massima impulso 450 mJ (1064 nm), 230 mJ (532 nm), 90 mJ (355 nm), 40 mJ (266 nm)
Range di energia selezionabile fino al valore massimo a passi variabili a seconda della lunghezza d'onda
Frequenza di ripetizione 1-20 Hz a passi di 1 Hz
Dimensione spot 7 mm
Due bracci articolati a focale fissa

Laser Er:YAG Light Brush – 2940 nm
Durata impulso modalità VERY SHORT 150 µs, modalità SHORT 250 µs, modalità LONG 400 µs
Energia massima impulso 500 mJ
Range di energia modalità VERY SHORT selezionabile da 50 mJ a 300 mJ (passi di 50mJ), modalità SHORT selezionabile da 100 mJ a 500 mJ (passi di 50mJ), modalità LONG: selezionabile da 100 mJ a 500 mJ (passi di 50mJ)
Frequenza di ripetizione 1, 2, 3, 5, 10, 15 e 20 Hz
Dimensione spot 1 mm
Braccio articolato a 7 specchi

Parameters for laser cleaning of Buddha sculptures:
LQS laser: Energy 130 mJ, filter E70 (E50 + E25), frequency 4-5 Hz, handle 6-7-8-9-10.
LQS laser: Energy 130 mJ, filter E25, frequency 3-4 Hz, handle 5-6-7.
LQS laser: Energy 130 mJ, frequency 3-4-5 Hz, handle 4-5.