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The *Alessandri Madonna* in the Sculpture Collection of the Berlin State Museums: 'Fake' or 'Original'? Research and Restoration of a terracotta relief attributed to Luca della Robbia

This article reports on a recent restoration of a work from the Sculpture Collection of the Berlin Museums. A painted terracotta lunette representing the Virgin and Child between two angels was attributed to Luca della Robbia in the early twentieth century, before being considered a nineteenth-century forgery and remaining confined to the museum's depot for decades. The analysis shows that the object cannot date from the nineteenth century but rather from the fifteenth century.

Since 2018, the permanent galleries of the Bode-Museum count an additional object that had not been on public view for almost a century. It is a terracotta relief representing the *Virgin and Child surrounded by two Angels*, nicknamed the *Alessandri Madonna* since it was acquired in 1883 from Count Giovanni degli Alessandri (1853-1894) in Florence by the Royal Museums of Berlin (fig. 1). At the time, the relief was attributed to the young Luca della Robbia by the main person responsible for the purchase, Wilhelm Bode. This attribution was at first accepted by international scholarship: in 1894, Allan Marquand accepted the relief as a work by Luca, in the same period of the marble tribune (named *cantoria*) made by the artist for the Cathedral of Florence, i.e. in the 1430s (fig. 2)[1].

Two decades later, Marquand however classified the relief as in the «manner of Luca della Robbia», suspecting it to be a modern forgery[2]. With the death of Wilhelm von Bode in 1929, the relief lost his most ardent supporter. In 1933, the catalogue of the Sculpture Collection does not even mention the work, a sign that it was considered a forgery[3]. During the Second World War, the relief remained in the facilities of the Museum Island – which saved it from the damages of the Friedrichshain bunker. After the war, it was apparently not exhibited in East Berlin. It appeared in the literature only to be considered a forgery, as was the case in two essays by John Pope-Hennessy and Massimo Ferretti published respectively in 1980 and 1981[4]. For Pope-Hennessy, the relief is exceptional not only in its gothic shape and in the fact that it was left unglazed, but also in its tentative handling, its stylistic inconsistencies and its rather trivial sentiment. On all these grounds, he argued, the piece is likely to date from the second half of the nineteenth century, which could be established by a thermoluminescence test. Shortly after the Reunification, such a thermoluminescence test was made by the Rathgen Forschungslabor in Berlin; it did not at all confirm Pope-Hennessy's opinion,

and remained unpublished[5]. In 1992, the monumental monograph on the della Robbia was published by Giancarlo Gentilini; no word was said on the relief, as if it had completely vanished[6].

In 2017, an exceptional funding by the Bank of America allowed the relief to be analysed and restored, in a sequence that ran from August of that year to the end of 2018. From the very beginning, it was clear to all those involved that, in addition to securing the object's conservation, it was also fundamental to clarify the question of its "authenticity"[7]. After the study and restoration of the relief, it became clear that many evidences testify to a long and lively history that is incompatible with a forgery made in the nineteenth century. The purpose of this article is to explain the methodology followed and the results found.

The relief and its restoration challenge

The work, executed in high relief, shows the central figure of the Virgin Mary with her Child, flanked by two angels. The terracotta relief has been preserved in the form of an ogival lunette, which is tightly enclosed by a wooden supporting frame. This construction is itself framed by a wooden decorative frame, probably made at the time of the acquisition[8]. If the subject of the present investigation is the ceramic body with the wooden supporting structure, the decorative frame from the nineteenth century was restored in parallel by Frank Barthelt[9].

The focus of active damage is in the contact point between the ceramic and the wooden support frame. This border area of different materials has become a "stress zone", especially in case of vibrations and varying climatic conditions. This specific damage is most likely the result of transport and relocation during the evacuation and storage of the relief in the cellars of the Museum Island during the Second World War. It also turned out that the relief had previously broken into several individual parts and was covered on the back with a gypsum mortar for stabilization and re-joined with the outer supporting frame (fig. 3). On the relief as well as on the transition from frame to relief there are different layers of paint[10]. An initially discussed separation of the framing from the relief with subsequent reassembly was discarded because of an overly intensive intervention. The adopted solution was to leave the framing and the ceramic relief in their historical connection and to secure them, creating a gap between them and building a new external framework. Potential material movements can thus be absorbed without adjacent materials affecting each other.

The intent was to connect individual elements to a metal construction at the rear of the relief to simultaneously support their weight. By transferring

the "dead weight" of the individual elements, it should be possible to create a minimal expansion joint between the different materials on the frontside. For a force-fit connection of the metal construction to the ceramic by bonding, the large-area mortar layers or residues on the back of the relief had to be removed. This intervention held the danger that the fragments of the ceramic could loosen uncontrollably among themselves or from the supporting frame due to vibrations.

The Restoration. Preparation and assembly of the rear supporting structure

With the help of an X-ray-image (fig. 4) made by Christoph Schmidt (Berlin State Museums, Gemäldegalerie) it became clear that the individual parts of the wooden frame are connected with nails (square, forged). The connections of the fragments to each other and to the supporting frame are made with gypsum mortar[11].

Before removing the rear gypsum mortar mounting, the relief had to be adequately secured against possible vibrations. For this purpose, the material boundaries and the visible fragment boundaries on the front side were temporarily laminated with Japanese paper[12]. In addition, the relief was brought into an upright position and connected to a rigid support structure mounted on the workbench.

After removing the mortar residues on the back, the cracks were closed with a completion mortar as filler[13]. Afterwards, the surface for the bonding points of the metal construction was cleaned, decreased and primed with the binder of the later bonding. The metal construction made of stainless steel could now be reversibly glued to the relief and screwed to the frame (fig. 5)[14].

