NY CARLSBERG GLYPTOTEK — THE COPENHAGEN POLYCHROMY NETWORK

Tracking Colour

The polychromy of Greek and Roman sculpture in the Ny Carlsberg Glyptotek

Preliminary Report 4, 2012

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The Copenhagen Polychromy Network is an interdisciplinary body formed in 2004 on the initiative of the Ny Carlsberg Glyptotek to conduct research on ancient sculptural polychromy, primarily but not only, in the collections of the Glyptotek.

PARTICIPANTS IN THE COPENHAGEN POLYCHROMY NETWORK 2012

- Ny Carlsberg Glyptotek
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- The School of Conservation of The Royal Academy of Fine Arts, Copenhagen
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- The Nordic Center for Earth Evolution, Natural History Museum of Denmark
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- The Institute of Chemistry, Technical University of Denmark, Copenhagen
  Rolf W. Berg, Ph.D., associate professor
- Lund University, Department of Archaeology and Ancient History and Humanities Lab
  Nicolo Dell'unto, Ph.D.,assistant professor

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- M. Abbe (The University of Georgia)
- D.H. Abramitis (The Metropolitan Museum of Art, New York)
- B. Bourgeois (C2RMF, Paris)
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- V. Brinkmann (Liebieghaus Skulpturensammlung, Frankfurt am Main)
- A. Claridge (Royal Holloway, University of London)
- U. Koch-Brinkmann (Frankfurt am Main)
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The members of the panel are in no way responsible for the content of the present Report.

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Contents

Preface

This 4th preliminary report follows the pattern of the earlier ones, for the years 2009, 2010, and 2011. The reports may be downloaded from the project website at trackingcolour.com.

The 2012 report has three main contributions. Two articles deal with the investigation of sculptures in the Glyptotek: the first, by Maria Louise Sargent, is on three Etruscan terracotta antefixes of the 5th century CE; the second, by Rikke Hoberg Therkildsen, reports on her examination of a 2nd century CE marble female head from Aphrodisias. In a third article, Chelsea Alene Graham writes about 3D-digitization and its uses in the context of the Tracking Colour project.

The other sections of the report offer information on our activities in 2012, and – through the abstracts from the 2012 Round Table meeting at the Liebieghaus in Frankfurt – an impression of work being done by our colleagues abroad.

The Tracking Colour project of the Ny Carlsberg Glyptotek and the Copenhagen Polychromy Network remains indebted to the Carlsberg Foundation which has funded our activities since June 2011 and will do so until May 31, 2013.

We are equally grateful for the important donations made by the A.P. Møller & Chastine Mc-Kinney Møller Foundation and the Kirsten & Freddy Johansen Foundation in support of projects in 2013–2014.

The existence of the Network is crucial to the project and we thank our Network partner institutions very much for their support. Of these partners, Mikkel Scharff, M.Sc. and Head of Department at the School of Conservation in Copenhagen, must once again be singled out for special thanks. He has continued to play a key role by supervising, supporting and encouraging the students from the School active in our project. His constructive advice and encouragement is much appreciated. Other partners are thanked individually in connection with the work reported on here.

In 2012, the Department of Archaeology and Ancient History and Humanities Lab of Lund University joined the Network. This came about through the work done by Chelsea Graham on a sculpture in the Glyptotek. We hope collaboration will continue in 2013, to our mutual benefit.

As director of the project, I thank all who have made a contribution this year's work and to this report. Most particularly, my thanks go to the core members of the team, project conservators Maria Louise Sargent and Rikke Hoberg Therkildsen, and PhD fellow Amalie Skovmøller.

Finally, I thank everybody at the Glyptotek for the support they have given, not least our technical staff under the direction of Karl Adrian.

Jan Stubbe Østergaard
Editor

On behalf of the Ny Carlsberg Glyptotek and the Copenhagen Polychromy Network

‘Tracking Colour’ in 2012

Jan Stubbe Østergaard

PROJECT FINANCING

Within its two year grant, the Carlsberg Foundation will provide funding until May 31st, 2013 for the core staff of one full-time classical archaeologist and two half-time project conservators. A full time position for a classical archaeologist ended March 31st, when Amalie Skovmøller started work on her Ph.D.

In December 2012 we received the welcome news that the Kirsten & Freddy Johansen Foundation has decided to support an important polychromy reconstruction project involving a marble copy of a Roman portrait in the Glyptotek (IN 821). With the grant received earlier from Dronning Margrethe og Prins Henriks Fond, we can now start up. Skovmøller will be working together with Rikke Therkildsen on this exciting venture and they will no doubt give more detailed information on its development in our 2013 report.

A further, very generous donation was made by the A.P. Møller & Chastine Mc-Kinney Møller Foundation, for the polychromy exhibition planned for 2014. We can now move confidently ahead on that important element of the Tracking Colour project.

THE NCG TEAM

The writer of these lines has served as project director throughout 2012. Maria Louise Sargent, now M.Sc. after having submitted her final thesis in 2011 on the methodology of documentation and investigation of ancient sculptural polychromy, continued in her half-time position as project conservator. Project conservator Rikke H. Therkildsen, B.Sc., completed her Master’s thesis in 2012, entitled “Antique Sculptural Polychromy. An Examination of Three Roman Portraits in Polished Marble” (in Danish only).

The project has profited from having Charlotte Eschen, B.A. and B.Sc. from the School of Conservation, on a 2-month internship in the spring, connected with her final thesis, on “Sculptural Encaustic, Ganosis and Ceroplastic in Antiquity”.[1] It was submitted in December and Eschen will now doubt become M.Sc. shortly.

Pernille Kokfelt, B.A. and M.Sc., spent three weeks with us as an intern. She assisted Maria Louise Sargent in the work space, learning about the uses of the VIL imaging technique and taking part in the activities organized for visitors to the Glyptotek during ‘Forskningens Døgn’, a three day festival highlighting research activities across Denmark.

Amalie Skovmøller began her three year Ph.D. fellowship on April 1st, under the auspices of the Department of Classical Archaeology at the Saxo Institute of the University of Copenhagen. The funding for the Ph.D. was generously provided jointly by the Augustinus Foundation and the Ny Carlsberg Foundation while the Glyptotek acts as host institution. Skovmøller’s subject is the polychromy of Metropolitan Roman portraits. She remains closely connected with the team.

In the spring, assistant professor Nicolo Dell’Unto of the Humanities Lab at Lund University[2] contacted us on behalf of a student of his from the department of Classical Archaeology, Chelsea Graham. She needed a to do a case study for the MA thesis she was writing on

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1 Eschen investigated our Fayum mummy portraits, our 1st century BCE statue of Kybele, IN 480, and the Palmyrene funerary portrait IN 2795, the ’Beauty of Palmyra’. She will be writing about her work in our 2013 report.

2 http://www.humlab.lu.se/

digitization and ended up working on our Roman portrait IN 821. The results are presented in this report.

The main project has thus provided a platform for three theses in conservation, as well as a thesis and a Ph.D. project in classical archaeology. This bodes well for further, future development of our project.

THE CPN PARTNERS AND OTHER LOCAL CONTACTS

The Humanities Lab at Lund University has now joined the CPN and we look forward to further collaboration in 2013.The Copenhagen Polychromy Network partner institutions are otherwise the same as before and their representatives have assisted the project with advice, access to instruments and analytical studies of pigment samples. The contribution made by the partners will be described in more detail elsewhere in this Report, but special mention should be made of our collaboration with the School of Conservation. We were also pleased that one of professor Minik Rosing's graduate students in geology, Peter Fink-Jensen, chose analysis of lead isotopes from the red lead on our Head of Zeus, IN 1664, as a subject for his Master's thesis.[3]

As foreseen in 2011, binding media analysis has been conducted in 2012 by the Department of Conservation at the National Museum of Denmark.

Contact has been established with the Danish National Research Foundation's Centre for Textile Research, based at the University of Copenhagen.[4] Since texturing of marble surfaces and its relationship to subsequent polychromy is an important aspect of Skovmøller's Ph.D., she will surely profit from a dialogue with the international team of specialist at the CTR.

THE INTERNATIONAL NETWORK

Relations with colleagues abroad have been actively maintained in 2012. The project has presented papers at meetings in Heidelberg, Rome and Frankfurt am Main – the latter being the venue for this year's Round Table, successfully organized by the Antikensammlung of the Liebieghaus. And, happily, colleagues from abroad have come to Copenhagen to visit us.

We have been in an especially close dialogue with the British Museum's Department of conservation and scientific research and of Greece and Rome for several years. It has been particularly intense in 2012 when we joined forces with the Collection of Classical and Near Eastern Antiquities at the National Museum of Denmark in developing a consortium research project. Our bid was unfortunately unsuccessful but a lot of useful ideas resulted. The Glyptotek and the British Museum are now looking ahead and continuing their collaboration.

THE VISUAL EXAMINATION WORK SPACE AND INSTRUMENTATION

In the spring of 2012, it became clear that the project work space would have to be moved. Lack of space and the laborious process needed to create black-out conditions for techni-

3 "Lead isotopes in pigments from a 1st century BCE Roman sculpture – A study of provenance and Roman ore extraction techniques" (working title). This research continues that initiated by Minik Rosing in Rosing and Østergaard 2009.

4 http://ctr.hum.ku.dk/

cal photography meant that working conditions for the project conservators were far from ideal. It was therefore decided to remove to a location behind the scenes. This has meant loosing the very close contact we had with our visitors, but it has certainly improved the aesthetics of the gallery. And the new space is far better suited to our purposes (fig. 1). In the gallery, we continue to offer the public information on the project and visitor tours to the new work space take place quite regularly.

Being sufficient, the instrumentation available for visual examination did not undergo significant changes in 2012.

'TRACKING COLOUR' ONLINE

The database and website solution for management and communication of our project and its digital data assets was launched in April at www.trackingcolour.com.[5] The site was made possible by the Carlsberg Foundation grant and is functioning satisfactorily.

One of our objectives in constructing the site is that the database will eventually become an integrated part of an electronic publication of the results of the NCG/CPN Tracking Colour project. Now that the base is there, we can begin to discuss how best to proceed. A very first step will be taken in this report: in a number of instances, the reader will find links to the information on individual sculptures offered on the front end of the Tracking Colour site. In this overview of 2012, there are therefore fewer illustrations in the actual pdf, but access to far more is provided. Links to the full, back end data sets will be tried out in our 2013 report – by that time we hope to have a rather clearer idea of what the possibilities and requirements of electronic publication are. We would very much welcome input on the subject from readers of this report. Critical comment on the project site as such are also needed.

INVESTIGATIONS IN 2012

ETRUSCAN ARCHITECTURAL TERRACOTTAS

In 2011, Maria Louise Sargent made the first examination of the polychromy of an object in the Etruscan collection of the Glyptotek, the Late Hellenistic alabaster urn HIN 60, a representative of a very large group of Etruscan monuments with well-preserved polychromy.[6] Her investigation was in fact to our knowledge the first of its kind to be undertaken on a monument of this type anywhere.[7]

Sargent then went on to look at other Etruscan monuments, different from the urn in time, material and function. In this report, she gives a preliminary account of her important investigation of three Etruscan architectural terracottas of the Classical period. The antefixes in question are recognized as being among the finest of their type to have come down to us.

Study of selected Etruscan sculptures in the Glyptotek is part of the programme which the Carlsberg Foundation is financing. There are three objectives: to establish a core of comparative data within prominent groups of Etruscan artefacts; to provide data which may be compared with, and throw light on, findings made of less well preserved polychromy on the Greek sculptures which inspired the Etruscans; and, finally, to exemplify the considerable

5 For information about the solution chosen, see Skovmøller 2012.

6 For a summary of her investigation see http://www.trackingcolour.com/objects/113

7 An Etruscan painted sarcophagus of the period has been studied in depth, cf. Bottini and Setari 2007.

Fig. 1:
The new work space is a *c.* 25 sqm room with access conditions and ceiling height permitting investigation of full size sculptures. On the heavy duty turntable is the portrait statue of Fundilia from Nemi, IN 708: on the smaller turntable mounted on a hydraulic lift table is the Egyptian limestone relief fragment ÆIN 1048. Between the two is the Leica DVM 5000 video microscope. On the left is the Leica 2500 optical microscope, on the right a glimpse of the Leica M65 operations microscope. The space is equipped for all types of technical, analytical photography.

Fig. 2:
Fragment of a relief from a wall in the palace of Apries at Memphis. Limestone. 26th dynasty, 589–568 bce. H. 39, W. 28, D. 6 cm. æin 1048.

potential which the Glyptotek's collection has for research on Etruscan sculptural polychromy for its own sake.

AN EGYPTIAN RELIEF

A similar strategy determined the choice of an object in the Glyptotek's Egyptian collection for investigation by Maria Louise Sargent. It is a fragment of a polychrome limestone relief from a wall in the Pharaoh Apries' palace at Memphis (fig. 2).[8] Belonging to the Late Period 26th dynasty, Apries reigned 589–568 BCE, and Egyptian polychromy on stone of the period is therefore contemporary with the early, Archaic phase of Greek sculptural polychromy. Just as the style of Greek Archaic sculpture is clearly dependent on, or inspired by, Egyptian models, the techniques employed by Egyptian sculpture painters may with reason be supposed to have been transmitted to Greece.

