

Release Date: August 23, 2019

Groundbreaking Scientific Research and Technical Study of Verrocchio's Masterpieces Revealed in Newly Published Exhibition Catalog



(Left) Detail of Andrea del Verrocchio's *Madonna and Child* (c. 1465/1470, Staatliche Museen zu Berlin, Gemäldegalerie, © bpk Bildagentur / Staatliche Museen, Berlin / Jörg P. Anders./ Art Resource, NY). (Right) The false-color composite image of the painting obtained with the Gallery's infrared reflectance imaging camera.

Washington DC—In preparation for the exhibition [Verrocchio: Sculptor and Painter of Renaissance Florence](#), on view at the National Gallery of Art from September 15, 2019, through January 12, 2020, a team of distinguished conservators and scientists from the Gallery studied masterpieces in different media by the Renaissance artist Andrea del Verrocchio (c. 1435–1488). The results of these investigations are presented in the exhibition catalog in two groundbreaking technical studies.

In the first study, Dylan Smith, the Gallery's Robert H. Smith Research Conservator in the department of object conservation, closely examines Verrocchio's bronze sculpture, offering a deeper understanding of his innovative casting methods and new insights into how his extraordinary skill as a founder developed over his career.

The second study, led by John K. Delaney, senior imaging scientist, with contributions by Kathryn A. Dooley, imaging scientist, and Francesca Gabrieli, former research fellow—all from the Gallery's

department of scientific research—uses modern imaging techniques such as x-ray fluorescence spectroscopy to examine a key group of paintings by Verrocchio, looking beneath the painted surface to reveal the master's preparatory drawings and modeling and to identify the materials he used.

The catalog, published by the National Gallery of Art in association with Princeton University Press, also features an essay that examines long-standing questions of attribution and the role of other artists in Verrocchio's large, active workshop. The essay is co-authored by Gretchen Hirschauer, associate curator of Italian and Spanish painting at the Gallery, and Elizabeth Walmsley, the Gallery's senior conservator of paintings.

Many conservators and scientists at the Gallery lent their expertise to the catalog, including Daphne Barbour, Shelley Sturman, and Katherine May in the department of object conservation; and Lisha Glinsman and Xiao Ma in the department of scientific research.

The project was also supported by a team of international experts. Marcello Picollo and Costanza Cucci, scientists from IFAC-CNR (Institute of Applied Physics in Florence), contributed to the analysis of the paintings and sculptures in Florence and co-authored the imaging study. Babette Hartweg, chief conservator of paintings, and Ute Stehr, painting conservator, offered vital information on two depictions of the *Madonna and Child* (c. 1465/1470 and c. 1470/1472) at the Staatliche Museen zu Berlin, Gemäldegalerie. The later version of this painting underwent an extensive treatment in preparation for the exhibition. Ina Reichle, conservation scientist formerly at Rathgen Research Laboratory of the National Museum in Berlin, performed additional XRF analyses (x-ray fluorescence spectroscopy) on the paintings.

Lesley Stevenson, painting conservator at the National Galleries Scotland, contributed new technical imaging of the *Madonna Adoring the Christ Child (The Ruskin Madonna)* (c. 1475/1480, National Galleries of Scotland) and collaborated on the study of the painting. Paul Hofmann, head of sculpture conservation at Berlin's Bode Museum, and Gerhard Kunze, the museum's sculpture conservator, carried out an investigation and treatment of the terracotta *Sleeping Youth* (c. 1470–1480, Staatliche Museen zu Berlin, Skulpturensammlung und Museum für Byzantinische Kunst) which appears in its newly conserved state for the first time. Arie Pappot, metals conservator at the Rijksmuseum, Amsterdam, offered new insights into the technique of Verrocchio's bronze *Candelabrum*, dated 1468–1469.