Expansion joint between support frame and terracotta

With the affixing of the pieces of the object to the metal construction it was now possible to insert a small expansion joint on the front side. With a micro-milling machine, the joint cut was made along the mortar joint (approximately 2 mm wide and up to 20 mm deep). This prevented direct transmission of material movements in the area of the paint layers or repair mortar layers close to the surface. After securing the cockling (flaking of paint layers)[15], the flanks of the newly added joint were infilled to match the surface level[16].

Reconstruction of a larger void (lacuna) in the garment area

The infills carried out so far followed the idea of securing and visually calming the damaged contact zone of the frame and ceramic and the edges of the inserted

joint. The "new ingredient" of the inserted mortar has very little influence on the information content of the relief. The situation is different with a larger void in the garment area of the figure of Mary, which is related to the fracture of the relief. When the relief was purchased in 1883, this area of the garment was completed with gypsum mortar and retouched. With the war-related relocation around 1945, parts of these mortar probably came loose. In 2017, a fragmentary state with larger missing parts was present. It was decided to remove the old completion and completely reconstruct the arrangement of the folds. This procedure involves two different issues. Can the original arrangement of the folds be reconstructed and how clearly should the reconstruction be readable for the beholder? As an indication of the original course of the folds, the breaking marks of the folds have been preserved. The historical completion was already a deviating interpretation of the folds shape. This can be seen, among other things, in the fact that the mortar was partly lying on the original surface and thus the course of the folds does not follow the original shape. The historical as well as the new reconstruction can only approximate the original shape. This is not only due to the size of the void, which includes complete shape changes of the folds, it is also because the fragments were not joined accurately, sometimes even offset in the surface level. The new reconstruction is based on the old fracture surfaces, on the historical reconstruction and on the formal language of the traditional arrangement of the folds. Despite or rather because of the awareness of the problem of a new addition to a work of art that is not or hardly visible, a full retouching was chosen. The reason for this was above all the wish for a homogeneous image. In the course of the history of the object, the damage to the ceramics was always subordinated to the general view or, like the intact areas, was treated in the same way. A different handling (visible additions or reduced retouching) of the new addition would have resulted in a undesirable hierarchization of the damages.

With a cautious cleaning[17] and a retouching[18] of the restored areas as well as all voids in painting layers at the front, the restoration could be finished.

After all restoration and conservation measures on the relief, the decorative frame, which was completed in parallel, could be tightly connected to the metal construction.

"Fake" or "original"?

The question of "fake or original" implies the possibility of a direct answer. However, the lack of clear written evidence has repeatedly led to various attributions in art historical discourse, up to and including almost complete

oblivion. The examination of the relief made it possible to document a variety of findings that have become very important for answering the initial question.

The Findings. The layers of paint

A first important clue for a possible dating was the painting layers on the terracotta and the wooden supporting frame. Several layers of paint with voids, some of which were retouched, indicate several phases in the coloration of the relief.

The image taken by means of simplified infrared reflectography (fig. 6)[19] clearly shows a fragmentary and aged painted surface. This consists of four painting phases (fig. 7), whereby the oldest painting surface phase was only defined by a small single finding. The four painted surface phases consist of a different number of layers each. Around it there are several very thin and partly weak bonded layers, which were classified as retouching or repairs and appeared more transparent in the IR image.

Between the painted surface phases 1, 2, and 3 there are layers of gypsum in several places, which are gypsum relining of voids[20]. No evidence of a polychrome surface could be found. In painted surface phase 1, a "grey" was found on a relining and a glue primer. Whether the "grey" is a grounding or part of a poly-chrome surface could not be clarified due to the singular finding. The remains of this painted surface phase are the only ones that most likely date from before the relief was broken[21]. This layer consists of a mixture of gypsum, ochre and ivory black[22]. The following phases of the painted surface appear in earth colors – brownish, reddish, or ochre. It is assumed that most of them are imitations of terracotta colors[23]. In the multi-layered painting phases, a change in the play of colors was probably achieved by varying or scumbled layer coverings. For the phases 3 and 4 a tempera could be determined as a binding agent[24]. The pigments are, besides the earth colors, lead pigments, barium sulphate, ivory black as well as gypsum and probably chalk (calcium carbonate) as coloring components. In phase 4, cadmium sulphide was analysed for the yellow pigment components. This finding provides a first opportunity for dating. In any case, the painting layers from phase four onwards are younger than the first third of the nineteenth century[25]. Due to their long tradition of use as painting layer components, all other pigment elements examined are not dating parameters for this object. Except the phase 1, which was found in the area of a very early relining[26], all other painting phases are equally arranged over the relief and the wooden supporting frame. On the supporting frame, the findings are thinner or less complete, but on the joint

fillings between the frame and the pottery, the painting phases are completely visible. This leads directly to the question: When was the wooden support frame installed?

The support frame

The support frame connected to the relief consists of seven individual parts, the majority of which are interlocked by laps. In the X-ray image (see fig. 4), metal nails (square, forged) could be documented, which in their position match the respective wood joints. Re-linings of the frame consist of a lime mortar. The use of glue as an adhesive was not further investigated. Probably the best known and most accurate way of dating woods is by using Dendrochronology. However, this is not applicable to poplar wood – as is present in this case[27]. For this reason, a dating by Radiocarbon examination (^{14}C)[28] was carried out. The examination of a first sample from the surface of the supporting frame revealed three possible time periods[29]. By taking a second sample (sample taken at a lower level, below the first), the result could be more precise[30].