The findings made on ÆIN 1048 remain to be assessed. This is no easy task since, to our knowledge, there are virtually no published datasets to compare with.[9] We would be very happy to receive further information – and be pleased if in-depth investigation of other Egyptian Late Period polychrome stone sculpture were to be undertaken in collections elsewhere.

ROMAN PORTRAITS

In 2012, Rikke Therkildsen has continued to work in tandem with Amalie Skovmøller to complete an investigation of those Roman portraits in the Glyptotek which have highly polished skin surfaces.[10] Therkildsen's Master's thesis, mentioned at the outset of this overview, focuses on three of them[11], while in her contribution to this report, she shares the preliminary results of her work on one of the many other sculptures in the Glyptotek included in her thesis, namely IN 2815, a 2nd century CE female head from the Hadrianic Baths at Aphrodisias.

Amalie Skovmøller is now on her three year Ph.D. trajectory, on a course parallel to the NCG/CPN Tracking Colour project which served as a launch platform for her mission; and she has the museum as her place of work. As a Ph.D. fellow, she is, however, working within the academic framework of the University of Copenhagen. In 2012, we have therefore aimed at aligning the Tracking Colour research programme on Roman portraits in the Glyptotek with that of Skovmøller's. For her, portrait polychromy, surface texturing and portrait context are of paramount importance; for the NCG/CPN project it is vital that investigation results cover the chronological, geographical and iconographical range of the Glyptotek's collection as well as possible, on the conditions given. The chosen common ground is the group of portraits of Julio-Claudian date from a votive room at the sanctuary of Diana at Nemi.[12]

So, since the autumn of 2012 set in, the portrait herms and portrait statues from the room of Fundilius and Fundilia at Nemi have been under investigation. Results are coming in, and we will give a report of them in due course.

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8 ÆIN 1048. Cf. http://www.trackingcolour.com/objects/126. To the bibliography add Bagh 2011, 40–42.

9 Accorsi *et al*. 2009, with fig. 1 (wall painting). Verri 2009b, with fig. 4 (12. dynasty stele from Asyut).

10 The portraits examined are: IN 778; IN 799; IN 819; IN 821; IN 822; IN 823; IN 826; IN 1461; IN 3282. Skovmøller and Therkildsen 2012 report on their study of IN 826 (Gaius Julius Verus Maximus); see also http://www.trackingcolour.com/objects/125

11 IN 821, IN 822, IN 826.

12 See Moltesen 1997 for the sanctuary and the finds.

SURVEYS IN 2012

In December 2011 and in 2012, surveys using VIL imaging were conducted on two major groups of monuments in the collections. Such surveys are to be understood as preliminary reconnaissance campaigns, designed to give a first impression of the presence or not of Egyptian blue – a pigment which serves as a marker of the possibility of finding further traces of polychromy.

Surveys are by their nature not thorough, on smaller objects involving just one overall image of each object; but on the other hand information may be gathered from a relatively large number of objects in a relatively short space of time – if the survey is properly planned. The survey VIL-imaging was carried out by Rikke Therkildsen and Maria Louise Sargent who are by now a very experienced team, able to work quickly and with a first hand knowledge of how to interpret the evidence of provided by VIL.

ROMAN SARCOPHAGI

The December 2011 VIL survey was only briefly mentioned our 2011 report[13] and is therefore to be briefly mentioned here. It involved the 18 Roman sarcophagi lined up in the colonnade of museum's Central Hall.[14] We found this to be the most efficient way of closing the section of our project devoted to the Glyptotek's important collection of sarcophagi from Rome itself – in fact the third largest outside Italy.

In the sarcophagus section, three sarcophagi have been investigated more closely.[15] Fig. 3–4 shows a Tungsten and a VIL image of the front of the Shipping Sarcophagus IN 1299, while fig. 5–6 are a Tungsten and a VIL image of one of the left short side. The latter two provide evidence that the short side of this sarcophagus chest with its iconography of crossed shields and weapons is rather inexpert in its carving – but it was polychrome, nevertheless, with Egyptian blue used for the metal of the weapons. The short sides were, one might suggest, an apprentice training ground for both carving and painting.

The sarcophagus VIL survey results enable us to focus on two particular reliefs for future closer attention. Very fortunately, they are both within the ambit of Metropolitan Roman workshop tradition. On is the lion hunt sarcophagus IN 849, the other IN 846, a mid-second century CE Dionysiac sarcophagus, perhaps produced locally at Ostia. Focusing on the latter (fig. 7–8, 10), the VIL images (fig. 9, 11) show the luminescence from Egyptian blue shining brightly on a number of details.

More than twenty sarcophagi and sarcophagus fragments remain to be surveyed…

ROMAN PORTRAITS

The original plan for the collection of Roman portraits was to proceed chronologically, but as has been explained above it was decided to continue investigation of portraits with highly polished skin surfaces, predominantly of the mid-second to mid-third century CE.

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13 Østergaard 2012.

14 Cf. J.S. Østergaard in Østergaard *et al*. 1996 for catalogue information on the pieces indicated here and in the following notes. The sarcophagus VIL survey involved the following IN numbers: 846; 847; 848; 849; 850–51; 852; 855; 857; 1890; 2301; 2342; 2343; 2347; 2349; 2350; 2430; 2631.

15 IN 1299, cf. http://www.trackingcolour.com/objects/40; IN 2468, cf. http://www.trackingcolour.com/objects/50 and Sargent 2012; and IN 843, cf. p. 8 and fig. 1–3 in Østergaard 2012,
http://www.glyptoteket.com/sites/default/files/trackingcolour-3_final_2.pdf
All investigation and documentation by M.L. Sargent and R. Therkildsen.

Fig. 3:
Front relief of a sarcophagus chest with shipping.
C. 300 ce. Perhaps from Ostia. H. 52, L. 178 cm. in 1299.

Fig. 4:
vil image of the relief in fig. 3. Egyptian blue was,
not surprisingly, used for the sea…

Fig. 5:
Tungsten image of the left short side of the relief in fig. 3. Pigment remains are mapped on the image, showing the extensive polychromy on the roughly carved representation of weapons.

Fig. 6:
vil image of the relief in fig. 5. Egyptian blue was used for the metal parts of the weapons.

Fig. 7:
Tungsten image of the front relief on a Dionysiac sarcophagus chest. Marble. Mid-2nd century ce. Perhaps from Ostia. H. 67, L. 220 cm. in 846.

Fig. 8:
The left half of the sarcophagus relief in 846.

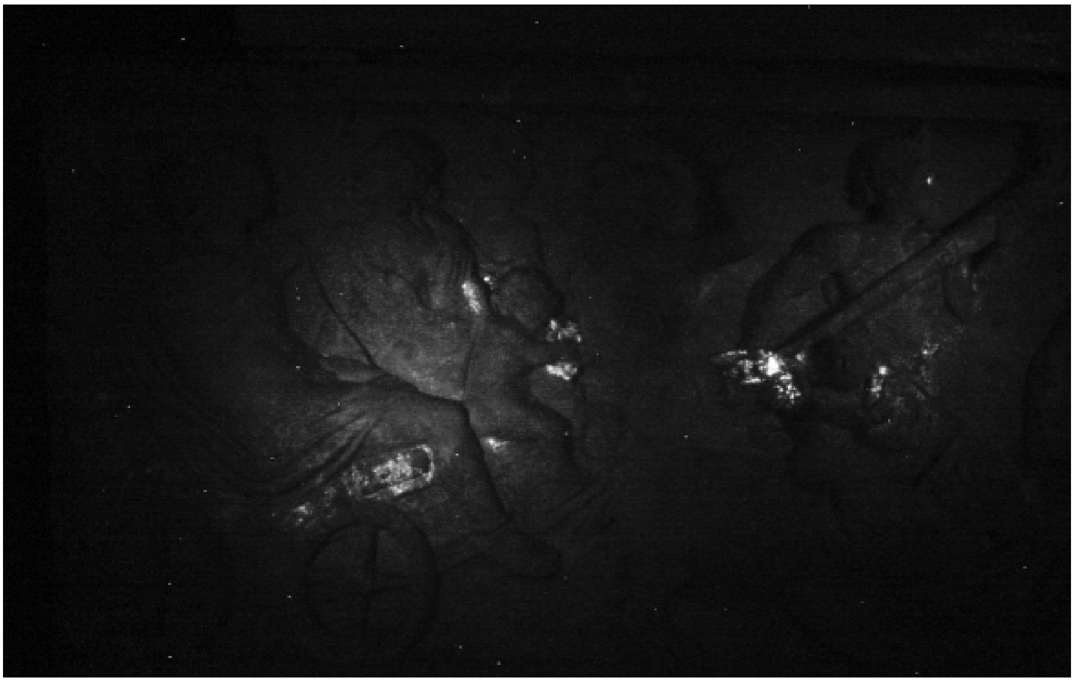

Fig. 9:
vil image of the left half of the sarcophagus relief in 846. The luminescence of Egyptian blue is seen on the wagon, on the wings of the two Cupids, and on the bunch of grapes in the hand of the Cupid to the left.

Fig. 10: The right half of the sarcophagus relief IN 846.

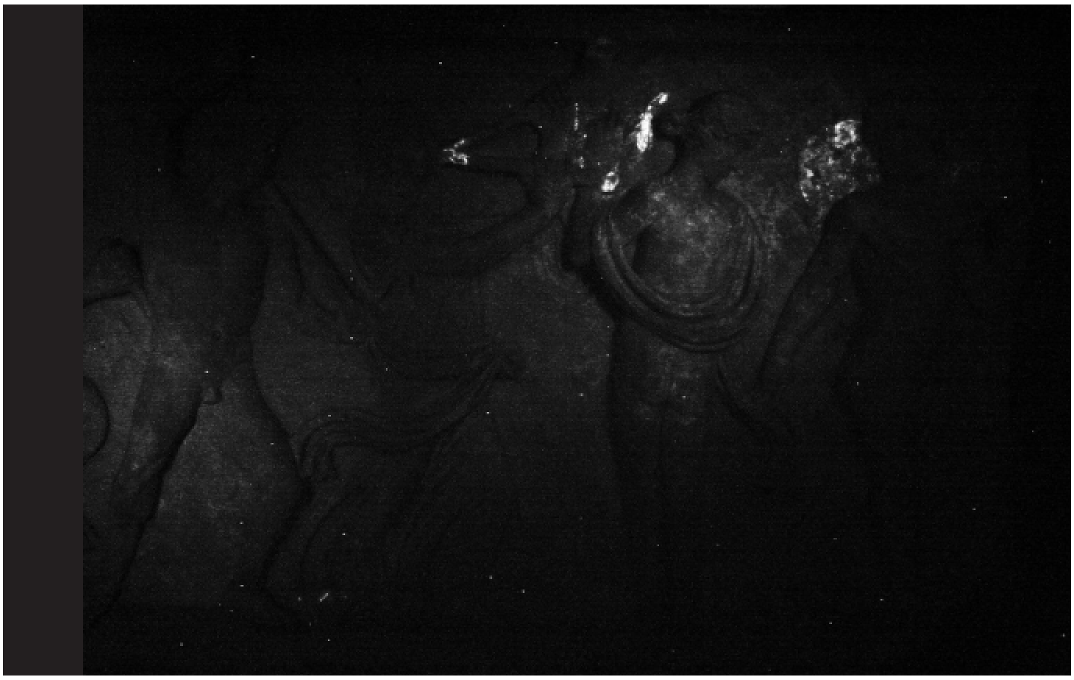

Fig. 11: VIL image of the right half of the sarcophagus relief IN 846. Egyptian blue was used on the mouthpiece of the double flute and the horns of the lyre, each played by a Maenad, and for the wine sack carried by the satyr on the far right.

Fig. 12: Tungsten image of a fragment of a wall painting, showing a satyr. Fresco. Roman, 1st–2nd century ce. H. of figure 44 cm.

Fig. 13:
vil image of the fresco fragment in fig. 12.

Fig. 14: Tungsten image of a fragment of a wall painting, showing a maenad. Fresco. Roman, 1st–2nd century CE. H. of figure 47 cm.

Fig. 15:
vil image of the fresco fragment in fig. 14.

Instead, a VIL survey of 32 of the Late Republican portraits in the Glyptotek was conducted in 2012, the aim being to identify sculptures which it might be worthwhile to take a closer look at. None of the portraits had traces of pigment clearly visible to the naked eye, but experience has shown that this may be deceptive. Microscopic to sub microscopic remains may offer very valuable evidence. The results of the VIL survey were however disappointingly meagre, with just two portraits having clear presence of Egyptian blue on the skin surfaces.[16] One may hope that the 10 or so portraits of the period which remain to be looked at have more to offer. As it is, virtually no data exists, neither on the polychromy of Late Republican Roman portraits – nor on the Late Hellenistic portraits which may have influenced them, such as those from Delos of the 2nd century BCE.

OTHER SURVEYS IN 2012

An IR survey of the museum's mummy portraits was undertaken by Maria Louise Sargent. Together with the VIL-images done of the mummy portraits, the results are of interest to the exploration of the relationship between antique 2D and 3D polychromy. A small VIL survey was therefore also done by Maria Louise Sargent and Charlotte Eschen of the just four fragments of Roman wall painting in the Glyptotek, to add some data sets to this aspect of polychromy studies (fig. 12–15).[17]

LOOKING FORWARD: 2013 – AND ONWARDS

Some of the goals set for 2012 in our Preliminary Report 3 have been reached. It is also an encouraging fact that for the third year running, looking ahead, there are some bright prospects to counter those less so.