Technical Studies of Verrocchio's Sculptures

The techniques used to cast Verrocchio's bronzes were studied through close visual examination and x-radiography of select sculptures. Their metallic alloys were identified with portable x-ray fluorescence spectroscopy (XRF) that was used to study the works on site in Florence at the Museo

Nazionale del Bargello, Museo di Palazzo Vecchio, Museo di San Marco, Orsanmichele, and the Church of San Lorenzo:

- The investigation supports the generally accepted dating of *David with the Head of Goliath* (c. 1465, Museo Nazionale del Bargello, Florence) to the mid-1460s and argued for a similar early date for *Putto with a Dolphin* (c. 1465/1480, Museo di Palazzo Vecchio, Florence), making its sophisticated design even more remarkable.
- A re-evaluation of the technique of the *Candelabrum* (1468–1469, Rijksmuseum, Amsterdam) also illustrates Verrocchio's early ambitions, as its delicate, highly attenuated form was cast in a single pour.
- Technical study of the *Nude Male, called "Il Pugilatore,"* (c. 1470/1480, Museo Nazionale del Bargello, Florence) and *Dove of the Holy Spirit* (1477, Museo Nazionale del Bargello, Florence) offers new evidence to support their inclusion in Verrocchio's oeuvre.

A larger context for the bronze sculptures featured in the exhibition was revealed through extensive on-site examinations of Verrocchio's other major works:

- The bell known as "La Piagnona" from the Church of San Marco, Florence, may be Verrocchio's earliest work in bronze and offers evidence of where his skills as a founder may have originated.
 - Alloy analysis of the grates and heraldic shields in the floor marker of the *Tomb of Cosimo de' Medici*, completed by 1467, helps to confirm these as part of Verrocchio's original design.
 - The investigation of the *Tomb of Giovanni and Piero de' Medici* (c. 1470–1473) provides new insights into how Verrocchio created the elaborate vegetal decoration of the sarcophagus and the remarkable bronze grille.
 - A new interpretation is given for the casting technique of Verrocchio's *Christ and Saint Thomas* (c. 1467–1483, Museum of Orsanmichele, Florence).
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- The history of Verrocchio's *Equestrian Monument to Bartolomeo Colleoni* in Venice is also considered from a technical perspective, offering new insights into its execution.

The exhibition also provided an opportunity to consider Verrocchio's works in clay. An exceptional number of his three-dimensional models in clay survive from the Renaissance. These played an important role in the master's design process and the transmission of ideas to his active workshop. *Putto Poised on a Globe* (c. 1480, National Gallery of Art, Washington), is a rare example of *terra cruda* (unfired clay) sculpture. A new technical study, including chemical analysis and x-radiography, provides insights into how it was created, how it survived from the Renaissance, and how it connects to Verrocchio's works in other media. Chemical analysis allows for comparison with Verrocchio's other sculptures and microscopic examination identifies the critical introduction of minute wool fibers to reinforce the unfired clay. New investigation of *The Adoration of the Shepherds* (c. 1475/1485, National Gallery of Art, Washington) by a sculptor closely linked with Verrocchio, Francesco di Simone Ferrucci, finds that this terracotta relief was also a model, likely made for a finished work in marble.

Unlike his models, Verrocchio's finished works in clay, such as the terracotta *Madonna and Child* (c. 1475, Museo Nazionale del Bargello, Florence), were painted. The pigments and paint media on this sculpture were investigated in Florence using portable XRF and fiber optic reflectance spectroscopy (FORS) to better understand how its appearance changed over time. Two additional works by Verrocchio that are too fragile to travel were also studied at the Museo Nazionale del Bargello. *The Resurrection of Christ* (c. 1463), a large multipart terracotta relief, as well as the innovative polychrome wood *Crucifix* (c. 1475), offered further evidence of Verrocchio's practices in polychromy.

Technical studies of Verrocchio's paintings

Technical examination of select paintings focused on the artists' working methods, while noninvasive scientific analysis focused on specific materials, such as pigments and paint binders, and the visualization of undermodeling and underdrawing. This analysis provided a deeper understanding of Verrocchio's working methods and resulted in new discoveries.

For example, technical examination of the *Madonna Adoring the Christ Child (The Ruskin Madonna)* (c. 1475/1480, National Galleries of Scotland) clarified the steps used to create the architectural setting in the painting. Praised for his mastery of perspective, Verrocchio used a stylus to meticulously incise the orthogonal perspective lines and individual masonry blocks before adding the painted figures in the foreground. By studying the painting with a microscope in the conservation studio in Edinburgh, Scotland, the narrow, furrowed lines could be seen extending across the faces of both figures.