A comparison of the two dating results leads to the conclusion that the most probable dating period is 1644-1670[31]. Consequently, in the period 1644-1670 the fragments of the terracotta relief were connected to each other and to the supporting frame with a gypsum mortar[32].

Mortar findings on the back of the relief

When the mortar mounting on the back side of the relief was removed, the findings indicated that there must have been a time gap between the breakage of the relief and the connection with the supporting frame.

The distribution of the gypsum mounting on the back of the relief was clearly oriented to the fracture pattern of the ceramic. It can be assumed that the fracture of the relief was secured with gypsum mortar in a makeshift manner. The arrangement of the mortars is not only evidence of a chronological sequence, it also shows that the fragments secured with gypsum mortar broke apart further before being inserted into a supporting frame (fig 8). It is not possible to answer whether damage caused the need for a wooden support frame or whether the fragments had to be separated again before they were fitted into the frame. However, it does indicate the possibility that some time must have passed between the fracture and the support frame. During the removal of the gypsum mortar, an enclosed wood fragment was secured. Radiocarbon dating of

this fragment revealed two possible time periods: 1458-1524 and 1558-1632[33]. Another finding could be used to specify these dating.

Under the gypsum mortar for the emergency measures there were remains of a lime plaster. At one point it was even possible to secure the complete plaster structure (two layers) with overlying painting layers (four layers) in the form of lime whitewash (see fig. 11). This finding points to a phase of the relief which must have been before the break and indicates the use of the relief in a special architectural context[34]. For the dating of this lime plaster layer, the fragment of a leaf could be separated from the mortar.

A radiocarbon investigation[35] was able to determine the period of origin of the leaf to the years 1486 to 1644. Compared with the dating results of the gypsum mortar mounting, it is obvious that the periods overlap strongly, although the gypsum mortar was certainly applied after the plaster mortar.

Even if the wood fragment from the gypsum mortar comes from a much older wood used secondarily, the only time period that can be used to date the gypsum mortar is after the beginning of the lime mortar period (leaf). If a plaster surface has been painted up to four times, a lifetime of several years to decades can be assumed. This makes it clear that the dating of the lime plaster layer (leaf) must have a corresponding "advance". Similarly, it can be determined for the lime mortar that it cannot be younger than 1632 – the latest limit of the gypsum mortar period. This creates a time window for the lime mortar of the still intact relief from ca. 1486 to 1632 and for the gypsum mounting from ca. 1500 to 1632. This specification corresponds to a 97% probability that the dates searched for are included. The result can be mathematically further modelled by the secured facts of a temporal sequence of the findings. By Bayesian modelling (Bayes factors, probability calculation), the time spans can be further limited. Thus, considering the stratigraphy, the time span for the plaster mortar is in the range of 1474-1617 (95%) and for the gypsum mortar is it in the range of 1555-1634 (80%) (fig 9).[36]

The breakage

Why the relief is broken we do not know. According to previous knowledge, material-technical irregularities have at least benefited the fracture. After the removal of the mortar layers, the relief shows an irregular rear surface and, as a result, very different wall thicknesses of the ceramic. The impression of a wooden board has been preserved on the back. This board, as part of the former working surface, originally stood out of the remaining ground in a higher position (approximately 1 cm). A deliberate measure or an accepted lack of alternatives?

We can no longer reconstruct the motivations of the originator. However, we can see that the artist was aware of the problems that such an edge in the working surface can cause when the clay object is dried and removed. The edge in the working surface was covered with moistened strips of textile (negative impressions) to avoid or reduce material tensions (fig.10).

The large vertical break, which divides the relief from top to bottom into two parts, is almost congruent with the offset landing on the back, i.e., the transition from thicker to thinner relief wall thickness. From this "predetermined breaking point" two further cracks lead horizontally through the right angel figure. Observations at the edges of the cracks and in the X-ray-image suggest that the gaps between the lumps of clay that were placed next to each other when the relief was built up promoted the crack. Without further evidence, the date of the break can only be vaguely narrowed down in the limits of the mortars before and after the break - probably in and around the sixteenth century.

Wire loop

The lime mortar residue with the overlying painting layers on the back was a stroke of luck for the questions within the project. Its existence, however, has a simple explanation. The preserved area, approximately 10x10cm, has therefore survived all changes to the relief well because it was in the area of a wire loop. This loop, anchored in the ceramic relief, functioned as a "reinforcement". It was probably used before the plaster was applied as a kind of "tilt protection" or "fastening". There are no further indications as to the length of time between the installation of the wire loop and the plastering of the rear side. After plastering, the wire loop was cut in the middle and the ends were inserted into a deepening of the lime mortar and then covered with gypsum. The painting layers of the lime mortar with simple lime-wash coats lie on the lime mortar and the gypsum filling in equal measure. Therefore, and because of a filler (gypsum) fixed the wire in level of the ceramic back side, it can be assumed that the wire loop can be dated before the lime mortar and after the firing of the ceramic. It is the oldest detectable intervention in the substance of the relief (fig. 11).

The Ceramic

The firing of a ceramic is an important clue for dating. In 1992, we already mentioned that a thermoluminescence dating was already carried out to determine the time of firing. The period 1403-1467 was ascertained for the

Alessandri Madonna[37]. In connection with the firing, damage has occurred (scaling a loss of them in the area of the posterior part of Maria's head) which suggests that the author lacked experience in handling objects of this size during the fire[38].