On the bright side, we have a Ph.D. fellow, Amalie Skovmøller, attached to the project, and we have the funding for a quite ambitious experimental archaeological project to learn-by-doing from the research on one of the Roman portraits investigated (IN 821), a project to which a core staff member of our team, Rikke Therkildsen, will be contributing her skills.

And, furthermore, we have now the financial means to move ahead on the planning and implementation of an exhibition at the Glyptotek in 2014. We want to show the public our results – and those achieved by all others working in this field of endeavour. It will be 'our' exhibition, in a broader sense.

Finally, it is quite certain that a Preliminary Report 5, 2013, will be published at the end of this year.

There is, however, no escaping the ominous reality facing the Tracking Colour Project: beyond 31st of May there is no financing available. Research on Greek and Roman sculptural (and architectural) polychromy has been gaining increasing momentum over the last few decades, it is attracting a lot of positive attention, but it remains fundamentally vulnerable – because it is almost entirely project based, lacking the continuity of an institutional foothold. Without such a foothold, there can be no continuity in the accumulation of knowledge and experience, no way of retaining specialized staff and facilities. Very considerable investments are at risk.

The outlook for creating any kind of institutional base is very dim in the short term. We must therefore focus our energies on finding funding for continuing our work over another

16 IN 2814; Johansen 1992, 128–129 no. 53. IN 3281, Johansen 1994, 198–199 no. 87.

17 IN 888a, IN 888a, IN 2486, IN 3624, cf. Østergaard *et al.* 1996, 250–253, nos. 156–159., 44–45 and 47 fig. 7. The pioneering work was done at the British Museum, cf. Verri 2009a and 2009b, and Verri *et al.* 2010.

project period, joining forces with others in our field. And this is of course what we have been, and are actively doing.

Meanwhile, the best thing to do is to keep producing good results and making them available to colleagues and a wider public alike.

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Investigations into the polychromy of some 5th century BCE Etruscan architectural terracottas

Maria Louise Sargent

ABSTRACT

Highly informative traces of original polychromy have survived on three Etruscan architectural terracottas of the 5th century BCE. The investigation reveals a relatively simple colour palette. Only a few different pigments have been identified – yellow and red ochre, Egyptian blue, black manganese and a white silicate-based ground. Despite the limited use of colours the chromatic scheme is much more nuanced. Though these Etruscan architectural terracottas were mould-made and produced in great numbers the standard of details was still high and investigation found that combinations of different pigments were used to create subtle tone variations.

KEYWORDS

Etruscan, antefixes, architectural, painted terracotta, VIL, EPMA

INTRODUCTION

Three architectural, polychrome terracottas from Etruria dated to *c.* 470–460 and *c.* 400 BCE were examined in the spring of 2012 to obtain information on the way they were produced.

Unlike antique marble statues, where the identification of pigments is often complicated by the limited amount of pigment, architectural terracottas are more amenable due to their extraordinarily well-preserved paint allowing us to obtain more information on the painting techniques and the colour palette employed by the artist. In spite of their remarkable state of preservation, the technique of execution of the polychromy of these architectural terracottas is still unknown, so that archaeological research has essentially been restricted to visual examination of general aspects.

This contribution presents the results of research into and examination of the terracottas providing us with new valuable information about their polychromy.

Etruscan terracottas are often noted for their extraordinarily well-preserved paint. The roofs of Etruscan buildings were among the most ornate in the ancient world and the antefixes were part of several important decorative elements of the roofs. The earliest antefixes were simple plaques attached to the end of the lowest cover tile on the slope and overhanging below the bottom edge of the cover tile, to cover the front joint between the eave tiles. The decoration of the antefixes most commonly included a head moulded in relief. During the 6th century BCE, the female head was by far the most common type used.

Their production required experience and certain skills and was probably often practiced by itinerant artisans, travelling with their tools and moulds. The moulds were used to produce decorative elements when several were needed, which was often the case. The artists exploited the local clay pits and constructed kilns on site.[1]

DESCRIPTION OF OBJECTS

In 1889 and again in 1924 the Ny Carlsberg Glyptotek acquired three beautiful antefixes from Italy. Two of the antefixes represent female heads; the last one represents a silenus head (hin 55, hin 452 and hin 453) (fig. 1–3).[2] The silenus measures 49.5 cm in height while the two females measure 37 cm and 36 cm respectively. Their origins are unknown, but they are related to finds from Caere and Orvieto respectively. Each of the three heads is surrounded by a floral shell frame. The shell consists of five palmettes of seven leaves each, alternating with smaller lotus flowers. On the shell of the silenus head, the area between the top of the palmettes and the lotus is cut out, allowing the sky to be seen when in place on the roof.

The silenus head has two rows of spiral curls across the low forehead, a beard with long wavy strands of hair and a moustache overlapping the beard. The female heads reflect Greek art in the coiffure and features of the face. The wavy hair is drawn to the side of the head and atop each head is a decorated diadem.

Each of the heads has been put together from several large pieces and part of the shell frame of the silenus head is missing. The surfaces of the two female heads are both covered with biological growth.

The antefixes were mould-made and produced from reddish-yellow and pinkish clay with many inclusions. There are other existing examples from the same mould of the female heads which have been associated with the Belvedere Temple at Orvieto.[3]

METHODOLOGY

For this study, the polychromy of the three terracotta was extensively investigated using non-invasive techniques including visual examination, ultraviolet (uv), visible-induced luminescence (vil) imaging and in situ xrf and invasive analytical methods combining microscopic cross-sectional analysis of paint layers with elemental analysis performed by means of empa.

A sample was taken from the silenus head for binding media analysis. The binding media analysis was performed by means of Gas Chromatography/Mass Spectrometry (gc/ms) in the laboratory of the Department of Conservation at the National Museum of Denmark.[4] The results of the investigation undertaken on the polychromy of the three antefixes are summarized and discussed below.

RESULTS AND DISCUSSION

The painting of the three terracotta antefixes bears striking similarities. The polychromy is dominated by earth pigments, iron-based oxides are especially extensively represented.

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1 Christiansen and Winter 2010, 14–18 (N. Winter)

2 Christiansen and Winter 2010, 100–101 no. 45 (hin 55); 104–105 no. 47 (hin 452 and 453) (N. Winter)

3 Christiansen and Winter 2010, 104

4 The analysis was carried out by Jens Glastrup of the Conservation Department of the National Museum of Denmark.

Fig. 1: Etruscan terracotta antefix with silenus head dated to 470–460 bce, Ny Carlsberg Glyptotek hin 55. Tungsten light photograph.

Fig. 2: Etruscan terracotta antefix with female head dated to 400 bce, Ny Carlsberg Glyptotek hin 452. Tungsten light photograph.

Fig. 3: Etruscan terracotta antefix with female head dated to 400 bce, Ny Carlsberg Glyptotek hin 453. Tungsten light photograph.

Visual inspection using an optical microscope shows that the pigments in the cross-section of all samples were mixed with diluted clay for application and painted onto a thin white slip. emp-analysis has unequivocally identified the presence of silicate-based, typical clay minerals in the white substrate, but shows no evidence of the use of kaolin.

The visual and technical importance of a preparatory ground has to be emphasized. The white ground layer not only served to isolate and level the rough surface of the terracotta – providing a reflective base for the application of paint – but also gave it the property of a greater adherence and resistance to the paint layer and more luminosity in bright colours.

On the basis of the results obtained by binding media analyses – which did not show any evidence of an organic binder – it is suggested that the polychromy was most likely made to adhere to the support by a low-temperature firing process rather than with *a secco* technique. This was also proposed by F. Bordignon *et al.* who undertook some work on Etruscan terracotta slabs from Ceri.[5] They believe that the firing technique was based on a two-step procedure; the first firing of clay at a temperature in excess of 800°C and a second firing of the painted terracotta performed at temperatures between 250°C and 300°C to fix the paint layer.

An ultraviolet photograph of one of the female heads (hin 453) shows the difference between the original surface and areas covered with biological growth (fig. 4). The skin colour appears in various shades of pinkish-violet. There is also a strong orange fluorescence observed next to a repair on the right side of the head.

floral shell frame

The palmette leaves were painted alternately black and red with white outlines. White was also used for the volutes, rolls and concave bands. The colour of the individual palmette leaves was produced by the superposing of four layers including the white preparatory layer. The initial layer was a thin, almost transparent, light brown slip. In the central area of each leaf these were coved with a second layer of yellow with a top layer of terracotta red (fig. 5).

The outer edge of the shell and the background below each palmette on the two female antefixes were painted red as were the upper band and boxes of the meander on the bottom border while the lower band and lower boxes of the meander were black.

On one of the female heads (hin 452) the original polychromy of the palmettes is today only preserved on the lower left palmette, as is the black background surrounding the palmettes, whereas the background surrounding the other palmettes on the rest of the female head appears in a pale greyish tone (fig. 6). The other female head and the silenus head are in a better state of preservation. Here the background is painted with a mixture of black and a small amount of blue grains which made it appear bluish-black (fig. 7). An inspection of the results of the cross-section and the elemental composition performed by means of empa on a sample of the black background from the female head (hin 453), reveals that the top layer appears as a very, fine, thin layer of manganese black (MnO_2) less than *c.* 20 µm with a few particles of copper (Cu) from the presence of Egyptian blue found in a matrix of silicate (fig. 8). The identification of Egyptian blue is further confirmed by vil-imaging. On the photos of all three antefixes the significant properties of the synthetically-produced blue pigment appear as a powerful white luminescence caused by a larger concentration of Egyptian blue on the background surrounding the palmettes, the outer leaves of the lotus flower and also in the area painted blue below the volutes on the silenus antefix (fig. 9–11).

5 Bordignon *et al.* 2007, 87

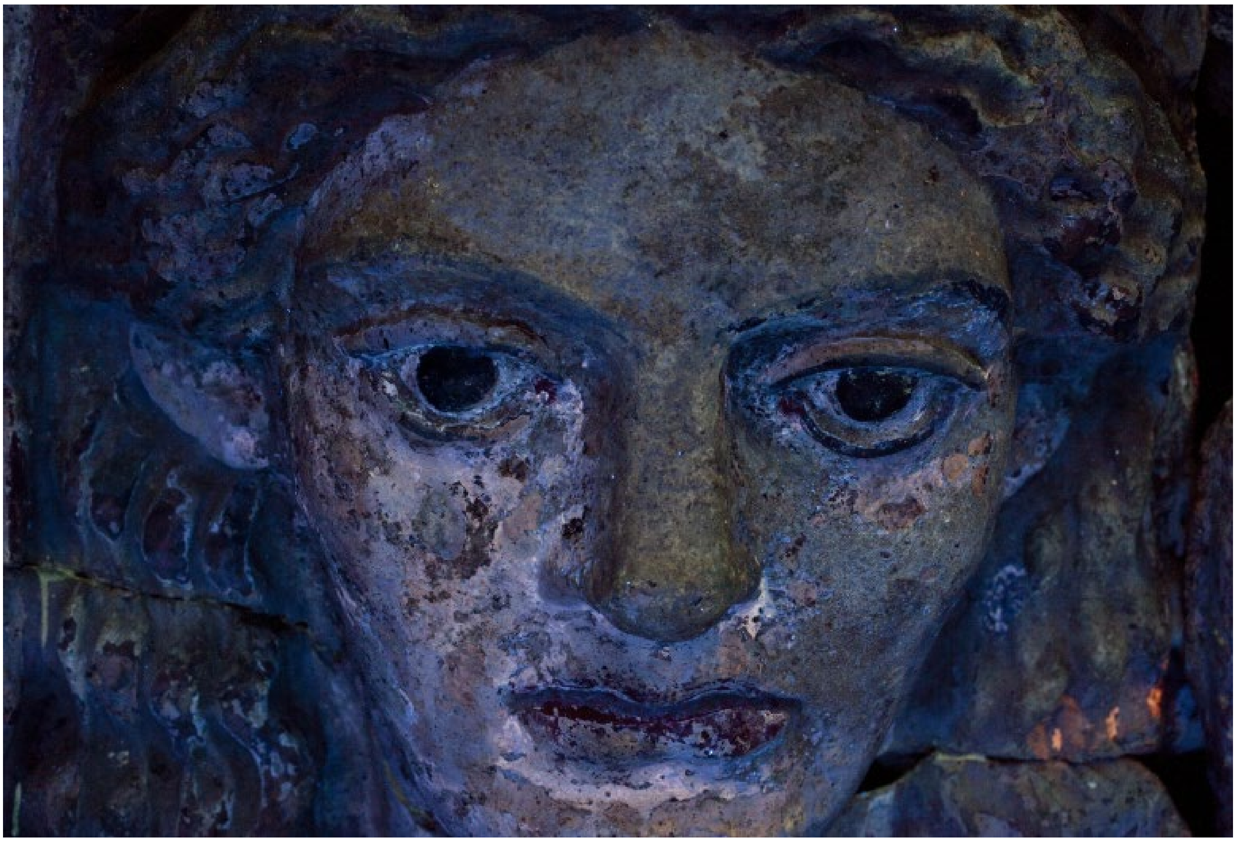


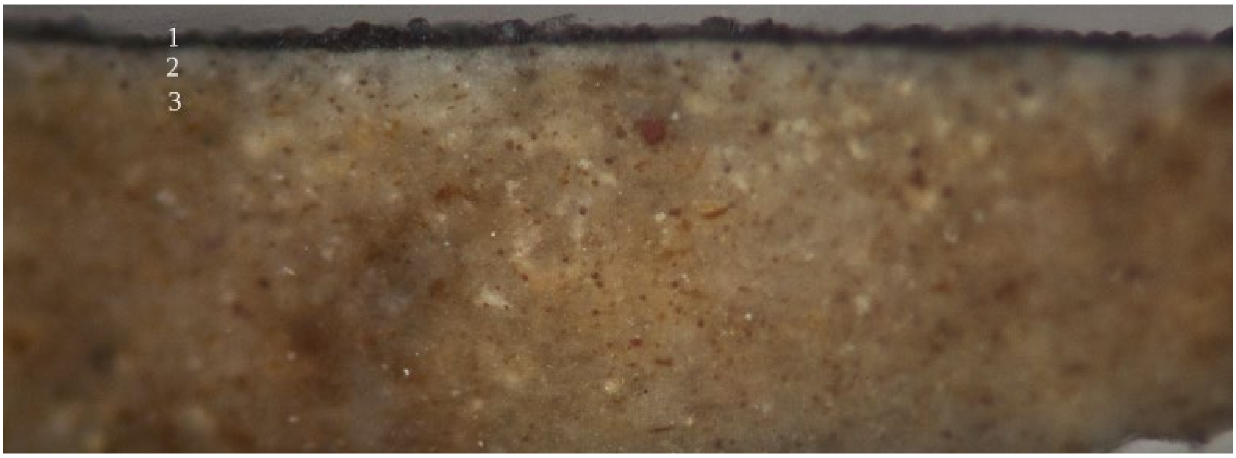
Fig. 4:
Ultraviolet photograph of female head HIN 453 clarifies the areas covered by biological growth, especially on the right cheek where a greenish substance covers the pink skin colour.