From the National Gallery of Art's permanent collection, two paintings from Verrocchio's workshop were studied. In Lorenzo di Credi's *Madonna and Child with a Pomegranate* (c. 1475/1480, National Gallery of Art, Washington), technical examination using infrared reflectography uncovered curtains at

the window and a book on the ledge, motifs shared among workshop members, that had been omitted at an early stage of the painting process. For Ghirlandaio's *Madonna and Child* (c. 1475, National Gallery of Art, Washington), microscopic study and infrared reflectography, along with scientific analysis that included x-ray fluorescence and reflectance imaging spectroscopy, found gold leaf under the edges of the painted figures, disproving an old art-historical theory that a painted landscape had been scraped down and replaced with the burnished gold background.

To study paintings for the exhibition, the scientific research department also used cutting-edge, noninvasive macroscale imaging spectroscopic methods that have been recently developed and pioneered at the Gallery, including visible and infrared reflectance imaging spectroscopy. These methods answered questions about the painting materials, including which pigments and paint binders were used, and allowed researchers to visualize undermodeling used in the development of the painted figures. Reflectance imaging spectroscopy examines how visible and infrared light is altered when it is diffusely reflected from the paint layers in an artwork. Due to the characteristic way that pigments and other materials absorb and scatter light at different wavelengths, it enables researchers to see non-visible paint layers, including undermodeling or preparatory drawings. Other advanced imaging methods were used to create maps of chemical elements that show the distribution of lead (associated with the pigments lead white or red lead), iron (associated with ochre pigments), gold (applied as a thin sheet of gold leaf), or tin (associated with the pigment lead tin yellow). These elemental maps complement the images obtained by reflectance imaging.

Technical examination using x-radiography of Verrocchio's *Madonna and Child* (c. 1465/1470, Staatliche Museen zu Berlin, Gemäldegalerie) suggested that the Virgin's green mantle was painted with a transparent green glaze in a drying oil binder over a thick paint layer of lead white, also in a drying oil binder, while the rest of the painting was executed in egg tempera, the medium that the artist generally used. To investigate this possibility in greater detail, the Gallery's custom-made, infrared reflectance imaging camera—optimized for the study of paintings—as well as a fiber optics reflectance spectrometer, were brought to Berlin to analyze the painting. The noninvasive study, conducted by the Gallery's imaging scientists, confirmed the presence of a drying oil paint binder in the Virgin's green mantle. Another new finding from the scientific analysis reveals the degree of modeling in the head, arms, hands, and legs of the Christ Child as well as the head and arms of the Virgin.

Verrocchio's *Baptism of Christ* (c. 1468/1475, Uffizi Gallery, Florence) is an important painting to study the working methods of the master and his workshop. It is one of the key paintings in Verrocchio's career—indisputably by him and his workshop—mentioned by Renaissance biographer Giorgio Vasari. The work also provides an important reference for interpreting the findings from the other paintings in the exhibition. An expanded scientific study of the painting was conducted that included visible and infrared reflectance imaging spectroscopy, high spatial resolution infrared reflectography, as well as point-based reflectance, and x-ray fluorescence measurements. Building on results from previous

studies, for example, the higher resolution infrared images provided a clearer visualization of the drawing of John the Baptist, known to have been transferred from a cartoon, a preparatory drawing traced onto the surface of a finished work. New images from reflectance imaging spectroscopy revealed a very sculptural quality to the undermodeling of Christ's proper right foot. In addition, the flesh of the angels' faces was painted in an early Italian Renaissance style. Evidence for *verdaccio* and green earth were observed underneath the surface paint, along with an egg-yolk-rich paint binder, whereas in some other areas evidence of a drying oil was found.

Press Contact:

Laurie Tylec, (202) 842-6355 or l-tylec@nga.gov

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For additional press information please call or send inquiries to:

Department of Communications

National Gallery of Art

2000B South Club Drive

Landover, MD 20785

phone: (202) 842-6353

e-mail: pressinfo@nga.gov

Anabeth Guthrie

Chief of Communications

(202) 842-6804
a-guthrie@nga.gov

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PRESS CONTACT ▼

Laurie Tylec
(202) 842-6355
l-tylec@nga.gov

Questions from members of the media may be directed to the Department of Communications at (202) 842-6353 or pressinfo@nga.gov

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