Using a thin section and a powder sample of approximately 1.5g, the composition of the clay and changes in individual indicator minerals were examined by means of X-ray fluorescence[39]. The clay used is characterized as a fine, fine-micaceous clay without added tempering. The evidence of fine mica and the decomposition products of calcite allows the conclusion that the firing temperature was around 800°C[40]. The comparison with two investigations of archaeological finds from Tuscany[41] – Arezzo (Roman), Montelupo (around 1400) – showed a very high agreement, especially in the area of trace elements (fig 12). The use of a very similar clay in the three samples speaks for the common origin of the clay deposits in the Arno Valley (Tuscany).

If one compares in the literature the results of research into the clay composition of other artists or works of art of the Italian Renaissance with the values of the *Alessandri Madonna*, one can very clearly see a further indication of the origin of the clay in the Greater Florence area. Especially the high congruence with the values of the main elements of a sculpture from the Louvre in Paris is remarkable[42] (fig. 13). The figure of the *Seated Virgin holding the sleeping child on her lap* (R.F.587), attributed to Luca della Robbia and dated between 1425-1430, is most likely made of the same clay as the *Alessandri Madonna*.

Conclusion

The aim of the restoration was to secure the object with the minimal possible intervention and return it to the museum's permanent exhibition. Changes and new additions were subordinated to the historically preserved impression. The findings documented during the restoration work now allow a better historical classification of the *Alessandri Madonna*. Firstly, many findings refer to a Tuscan place of origin; secondly, they date back to the fifteenth or sixteenth century There are also findings that speak for changes in the following centuries (fig. 14). Not every finding could be examined in detail or interpreted beyond doubt and many questions remain. Nevertheless, in connection with the scientific investigations, a chain of evidence is emerging which points to a work from the early fifteenth century of the Tuscan or Florentine Renaissance. The parallel to a work in the Louvre, also attributed to Luca della Robbia, is less a proof of authorship than an indication of the direction of further research and reflection. In such a publication, it is impossible to mention all the findings made during

the restoration; all are documented in the archive files of the Sculpture Collection Restoration Department. One of which is the many fingerprints that have survived in fragments. Perhaps one day these could be convincingly used to identify the author of the relief?

1 A. Marquand, *The Madonnas of Luca della Robbia*, in «The American Journal of Archaeology and of the History of the Fine Arts», 1, 1894, pp. 1-25.

2 A. Marquand, *Luca della Robbia*, Princeton, 1914, p. 228.

3 F. Schottmüller, *Die Bildwerke in Stein, Holz, Ton und Wachs*, Berlin, 1933.

4 J.Pope-Hennessy, *Luca della Robbia*, Oxford, 1980, pp. 273-274, cat. 85; M. Ferretti, *Falsi e tradizione artistica*, in *Storia dell'arte italiana*, 3. *Situazioni, momenti, indagini*, 3. *Conservazione, falso, restauro*, a cura di F. Zeri, Torino, 1981, s. p., fig. 225: «Imitatore ottocentesco di Luca della Robbia».

5 Museums internal investigation report *Datierung von Skulpturen aus SKS*, Rathgen Forschungslabor, 29 June 1992.

6 G. Gentilini, *I Della Robbia, La scultura invetriata nel Rinascimento,* Firenze, 1992.

7 Julien Chapuis, Deputy Director; Neville Rowley, Curator; Paul Hofmann, Head of Conservation, Skulpturensammlung und Museum für Byzantinische Kunst, Berlin.

8 The frame is described as modern in W. Bode, H. von Tschudi, *Königliche Museen zu Berlin. Beschreibung der Bildwerke der christlichen Epoche*, Berlin, 1888, p. 37, cat. 113. The earliest available photograph after the 1883 acquisition shows the relief with the ogival decorative frame (W. Bode, *Luca della Robbia ed i suoi precursori in Firenze*, in «Archivio Storico dell'Arte», 2, 1889, pp. 1-9, rif. p. 8)

9 Freelance graduate restorer, Potsdam.

10 Around 1900, the description of the object in the inventory book of the Kaiser-Friedrich-Museum mentions, in addition to information on the acquisition, the fact that the relief was «unpainted» (archive of the Bode-Museum).

11 All mortar analyses were carried out by the Labor für Baudenkmalpflege Naumburg, Prof. Dr. Robert Sobott (thin sections, qualitative determination of the mineral phases using energy dispersive X-ray fluorescence analysis EDXRF and X-ray powder diffraction XRD).

12 Before the Japanese paper mounting could be applied, the layers of paint had to be strengthened in the corresponding areas. The risk of simultaneous dissolving of the frame layers during the removal of the mounting was countered by using different adhesives or adhesive concentrations (sturgeon glue, Tylose).

13 The completion or filler masses are based on an aggregate mixture of quartz, marble, and brick powders and an acrylate (Primal AC35) as binder (10-20%).

14 Design and production of the metal construction by Hans Höpfner (metal worker Berlin), bonding with cold-curing polymer Kalloplast R+AC. The bonding was carried out with a paste-like adhesive mass adjusted with marble powder (recipe by Paul Hofmann, Head of Conservation, Skulpturensammlung und Museum für Byzantinische Kunst, Berlin).

15 Different concentrations of sturgeon glue.

16 Fine mineral powder/alumina (bolus) with various binders were used for the relining. For the areas with mineral subfloors acrylate-bonded and for the wooden subfloors masses with sturgeon glue were applied.

17 Removal of loose dirt deposits (water-ethanol mixture).

18 Full retouching with watercolors.

19 The picture was taken with a modified Canon EOS 550D (removal of the IR-cut filter and addition of a pass filter, which allows IR radiation to pass only from a wavelength of 807 nm). 20 Most of the samples taken come from damaged areas, which also showed damage in the past and therefore often show remnants of re-linings.