Fig. 5:
Detail photo of palmette from the silenus antefix HIN 55. In the central area of the leaf yellow is visible underneath a top layer of terracotta red.

Fig. 6:
Detail photo of palmette from the female antefix HIN 452. The original polychromy of the background surrounding the palmettes today appears in a pale greyish tone.

Fig. 7:
Detail photo of palmette from the female antefix HIN 453. Egyptian blue is mixed with black to create a bluish-black appearance.

Fig. 8:
Photomicrograph of cross-section from the female antefix HIN 453 shows a thin layer, less than 20 µm, of manganese black with a few grains of Egyptian blue. × 100.



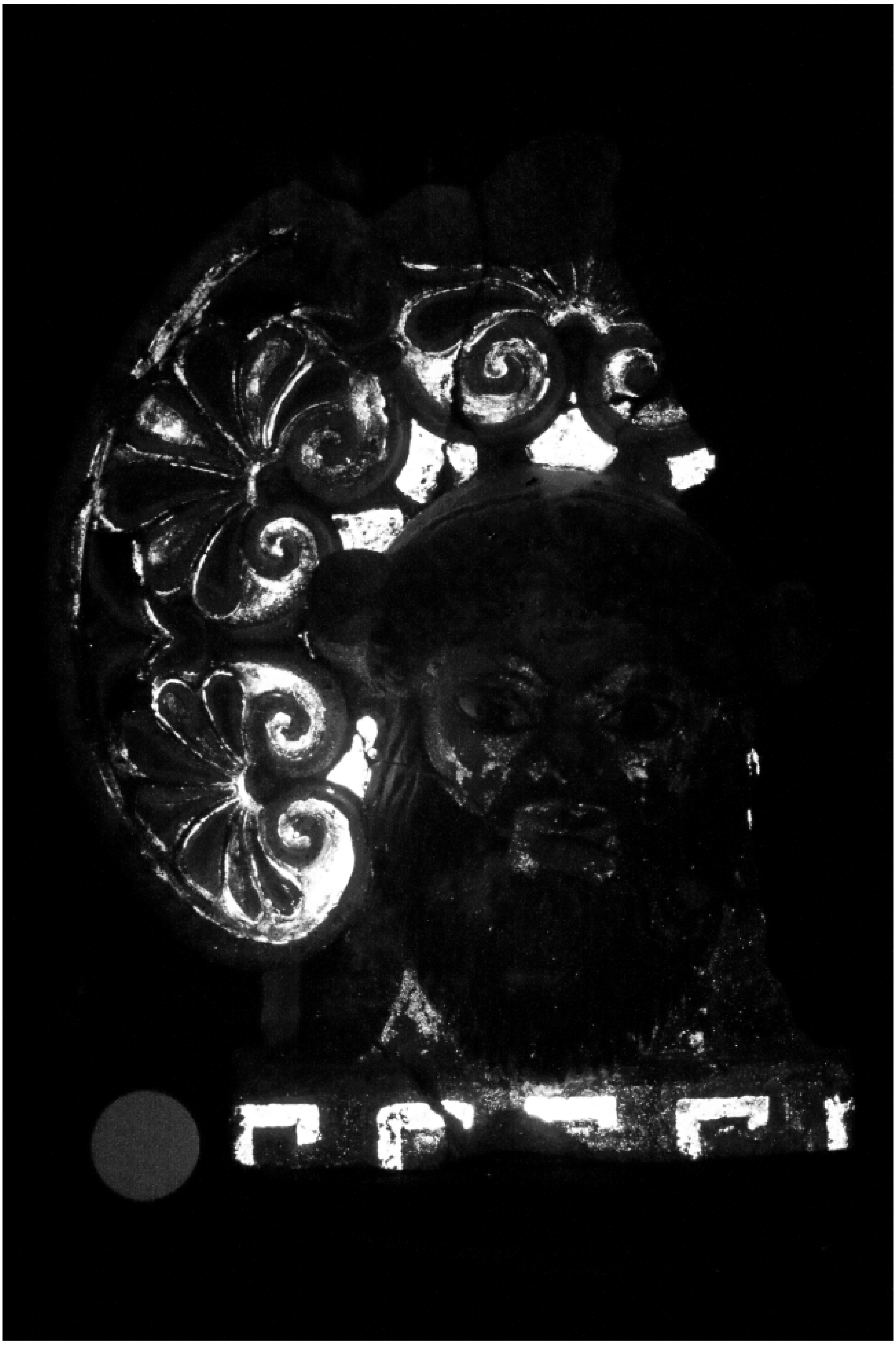


Fig. 9: VIL-image of HIN 55 showing the distribution of Egyptian blue as shining white areas.

Fig. 10: VIL-image of HIN 452 showing the distribution of Egyptian blue as shining white areas.

Fig. 11: VIL-image of HIN 453 showing the distribution of Egyptian blue as shining white areas.

xrf measurements taken *in situ* on all three antefixes show that the content of iron from points in the red areas is due to hematite (α-Fe_2O_3) and that the colour of the black areas is due to the use of manganese (MnO_2).

facial features

The skin colour of the two females is pale pink but on one female head (hin 452) the original skin colour is only preserved on the right side of the face (fig. 12). On the other female head (hin 453) different tones of pink are observed (fig. 13). The painterly accentuation is found particularly on the cheeks and the chin where a darker pink is observed than on the rest of the face where a light pink is used to create the effect of a blush. A cross-section taken from the skin colour of the right cheek of hin 453 shows three layers. The pinkish top layer contains small, fine grains of iron (Fe) suggesting the use of hematite (α-Fe_2O_3) mixed together with silicate-based clay with a high content of calcite and a few grains of a black pigment. A visual inspection reveals that the pink colour is produced by finely-milled grains and a few larger red grains. Underneath the pink layer a white silicate-based ground layer is seen consisting of a cluster of small white grains in which a few larger red grains are embedded. The third layer is the preparation layer. The second layer and the third layer contain almost the same complex mixture of many different clay minerals which includes quartz grain, silicate, feldspar, iron, aluminium, magnesium and calcium. The difference between the second layer and the third layer is due to the preparation. While the second layer seems more fine-grained and compact, the third layer is more uneven and porous with larger grains in the sediment (fig. 14).

The skin colour of the silenus head is brownish. A cross-section of the skin colour reveals three layers evenly applied with an average total thickness of *c.* 120 µm. The top layer is a ground mixture of hematite (α-Fe_2O_3), goethite (α-FeO·OH) and some unidentified black grains, probably carbon. Hematite and goethite are the principal colorants in naturally-occurring red and yellow ochres respectively. The second layer is a fine-grained, thin layer (less than 20 µm thick) of goethite while the third layer is the preparation layer (fig. 15).

On the lower cheek of the face where the beard begins, it is apparent that there was originally a band roughly 5 mm wide where the black colour was applied on top of the yellow ochre layer, to define the edge, though much of this black has subsequently flaked off (fig. 16).

While the colour of most of the beard is black, the moustache and the area directly under the mouth have red superposed on the black thereby achieving a deeper, richer shade of vermilion. This approach also seems to have been used with the hair. On a detail photo of the moustache the black colour is observed shining through the red colour (fig. 17). A cross-section taken from a lock of hair from the left side of the head emphasises the fact that the red colour has been intentionally applied in a very thin layer (less than 20 µm thick) making the black colour visible underneath (fig. 18).

There is a slight variation in the hair between the two female heads. On one female (hin 452) the hair colour is similar to the silenus head with red applied on a black ground (fig. 19) while the other female (hin 453) has yellow hair on a black ground.

No Egyptian blue is seen in the section from the skin nor on the hair, but its presence was detected by means of vil on all three antefixes. An even distribution of relatively uniform blue grains is present on the surface of the skin and hair and was undoubtedly part of a mixture of various pigments to obtain the right tonal variation and a more lifelike appearance (fig. 20–22). The particles distributed in the hair seem to appear more fine-grained than in the face. The use of Egyptian blue in the flesh tones has been recorded before by

Fig. 12:
Detail photo of female antefix hin 452 showing the traces of the preserved skin colour.

Fig. 13:
Detail photo of female antefix hin 453. Different tones of pink are observed on the skin.

Fig. 14:
Photomicrograph of cross-section from the female antefix hin 453 showing three layers including the white grounding layer on the skin. The pinkish top layer contains finely-milled grains and a few larger grains of hematite mixed together with white and a few grains of a black pigment. ×100.

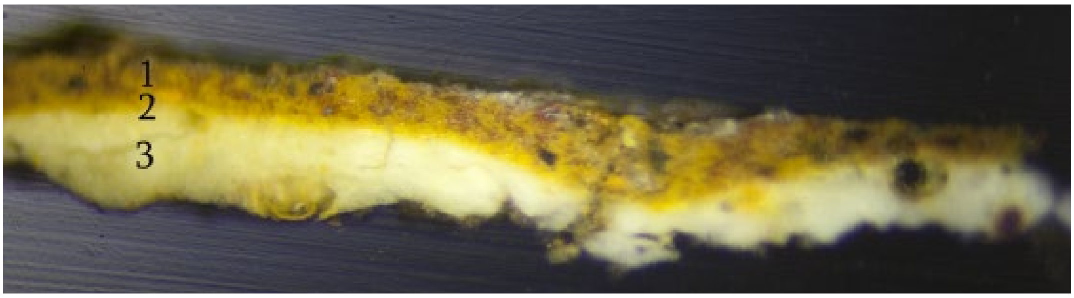


Fig. 15: Photomicrograph of cross-section from the silenus head showing the colour of the skin which is produced by a top layer of hematite, goethite and some few black grains and a second of fine-grained goethite. ×100.

Fig. 16: Detail photo of the lower side of the face of the silenus head showing how the black beard was applied on top of the yellow to define the edge.

Fig. 17: Detail photo of the moustache of the silenus head showing how the black colour of the beard shines through the red colour of the moustache.

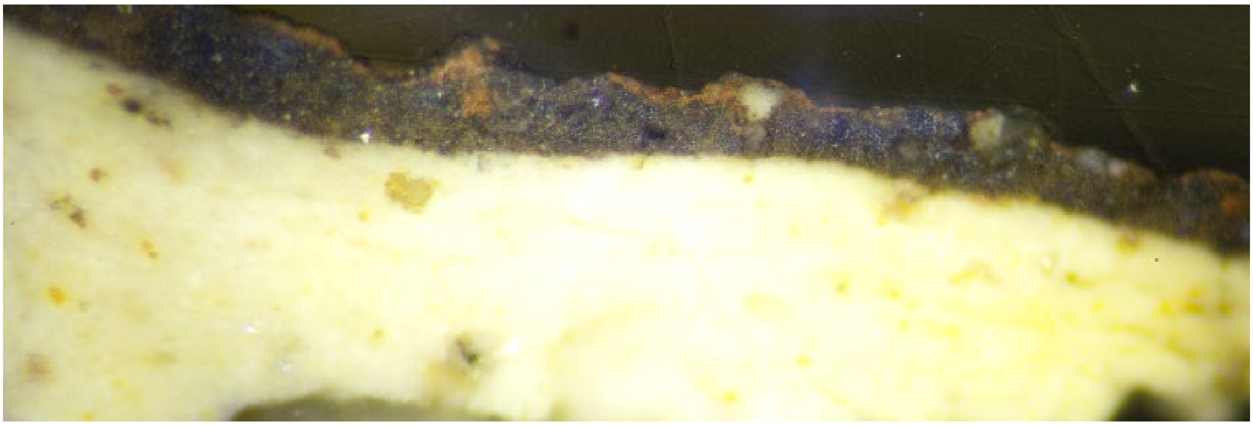


Fig. 18:
Photomicrograph of cross-section taken from a lock of hair of the silenus head hin 55 showing the red colour intentionally applied in a very thin layer to make the black colour visible underneath.