21 The reason for the low number of findings in the area of the phase 1 could be cleaning measures or the removal of the painting related to the fracture.

22 Investigation of painting remnants by Dr. Sylvia Hoblyn, chemist for analytics and spectroscopy, Radebeul, cross section samples (light microscopy, UV fluorescence, determination of the main element distribution by means of SEM/EDX, determination of organic layers by means of infrared spectroscopy).

23 Within this project, the color shades were assessed purely visually based on the findings on the object or the cross sections under the microscope. Environmentally caused pigment changes (browning, blackening or other bleaching) have not been specifically investigated. Such a change is quite possible, since nothing is known about the place of presentation or storage of the relief so far. Element analysis revealed conspicuous accumulations of chloride values in some findings, which could indicate that pigments have been "weathered".

24 Binder analyses by Dipl. Chemiker Frank Mucha, University of Applied Sciences Erfurt (Cross section samples, light microscopy, UV fluorescence, determination of organic layers by pyrolysis gas chromatography/mass spectroscopy Py-GC/MS).

25 Cadmium sulphide or-yellow was first produced in the laboratory in 1818 and was manufactured in Germany from 1825. From H.-P. Schramm, B. Hering, *Historische Malmaterialien und ihre Identifizierung*, Graz, 1988.

26 These relining are related to damages that probably occurred during the firing of the pottery (see passage *The Ceramic*).

27 Investigations by Dipl. Rest. Marion Böhl, Skulpturensammlung und Museum für Byzantinische Kunst, Berlin (Fibre Analysis, Microscopy).

28 Dr. Ronny Friedrich, Klaus Tschiara Centre for Archaeometry, University of Heidelberg, CEZ Archaeometry gGmbH.

29 The period between 1630 and 1950 is generally problematic for radiocarbon dating because of multiple results (recurring peaks in the calibration curve).

30 During radiocarbon analysis, impurities lead to falsification of the result. For this reason, the sample material is pre-treated in the laboratory. In the present case, contamination, especially of the first sample, by residues of organic binders (surface treatment) and calcium carbonate (relining) is very likely. Contamination with "younger" particles falsify an age specification to be dated to a younger point in time.

31 Besides the working hypothesis that it is probably the period from 1644 to 1670, it should be noted that the radiocarbon results limit the period of felling of the tree. A longer storage or a second use of the wood cannot be excluded.

32 This is a gypsum mortar which, in addition to components such as calzi, dolomite and quartz, consists mainly of a hemihydrate of gypsum, the bassanite (studies by Prof. Dr. Robert Sobott, Laboratory for the Preservation of Historical Monuments Naumburg - thin sections, qualitative determination of the mineral phases by means of energy dispersive X-ray fluorescence analysis EDXRF and X-ray powder diffraction XRD).

33 See note 28.

34 The ogival shape of the relief and the fact that it is visible on both sides speaks in favour of an ogival wall opening, possibly in the area of a doorway (lunette).

35 See note 28

36 This high probability figure (2-sigma) corresponds approximately to a doubling of the range of the measured standard deviation (1-sigma). The time periods of 1-sigma are more limited, but there is "only" a probability of 68,2%. General information on examination methods and interpretation of the results of radiocarbon dating by Dr. Ronny Friedrich, Klaus-Tschiara-Archeometry-Centre, University of Heidelberg, CEZ Archeometrie gGmbH and M.A. Geyh, *Erwartungen und Enttäuschungen bei der Deutung von 14C Daten*, in *Beiträge zur Siedlungsarchäologie und zum Landschaftswandel*, conference proceedings (Regensburg, 9-10 October 2000; 2-3 November 2000), Regensburg, 2001, pp. 59-75.

37 Investigation report *Datierung von Skulpturen aus SKS* by Rathgen Forschungslabor, 29 June 1992. For objects from collections, the problem with TL (thermoluminescence) is that a necessary calculation value (dose rate from a defined and continuously acting environment) cannot be measured and must therefore be estimated. Thus, the uncertainty regarding the determined age can be plus/minus 25% (S. Berry, *Antike im Labor,* Darmstadt-Mainz, 2012, p. 58).

38 The observed damage may have already been applied when the clay model was drying, or temperature-dependent material loads within the firing chamber may be assumed. With reference to the appearance of the glazed terracotta works by Luca della Robbia, it is assumed that there must have been a certain start-up period or test phase in dealing with terracotta: «(...) his earliest works often show a mastery of materials and technique, implying a sustained period of experimentation at least from a decade earlier». *Earth and Fire. Italian Terracotta Sculpture from Donatello to Canova*, exh. cat. (Houston, Museum of Fine Arts, 18 November 2001 – 3 February 2002; London, The Victoria and Albert Museum, 14 March – 7 July 2002), ed. by B. Boucher, New Haven-London, 2001, p. 13.

39 Investigation report of 18 September 2018, carried out by Malgorzata Daskiewicz and Gerwulf Schneider, Freie Universität Berlin (Cluster of Excellence 264-Topoi) and Laboratory ARCHEA Warsaw (qualitative determination of the mineral phases by means of energy dispersive X-ray fluorescence analysis EDXRF and X-ray powder diffraction XRD) and Michael Köhler MkFactory Berlin (thin sections).

40 Between 700 and 850°C firing temperature carbonates are decomposed with the release of carbon dioxide (*Science and Conservation for Museum Collections*, ed. by B. Fabbri, Firenze, 2012, p. 158). Related to the lack of knowledge of the fire process (kind of oven etc.), deviating temperatures are possible with such a large object. The powder sample was taken centrally on the backside by means of small holes.

41 The same investigation by Daskiewicz and Schneider (see note 39).

42 Despite the use of two different methods of element determination (Paris Louvre - ICP-OES; Berlin XRF), the results are surprisingly close. Possible deviations in the examination results

when using different examination methods are often discussed and also documented (e.g.: A.H. Elzian *et al*., *Comparison between XRF, PIXE and ICP-OES Techniques - Applied For Analysis of Some Medicinal Plants*, in « IOSR Journal of Applied Chemistry», 4, 2016, pp. 6-12). There are comparative test series on terracotta objects that describe the resulting deviations as very small (M.L. Amadori *et al*., *The Altarpieces of Della Robbia atelier in Marche region: investigation on technology and provenance*, in «Applied Physics A - Materials Science & Processing», 113, 2013, pp. 1129-1141).

Fig. 1: *Alessandri Madonna*, Staatliche Museen zu Berlin, Skulpturensammlung und Museum für Byzantinische Kunst, after the restoration in 2018. Photo: © C. Schneider.

Fig. 2: The *Alessandri Madonna* in the Sculpture Collection of the Kaiser-Friedrich-Museum, Room 25, 1904. Photo: Staatliche Museen zu Berlin, Zentralarchiv ZA.2.18.-1002.

Fig. 3: Pre-state, back – ceramic relief with gypsum stabilization and supporting frame © C. Schneider.

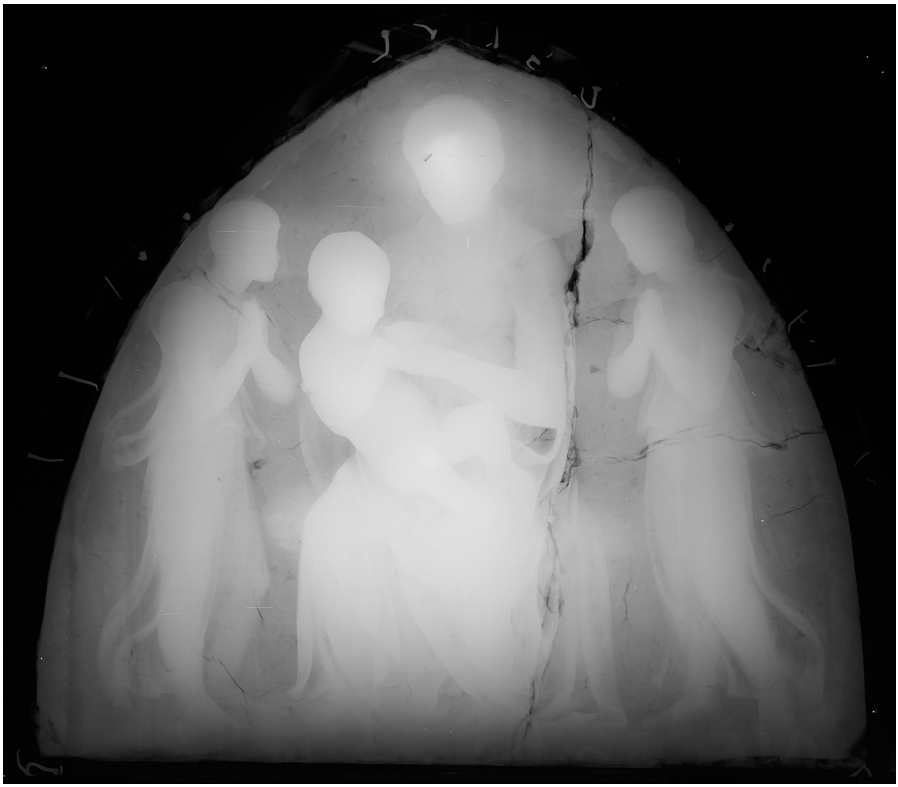

Fig. 4: X-ray image of the relief with clearly visible cracks and nails in the area of the support frame. Photo: © Staatliche Museen zu Berlin, Gemäldegalerie / C. Schmidt.

Fig. 5: Support metal construction on the back after the restoration in 2018.
Photo: © C. Schneider.

Fig. 6: Image of simplified infrared reflectography. Retouching on areas with complete loss of painting can thus be made visible. Photo: © C. Schneider.