Fig. 19:
Detail photo of the hair of female antefix hin 452 showing a red hair colour superposed on black to achieve a deeper, richer shade of vermilion.

Fig. 20:
vil-image of the face of hin 55 showing the distribution of Egyptian blue as shining white particles both on the skin and in the hair.

Fig. 21: VIL-image of the face of HIN 452 showing the distribution of Egyptian blue as shining white particles both on the skin and in the hair.

Fig. 22: VIL-image of the face of HIN 453 showing the distribution of Egyptian blue as shining white particles both on the skin and in the hair.

vil imaging in the Ny Carlsberg Glyptotek such as on a Roman marble copy of an Amazon[6], a portrait of the Emperor Caligula[7] and recently on a high-gloss polish Roman portrait.[8] A similar use of Egyptian blue was observed on a marble female head of c. 140 ce in the British Museum.[9]

Though the antefixes were placed a considerable distance above the viewer, the painter still made the effort to paint a number of details. The eyes, upper and lower edges and eyebrows are painted black in all three cases and on the two female heads the lachrymal ducts are highlighted in red (fig. 23). Another example is the lips on the female head hin 453. The lips are painted using two different shades of red; dark red on the lips and a brighter red between the lips (fig. 24). Only one colour is observed on the lips of the other female head (hin 452). This could perhaps indicate the painting skills of two different painters. This is furthermore supported by the general impression and a few differences observed in the quality on the two female heads. For instance red colour has unintentionally been applied on the white volute below the palmettes on the female head hin 452 (fig. 25).

CONCLUSION

The result of the investigation carried out on the Etruscan antefixes did indeed provide reliable and significant data on the nature of the colour palette, the preparation layer, and about the manufacturing process. At the same time this underlines the potential of the combined use of different techniques including technical imaging with vil and elemental analysis performed by means of empa.

A fairly limited range of colours were used to create a sophisticated appearance. The investigation demonstrates that natural and mineral pigments were used, pigments which were probably readily available in the areas surrounding the workshop. The elementary composition of the pigments is similar to the clay from which the antefixes were produced as they are dominated by earth pigments, especially iron-based oxides (hematite and goethite). Beside the wide use of the hematite and goethite a few other pigments were found, including the synthetically produced pigment Egyptian blue and black manganese. Egyptian blue was detected by means of vil on the skin and on the bluish-black background surrounding the palmettes of all three antefixes. The use of Egyptian blue, red, yellow, white and a few grains of black was undoubtedly part of a mixture of various pigments to obtain the right tonal variation and a lifelike skin colour.

As for the white pigment, which was mixed with the different pigments to obtain differently coloured tones and which also was employed as a ground layer for all the polychromy, a silicate-based, typical clay mineral was identified.

The results of the recent investigation stress the fact that more information as to actual pigments and painting technique can be obtained from the examination and study of Etruscan architectural terracottas, many of which preserve more extensive visible traces of polychromy in comparison with marble sculptures, on which there are seldom more than sporadic traces.

6 Sargent and Therkildsen 2010a, 35

7 Sargent and Therkildsen 2010b, 21

8 Skovmøller and Therkildsen 2011, 37

9 Verri, Opper and Deviese 2010

Fig. 23:
Detail photo of the right eye of female antefix hin 453 showing the red lachrymal duct.

Fig. 24:
Detail photo of the lips of female antefix hin 453 showing a dark red on the lips and a brighter red between the lips.

Fig. 25: Detail photo of a white volute from the female antefix HIN 452 showing how the red colour in some places has been applied in a rather crude manner.

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A 2nd century CE colossal marble head of a woman: a case study in Roman sculptural polychromy

Rikke H. Therkildsen

ABSTRACT

This contribution presents recent work on a colossal head of a woman in white marble, IN 2815, in the Ny Carlsberg Glyptotek. The head showed extensive remains of original colour on both hair and skin. The polychromy of the head was investigated using non-invasive techniques and invasive-analytical methods and the results give new in-sights into the colour palette and painting techniques on Roman portraits.

KEYWORDS

Roman portrait, polychromy, microscopy, UV-FL, VIL, XRF, EMP, cross-section, gilding, skin colour, stratigraphy.

INTRODUCTION

Since the beginning of 2012 the collection of Roman portraits has been the centre of investigation at the Ny Carlsberg Glyptotek's Tracking Colour project. This portrait has extensive traces of colour preserved not only in the hair but also on the skin. Due to the renewed interest in antique sculptural polychromy our knowledge on the original palette has expanded considerably over the last decade but many questions still need answers and testimony as to, for example, the original painting of the skin parts still remains very fragmentary.[1]

IN 2815 – A ROMAN WOMAN

DESCRIPTION AND STATE OF PRESERVATION

The head[2] is colossal, with a total preserved height of 53.0 cm. Figures 1–4 show the portrait from four different angles in its current state. The head is carved in a fine-grained and bright white marble. The formation of the neck indicates that the head had been intended for insertion in a statue. Today IN 2815 adorns the Central Hall of the Ny Carlsberg Glyptotek.

The head is slightly turned to the right. The hair is voluminous and parted at the centre and gathered in a bowlike knot at the top of the head. The wavy strands are divided by deeply drilled grooves. Areas of the skin are finely smoothened and the rendering of the eyes shows great attention to detail. The eyebrows are represented carved with a flat chisel whereas the irises are incised and pupils drilled. The back of the hair and neck are coarsely-hewn and

1 Scharff *et al.* 2009, 33–36 (Østergaard); Skovmøller and Therkildsen 2011

2 Johansen 1995

the shape relatively flat. A hole in the neck could have been for a dowel and it is possible that a separately-cut piece of marble, for example in the shape of a veil, was meant for insertion. However, at this stage it remains unclear if the hole was part of the original carving of the portrait or if it is a post-antique addition/repair.

The head is in a relatively good state of preservation but the nose is missing and the rim of the left ear is partly damaged. Vestiges of incrustation and biological growth are primarily observed in the hair and on the left side of the face and neck. The portrait has well-preserved traces of original colour. Traces of black and red colours are observed in the hair and on the left cheek patches of skin tones survive. In addition a distinct red layer can be seen between the lips.

DATING AND PARALLELS

It has been said of IN 2815 that it has portrait-like features, even though a clear identity cannot be established.[3] At the same time the hairstyle corresponds to that of the goddess Aphrodite and the colossal size is suggestive of a cult statue. The stylistic rendering of the hair, along with the drilled pupils and chiselled eyebrows date the female head from the Ny Carlsberg Glyptotek to the mid- second century CE.

Similar female heads have been brought to light from excavations in the ancient city of Aphrodisias renowned for its production of marble and marble sculpture in Antiquity. The female heads belonged to a series of statues adorning the forecourt of the Hadrianic baths complex and were probably caryatids. The statues were dedicated by prominent local women over the course of the second century CE.[4] Figure 5 shows a well-preserved example of one of the female heads. The head is over-life-size and carved in a bright white marble where the skin parts have been polished to achieve a high-gloss. The detailed voluminous hair with deep drillings and gathered in a knot on top resembles IN 2815. However, the hairstyle is highly schematic and the facial features are more idealized on the caryatid head from the Hadrianic baths.[5]

DISCOVERY AND ACQUISITION

As is often the case with antique marbles in private collections the provenance of IN 2815 is unknown but isotope analysis suggests either Aphrodisias or Mylasa in Asia Minor as provenance.[6] The connection with Aphrodisias is reinforced by the archival records in the Glyptotek concerning the acquisition of IN 2815. The head was acquired in 1931 in Paris but according to the late archaeologist and professor Kenan Erim, who excavated the ancient city from 1961 until his death in 1990, it was found in Aphrodisias in 1904 during excavations of the Hadrianic baths. We have no knowledge of the head's state of preservation at the time of acquisition. However, macroscopic examination of the marble surface reveals that IN 2815 had been partly freed of burial deposits, crust and biological growth sometime between excavation and acquisition. After acquisition the head was cleaned and remounted in 1958. Detailed information on the cleaning was not recorded but cleaning procedures at the Ny Carlsberg Glyptotek in the 1950s usually involved water and a brush.

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3 Johansen 1995.

4 Abbe 2008a, 139.

5 Abbe 2008b, 279.

6 Internal conservation report from 1990 at the Ny Carlsberg Glyptotek.

METHODOLOGY

The investigation of the Roman female portrait was not only concerned with the identification and spatial distribution of traces of original paint but was also intended to contribute to our fragmentary knowledge of the painting techniques on polychrome antique sculpture in white marble. Due to the patches of what appears to be skin tone it was considered important to conduct an in-depth examination and therefore invasive methods for analysis were included in the investigation.

The documentation and identification of traces of colour on the female head were divided into two main steps: visual examination followed by technical imaging including microscopy, ultraviolet fluorescence imaging (UV-FL) and visible-induced luminescence (VIL).[7] Microscopic documentation of preserved original paint was accompanied by x-ray fluorescence spectrometry (XRF). A sampling strategy was developed on the basis of the visual examination and photo-technical analysis and minute samples were prepared for cross-sections. The cross-sections were analysed by means of electromagnetic pulse (EMP) to investigate elemental composition of colour as well as secondary deposits.[8]

RESULTS AND DISCUSSION

THE ANTIQUE TREATMENT OF THE MARBLE.

Microscopy of the marble surface documented that the face, especially, had been deeply cleaned and marks from abrasive tools were visible over the entire surface. On the neck, a few areas revealed a high gloss indicating a mechanical polishing of the marble. The polished parts were probably the outcome of post-antique removal of secondary deposits and at this stage it remains highly uncertain whether the portrait was originally polished.

THE HAIR

Microscopy of the hair revealed extensive traces of original paint both preserved as scattered particles and as cohesive layers. In the drilled recesses carbon black was usually used as a ground, topped with a red layer and occasionally with a yellow one. The XRF-analysis of the red layer documented a mixture of pigments based on ochre, umber, lead and copper. In some instances the presence of mercury in the mixture suggested the use of cinnabar adding to the tonal effect in the hair and VIL-images (fig. 6–9) confirmed the use of Egyptian blue in the hair where it is present as scattered particles. As figure 10 illustrates, gilding on a red ground on top of some of the individual locks of hair was identified in a couple of instances suggesting the use of golden highlights to contrast the dark recesses of the hair (1, fig. 11).

THE EYES AND LIPS

The original colouring of the eyes is poorly preserved. Microscopy revealed few red grains mainly restricted to the iris and together with XRF-analysis red ochre and smaller amounts of cinnabar and lead were identified. Recent investigations of other Roman portraits have

7 Information on experimental set-up, see: Sargent and Therkildsen 2010.

8 EMP, JEOL SuperProbe JXA 8200 operating at 15kV and 7nA in a vacuum with a built-in EDS detector for chemical characterisation and a backscattered electron detector. Analysis by ass. prof. Tod Earle Waight, Department of Geography and Geology at the University of Copenhagen.

testified to the intentional use of Egyptian blue for the white of the eyes but this was probably not the case with IN 2815. Nor was the (traditional) use of organic lakes for the rims and corners of the eyes detectable by means of UV-FL.

Between the lips, on the other hand, original colouring was well preserved where a cohesive, red layer based on red ochre in combination with cinnabar was found. Figure 12 is a detailed insight into the polychromy of the lips where on top of the red layer a lead-white layer highlighted the discrete opening of the mouth and carbon black was added to the corners of the mouth to represent shadows (2, fig. 11).

THE SKIN

As mentioned above, microscopy of the head yields evidence of post-antique treatments and skin parts appear to have been deeply cleaned. Original colour was in the main preserved as a few scattered particles of red ochre on the forehead, cheeks and neck. VIL-imaging of the skin was able to identify only few grains of Egyptian blue. However, on the left cheek the fragments of paint layers resembling skin tone were visible to the naked eye (3, fig. 13). Figure 14 and 15 are macroscopic and microscopic images of the skin tones on the left cheek. Fragments of a pink layer and a single blue grain were partly visible beneath secondary incrustation. XRF-scanning identified a paint layer based on ochre together with considerably smaller amounts of copper and lead. The relatively small amount of lead was probably due to contamination and was not used as, for instance, a filler in the carnation colour. A minute sample of the layer was extracted and prepared for cross-section analysis. The cross-section gave an interesting insight into the stratigraphy of the carnation colour. Figure 16 shows a yellowish layer with vague traces of red applied directly on the marble and with a maximum thickness of 20 µm. On top of these, scant traces of a reddish layer measuring no more than 5µm were observed. EMP-analysis of the cross-section identified iron and calcium as the constituent parts of the carnation colour.