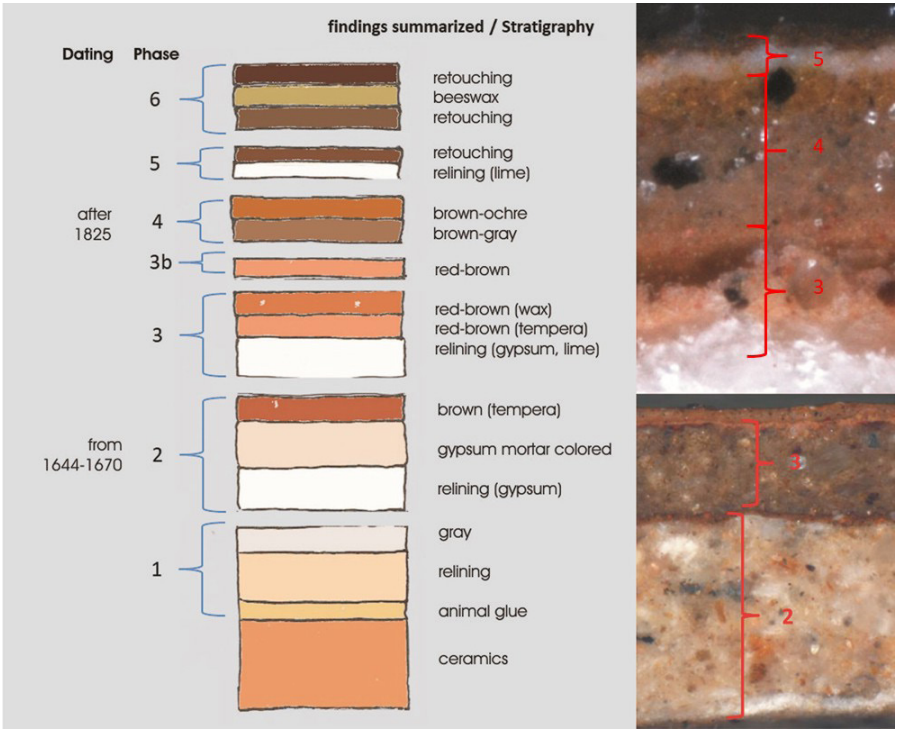

Fig. 7: Stratigraphy of painting layers. Photo: © C. Schneider.

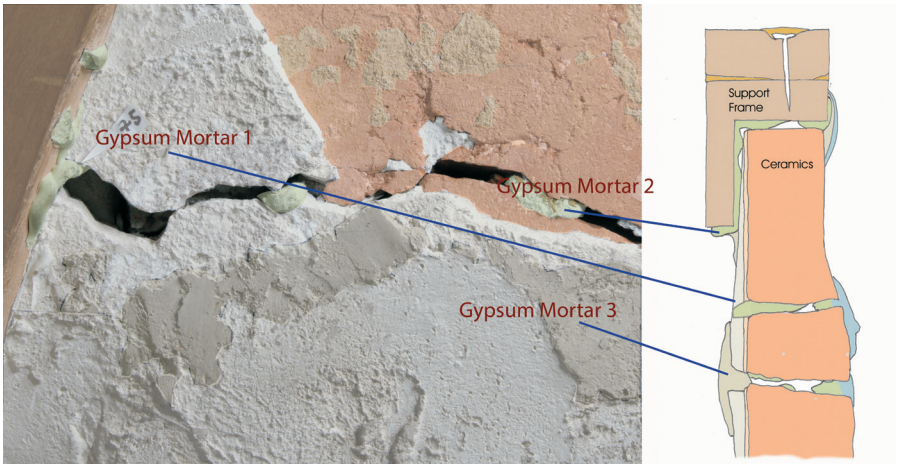

Fig. 8: Stratigraphy of the plaster mortar around the break joint (back). For better differentiation, the features in the picture on the left are coloured after the schematic drawing on the right. Photo: © C. Schneider.

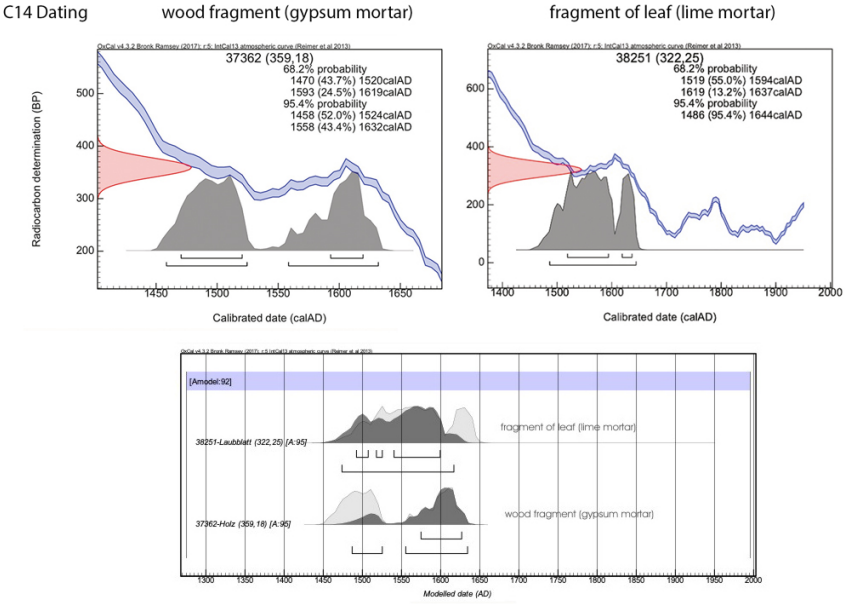

Fig. 9: Measurement diagrams C14 method. Individual measurements (top) and narrowing down the results using probability calculation (Bayesian model, bottom). Photo: © C. Schneider.

Fig. 10: Sidelight image of the backside after the removal of the mortar layers, schematic illustration (below) of a horizontal section trough the relief. The gaps between the lumps of clay, the vertical break parallel to the vertical offset due to the impression of the wooden board as well as the rectangular imprints of fabric panels around this edge are clearly visible. Photo: © C. Schneider.

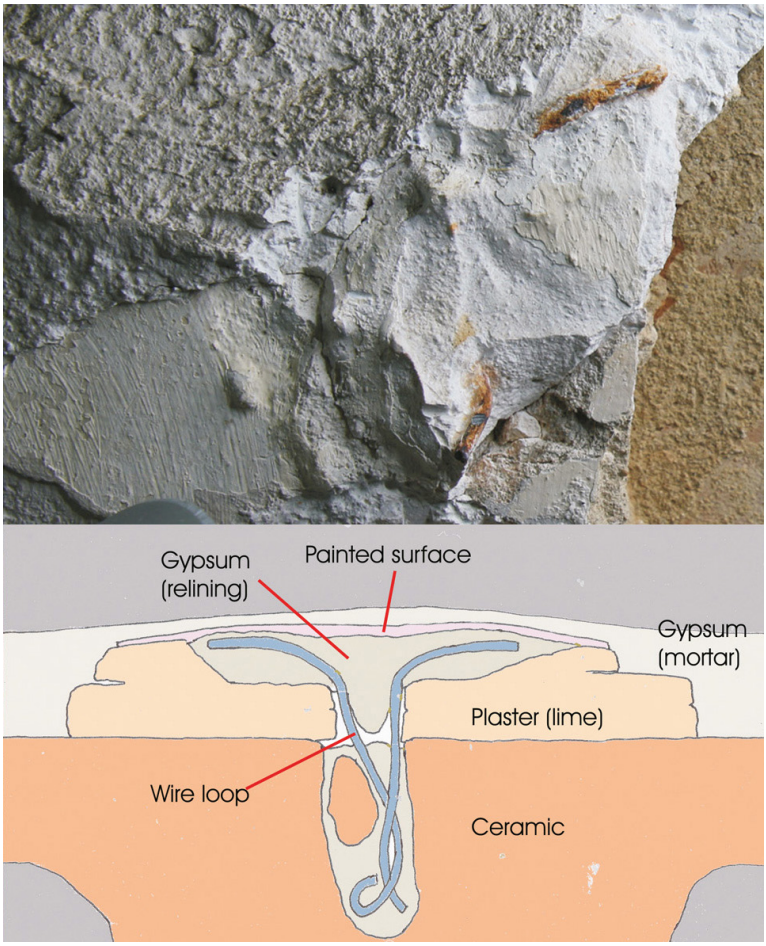

Fig. 11: Finding of the remains of lime plaster and the wire loop (top view) with schematic illustration of the stratigraphy (sectional view). Photo: © C. Schneider.

Spurenelemente		V	Cr	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb	Ba	La	Ce	Pb	Methode
Alessandri Madonna (1)	ppm	133	186	110	71	121	148	219	37	203	16	634	36	63	48	XRF
Majolika Montelupo um 1400 (1)		139	189	100	292	115	172	219	35	150	14	413	35	66	156	XRF
Terra Sigillata, Arezzo, römisch (1)		123	188	100	48	119	139	283	28	151	13	877	38	78	21	XRF
Montecassiano Altar, Marco della Robbia, 1527-1530 (3)		110	85	73	37	146	73	435	24	111	10	185	22	48	666	XRF
(1) Daszkiewicz/Schneider, FU Berlin, Exzellenzcluster Topoi Archäokeramik, Labor ARCHEA Warschau 2018																
(3) Amadori u.a. 2013 The altarpieces of Della Robbia atelier in Marche region: investigation on technology and ..																

Konzentration der Hauptelemente in Oxidprozent		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Methode
Alessandri Madonna (1)	(Gew.%)	61,61	0,846	17,53	6,81	0,151	2,92	5,91	1,25	2,78	0,18	XRF
Jungfrau und Kind, Luca della Robbia zgs. 1425-1430 Louvre (2)		61,44	0,83	17,34	6,92	0,12	2,81	5,52	1,55	2,9	0,24	ICP-OES
(1) Daszkiewicz/Schneider, FU Berlin, Exzellenzcluster Topoi Archäokeramik, Labor ARCHEA Warschau 2018												
(2) A. Bouquillon "Terre, vivi per me cara e gradita ..." in Della Robbia - dieci anni di studi dix ans dètudes (2011)												

Fig. 12: Trace elements, clay (ceramic) of the *Alessandri Madonna* in comparison with other ceramic objects from central Italy © Photo: C. Schneider.

Fig. 13: Main elements, clay (ceramic) of the *Alessandri Madonna* in comparison with a *Virgin and child* attributed to Luca della Robbia (Louvre, Paris), from other ceramic objects from central Italy. Photo: © C. Schneider.

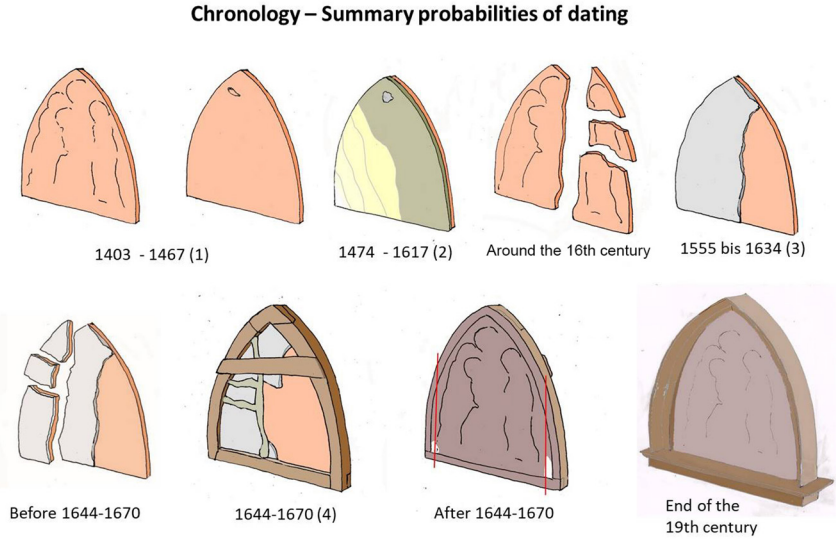

Fig. 14: Chronology – Summary of probabilities of dating. Photo: © C. Schneider.