CONCLUSIONS

The examination of IN 2815 provides new knowledge concerning the sculptural polychromy of Antiquity. The results of the examinations reveal the use of refined painting techniques on the female head using mixtures of pigments and superposition of paint layers for both hair and skin. The pigments found on IN 2815 are consistent with the Graeco-Roman period and the mixture of ochre and Egyptian blue together with calcium carbonate as a filler has been identified on skin parts on other antique sculptures.[9] The painting of the hair with carbon black in the drillings and gilding on a red ground on top of the individual locks to create contrasts of light and shadow were also observed on the above-mentioned parallel from Aphrodisias.[10] The results of the examination of IN 2815 are not sufficient to determine fully how the paint was applied and there are still questions which need answering in the research into the original appearance of the polychromy of IN 2815.

9 Verri *et al*. 2010: 44; Brinkmann *et al*. 2003.

10 Abbe 2008a and 2008b; Skovmøller and Therkildsen 2011.

Fig. 1:
Roman woman
NCG IN 2815,
c. 160 CE.
H. 53,0 cm.
Tungsten light
photography
(museum
photo).

Fig. 2:
Roman woman
ncg in 2815,
c. 160 ce.
H. 53,0 cm.
Tungsten light
photography
(museum
photo).

Fig. 3:
Roman woman
NCG IN 2815,
c. 160 CE.
H. 53,0 cm.
Tungsten light
photography
(museum
photo).

Fig. 4:
Roman woman
NCG IN 2815,
c. 160 CE.
H. 53,0 cm.
Tungsten light
photography
(museum
photo).

Fig. 5: 'Caryatid' head from the Hadrianic Baths, Aphrodisias Museum inv. 66–271, 2nd century CE. H. 48,5 cm (Photo: Courtesy Mark Abbe).

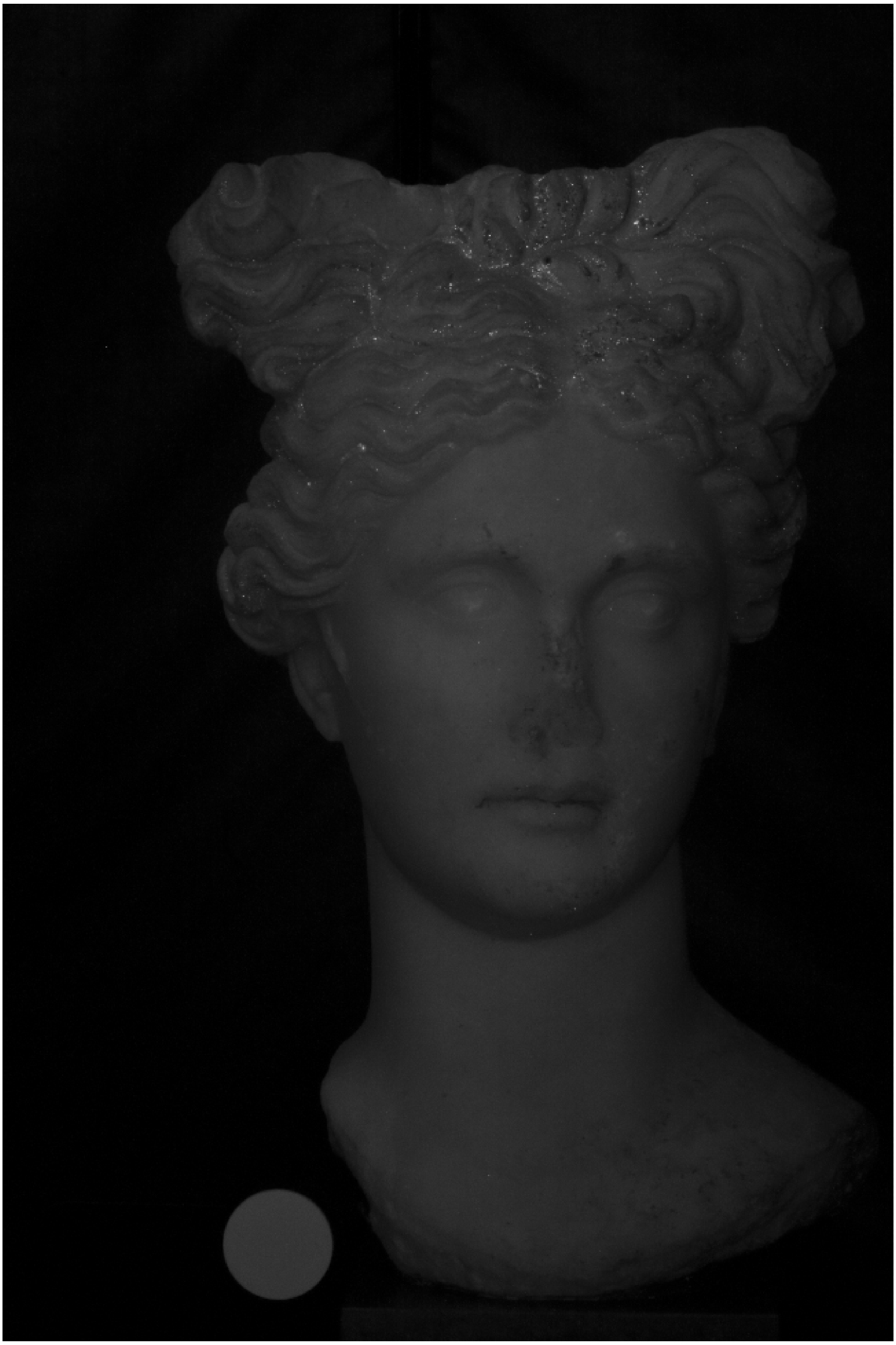

Fig. 6: VIL-image of the hair showing the distribution of particles of Egyptian blue as spots of bright white luminescence. Only very few particles were observed in the eyes and on skin parts (museum photo).

Fig. 7: VIL-image of the hair showing the distribution of particles of Egyptian blue as spots of bright white luminescence. Only very few particles were observed in the eyes and on skin parts (museum photo).

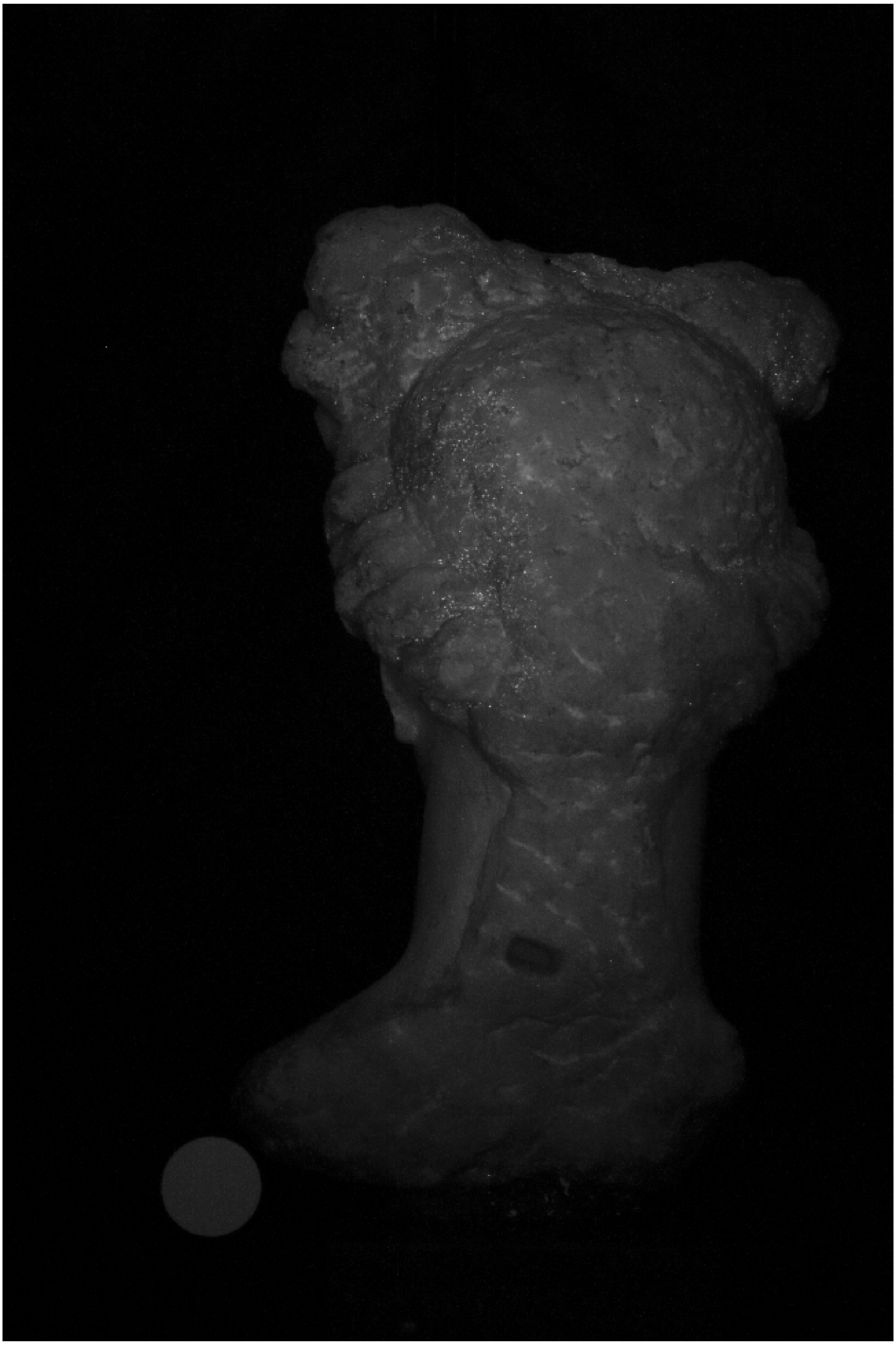

Fig. 8: VIL-image of the hair showing the distribution of particles of Egyptian blue as spots of bright white luminescence. Only very few particles were observed in the eyes and on skin parts (museum photo).

Fig. 9: VIL-image of the hair showing the distribution of particles of Egyptian blue as spots of bright white luminescence. Only very few particles were observed in the eyes and on skin parts (museum photo).

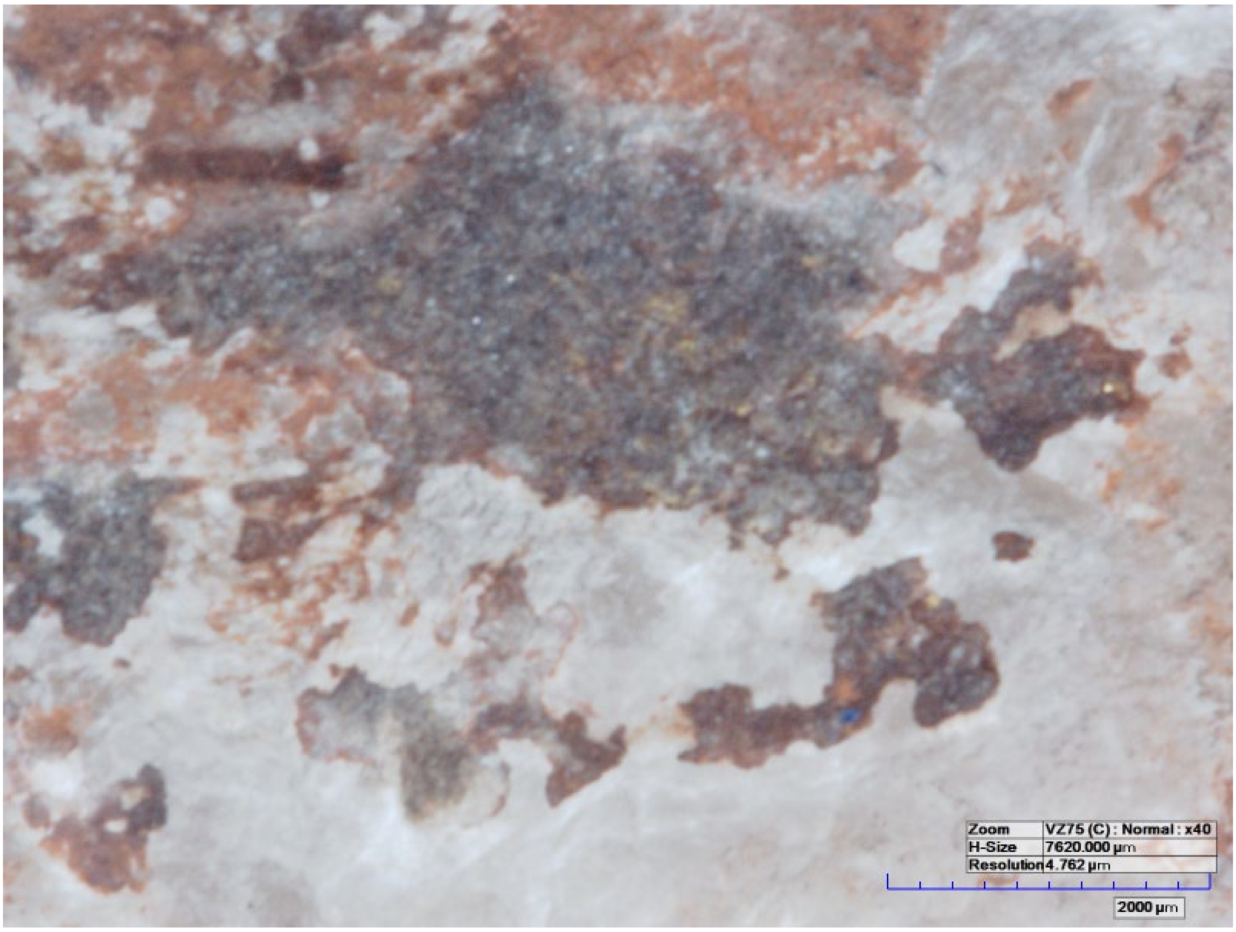

Fig. 10:
Micrograph of a lock of hair above the left eye. Gilding on top of a red layer was observed. Usually the gilding was partly covered by secondary, dark deposits, ×40.

Fig. 11: Location of points of analysis, micoscopic imaging and non-invasive XRF-analysis (1 and 2).

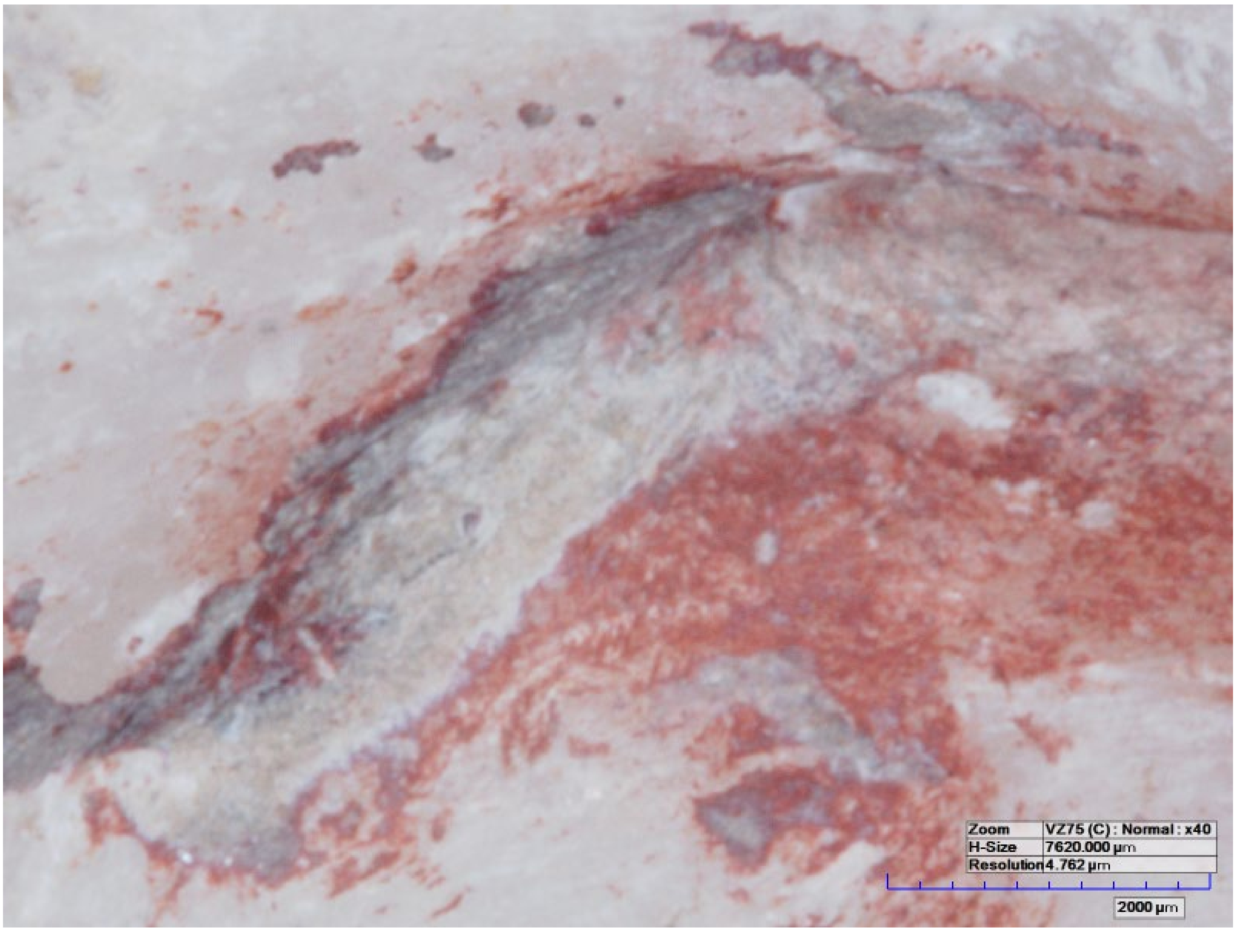

Fig. 12:
Micrograph of the right corner of the mouth. Extensive remains of an opaque red colour were observed and on top of this a white layer, ×40.

Fig. 13: Sampling location for cross-section preparation and invasive EMP-analysis. (3)

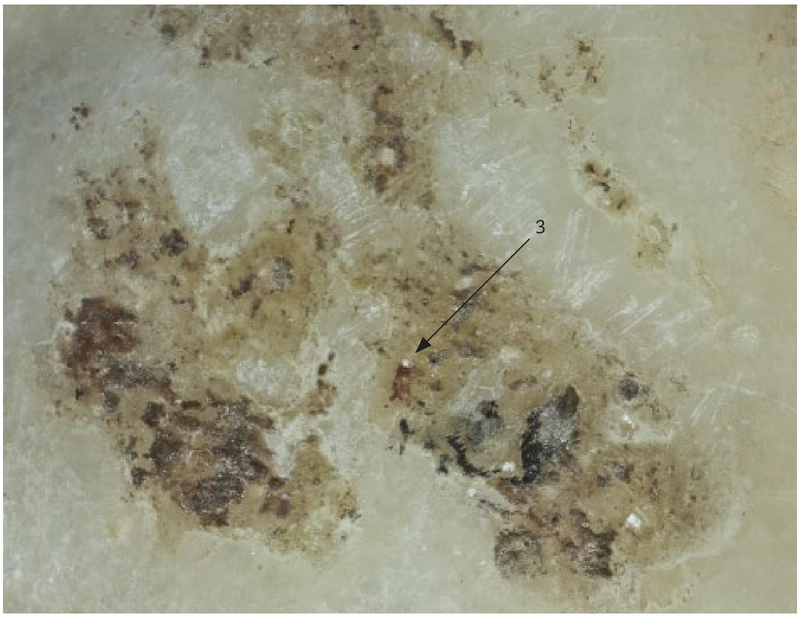

Fig. 14:
Detail of skin colour preserved on the left cheek showing the area (indicated by an arrow) from which sample 3 was taken. Tungsten light photography (museum photo).

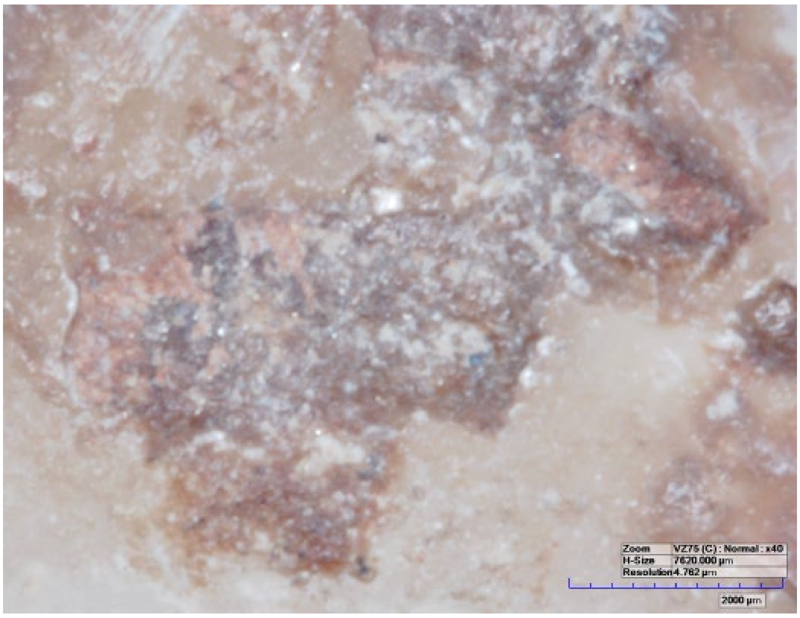

Fig. 15:
Micrograph of the left cheek. Remains of skin colour were preserved beneath secondary deposits, ×40.

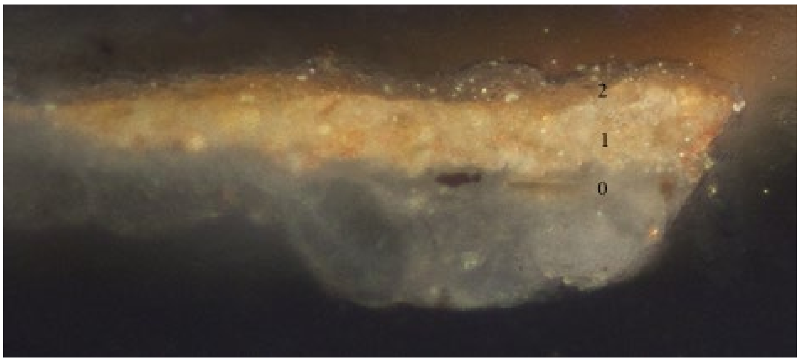

Fig. 16:
Micrograph of polished cross-section of sample showing the stratigraphy of the skin colour on IN 2815. On top of the marble (0) a yellowish layer with a few red grains was observed (1). On top of this is a thin, reddish layer (2). The second layer was partly covered by incrustation, ×200.

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- Project conservator Maria Louise Sargent and Ph.D. student Amalie Skovmøller (Ny Carlsberg Glyptotek and the University of Copenhagen, SAXO Institute).

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3D Digitization in an Applied Context: Polychromy Research

Chelsea Alene Graham

ABSTRACT

This paper[1] concentrates on a case study rooted in the application of digital technologies to museum collections management, research and accessibility. The case study presented in first outlines what creating a 3D model of a museum object entails, including geometric data capture, post-processing and projection of color information, and second how 3D models can be applied in a museum setting. More specifically, this case study highlights the usefulness of digitization and visualization in the context of classical polychromy research, rumination and hypothesis.[2]

INTRODUCTION

3D applications in polychromy studies allow portraits to be documented, explored and shared in interactive ways that impel new discovery and correlation. Creation of a 3D model begins with the acquisition process: using a triangulation laser scanner and computer software, surface geometry of portraits can be acquired and refined. Given the precision of these methods, surface geometry can be replicated with high fidelity, allowing polychromy to be studied in relation to the morphology of tool marks and areas of polish. The final geometry of the 3D model then stands as a point of confluence for data associated with polychromy studies and serves as an arena for fitting together data to bring more understanding of painting methods and placements. Through digital methods, deteriorating traces of color may be documented, interpreted, visualized and interacted with before they are lost.

ABOUT THE CASE STUDY PORTRAIT

The Roman portrait that serves as the subject of this case study, IN 821 (fig. 1), was acquired by the Ny Carlsberg Glyptotek in 1888. Considering the portrait dates to around 235 CE, it is in quite good condition, save for a broken nose, chips to the ear, and scratches and incrustations on the face. The portrait was sculpted from a fine-grained white marble and displays meticulous detail characteristic of a high level of craftsmanship. Subtle differences in texture give depth and dimension to hair, eyebrows and the expression of the youth.

This portrait is of particular interest to the Glyptotek's Tracking Colour project[3] because of the highly polished skin surfaces. The Roman boy (IN 821) and a selection of other Late Severan Roman portraits with highly polished surfaces are being investigated in order to assess whether the onset of incised and drilled eye details and a high degree of polish of the skin are evidence of a monochrome, marble aesthetic.[4]

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1 This paper is in effect, a modified version of a chapter of my archaeology MA thesis undertaken at Lunds universitet in 2012. Graham, 2012: 37–68.

2 For case studies related to digitization and polychromy, please see Beale and Earle, 2011; Pintilie, 2011.

3 For the project see www.trackingcolour.com

4 Østergaard, 2008, 56.

Preliminary investigation results confirm that they are not.[5] Examination under raking light, microscopy, ultraviolet fluorescence (UV-FL) and visible-induced luminescence (VIL) digital imaging were undertaken in order to detect traces of color. These investigations yielded traces of colour on all features of the portrait.

Why, we must then ask, was polychromy applied to such a carefully refined surface as that of the skin of IN 821? If not to showcase the quality of the material and artistry of the sculptor, the highly polished surfaces must somehow have contributed to a highly valued aesthetic by interacting with the polychromy.[6] This may have been achieved by the application of thin layers of paint by skilled artisans using techniques of shading, highlighting and tonality to achieve a realistic representation of the subject. Applying thin layers of paint would allow light to penetrate into the marble and be refracted by its crystals, achieving special optical effects.

METHODOLOGY ADOPTED

The digitization undertaken in this case study can be divided into two phases: digital capture and the processing of this data into a 3D model. In the first phase, a triangulation laser scanner was used to collect points of reference from the surface of the portrait. In the latter, these points were merged and connected to create geometry mirroring that of the portrait.

ON-SITE DATA ACQUISITION

The Roman boy (IN 821) was digitally acquired over the course of a few hours using a scanning technique based on trigonometry. The laser scanner emits a laser beam from a known distance and angle from the scanner's lens, which allows it to obtain the precise x, y, and z coordinates for each point of the object's surface topography.[7] Scans convey these measured vertices in three dimensions through the creation of points clustered in a cloud, or point cloud. These points can then be connected to create geometry of the distinct morphology of the object.

Of interest in the acquisition campaign were the properties of dimension, surface geometry, and color information. The portrait was presented for scanning on a turntable in the middle of one of the sculpture galleries. Scans were taken from specific angles and heights as opposed to a head-on approach in an attempt to acquire as many points as possible from the more geometrically complex areas, for example under the chin and the top of the head, around the ears, and below the brows.

The scanning acquisition campaign entailed capturing two sets of single scans revolving 360° around the portrait. The turntable allowed the scanner to remain stationary at a distance of 43 cm. The first set of 16 scans was captured with the scanner tilted about 135° away from and situated nearly below the portrait, while the second set of 16 scans was captured with the scanner tilted about 45° toward and positioned nearly above the portrait. The turntable was rotated incrementally after each scan to allow overlap between scans for alignment purposes.

With the settings used to capture the geometry of this particular subject, the NextEngine 3D Scanner HD[8] had a dimensional accuracy of 0.015 inch and a capture density of 22,500

5 Skovmøller and Therkildsen, 2012.

6 Skovmøller and Therkildsen, 2012, 40–44.

7 Boehler and Marbs, 2004, 292; Kelly, 2011, 3.

8 http://www.nextengine.com/

points per inch squared.[9] Daylight, delivered through the sculpture gallery's large window, served as backlighting and two diffuse lights were employed as side lighting for the campaign.

POST-PROCESSING

The acquisition yielded a project file containing the 32 single overlapping scans. These scans needed to be cleaned and aligned with one another in order to create a cohesive model. The Align feature in the acquisition software, NextEngine ScanStudio HD Pro[10] offered pins to place in points of common geometry to both scans (fig. 2). One by one, each scan was manually aligned. Next, extraneous points were trimmed from the project. Processing up to this point was carried out over the course of two to three days. From this manually aligned and trimmed model, a .ply (polygon file format) file was created for further geometrical refinement in MeshLab[11] (fig. 3a). MeshLab is free, open source software created in the visual computing lab of the Italian Institute of Information Sciences and Technologies, ISTI–CNR, for processing point clouds into 3D models. MeshLab has been designed specifically with cultural heritage applications in mind and has been used extensively in instances of the documentation and restoration of artifacts, cultural monuments and historic buildings.[12] MeshLab is quite the protagonist of this case study and it is in this software that the model truly takes shape.

Since extraneous points can cause inaccuracies, in order to create geometry with the highest fidelity to the morphology of the subject, it was necessary to make the model as clean and compact as possible. A pipeline of filters to tidy up the model and remove outlying points was run.

Although thirty-two scans worth of points make for a geometrically precise model, the sheer density of point cloud creates havoc in terms of file size. In order to decrease the large size of the file and make it practical for use, the number of points within the model had to be reduced. It was imperative in this case study to strike a balance, creating a model light enough for scientific use without sacrificing the quality of the model. With a clean set of data, the model was next subsampled, meaning that the vertices, faces and edges that comprise the geometry of the model were assessed and a new point cloud was created uniformly reflecting the arrangement of the samples (fig. 3b).

From this simplified point cloud, a Poisson mesh was created, in effect connecting the dots to create polygons comprising a cohesive model. While the Poisson mesh gives dimension to the model it contains no color information (fig. 3c). Smoothing pipelines were then run in an attempt to reduce rough patches on the model that appeared slightly noisier than the Roman boy (IN 821). These areas were some of the smoothest on the portrait and perhaps their reflectivity caused the laser to create some noise. These actions resulted in the final geometry (fig. 3d). This stage of model creation and refinement accounted for a day and a half of work. Once the model has been subsampled and the file size decreased, subsequent applications take less time to carry out.

There are a few different ways of projecting color information on the white Poisson mesh.[13] Within MeshLab, color information can be transferred from the original point cloud to the final Poisson mesh within minutes.

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9 Since this scanner is developed in America, its accuracy is stated in terms of inches. 1 inch = 2.54 cm.

10 http://www.nextengine.com/products/scanstudio-hd-pro/specs/overview

11 http://meshlab.sourceforge.net/

12 Cignoni *et al.*, 2008.

13 Callieri *et al.*, 2002.

Fig. 1:
The Roman boy (IN 821).
Images taken by R.H. Therkildsen and provided courtesy of the Ny Carlsberg Glyptotek.

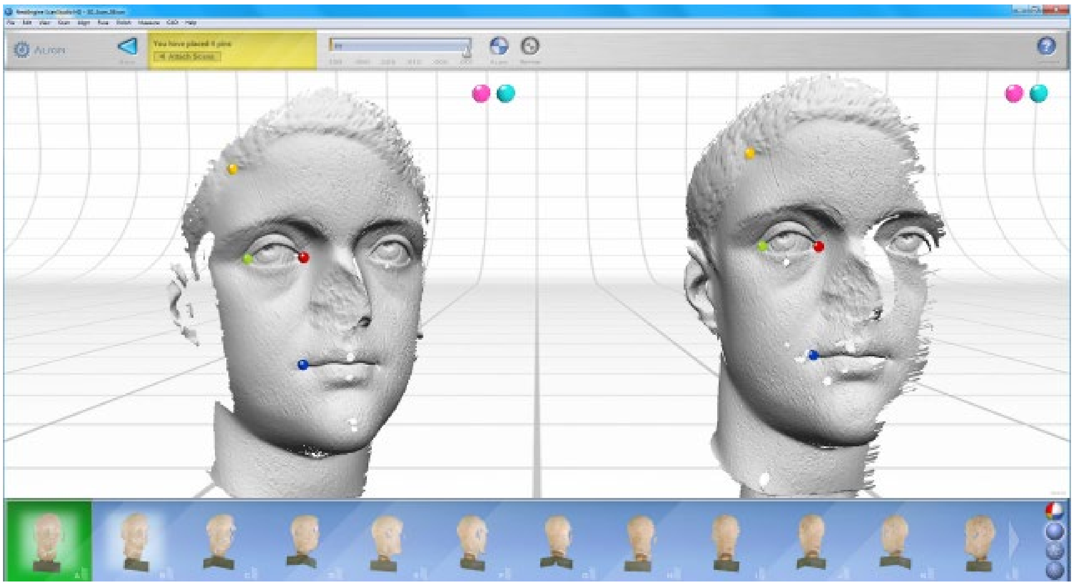

Fig. 2:
Alignment process in NextEngine ScanStudio HD.

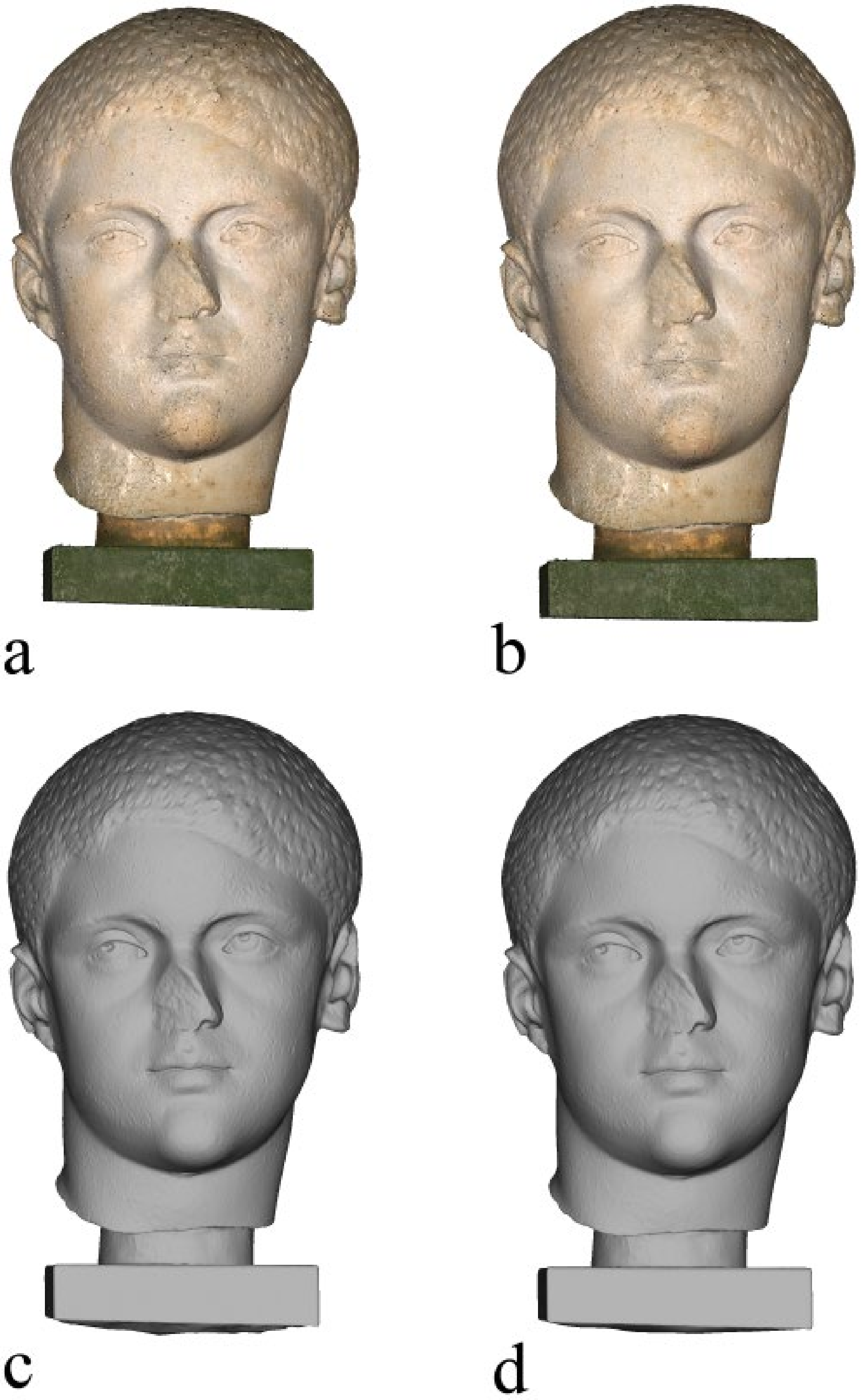

Fig. 3:
Stages of model creation in MeshLab.

a. Scans aligned into point cloud.

b. Subsampled point cloud.

c. Poisson mesh.

d. Laplacian smoothed mesh.

This is a per vertex method of projecting color where each vertex is assigned red, green and blue (RGB) color values.[14] In many cases, the color information captured by the scanner is not of a very high quality and gets distorted in the process of alignment. Color projection is also possible by texture mapping color information captured in digital images. In MeshLab, images can be aligned to the geometry of the model by eye and/or optimized by the program.[15] To reach a precise outcome, aligning each image on the model takes a few minutes of concentration and manipulation. For each file aligned to the model, depth maps and masks are created in order to yield texture mapping with the highest fidelity. Masks assign a weight to each pixel, calculated by considering three main values: the angle between the normal of the vertex associated with the pixel and the direction of view, the distance between the point of view and the vertex (depth) and the distance of the pixel from a discontinuity in the 'depth map' (that is a map where each pixel has the value of the depth of the associated vertex). These values are combined to calculate a weight. The colour value of each vertex is a 'weighted sum' of the contributions of all images.[16]

In total, texture mapping four images on the model took approximately an hour.

model realized

The color projected onto the final model originated from four photographs (taken in 90° increments) provided by the Ny Carlsberg Glyptotek (fig. 1). The color obtained in these images was calibrated using Munsell Color X-rite standards. Images were originally taken in RAW format at a high resolution under tungsten light. Texture mapping these images onto the model proved a more effective manner of projecting color than performing a vertex attribute transfer of the color information captured by the scanner (fig. 4). The transfer of the scanner's color information produced decent coverage but not as faithful color information. The four-image standard used in initial research of the portraits posed a problem for projection. These four images did not provide 360° coverage of the portrait. Information for the areas around the ears, chin and on the top of the head was not captured (fig. 4b). Since imaging for a 3D model requires images to be taken from more angles than normally needed, the incorporation of a 3D model can expand the scope and structure of a study.

Although the current color information is important for general aesthetics and in demonstrating the processes of pigment fading and erosion, viewing the model without color information is a method of visualizing geometry that is otherwise easily obscured by color texture.[17] In the case of the Roman boy (IN 821), texture is understood as having been intimately connected with the painting. Surface geometry of portraiture was carefully planned out and precisely constructed. The juxtapositions of smooth and textured surfaces played an important role both in setting the stage for paint layers and creating special optical effects. In order to best visualize the detailed topography of the model's surface, geometry-accentuating shaders were applied in MeshLab (fig. 5). These shaders enhance perspective of subtle details, for example, the fine chisel strokes that created the eyebrows and hair.

Equally important to the optical aesthetics of the portrait is the materiality of marble. To access this, the model was next decimated and imported into Blender,[18] a free, open

14 Callieri *et al.*, 2008.

15 Corsini *et al.*, 2009; Sottile *et al.*, 2010; Dellepiane and Callieri, 2011.

16 Dellepiane and Callieri, 2011.

17 Wachowiak and Karas, 2009, 155.

18 http://www.blender.org/

source software. This program is used for generation and elaboration of 3D models and computer animation, especially for creating renderings with realistic light qualities. The model needed to be decimated, or reduced in size and quality, in order to be a manageable size for Blender. In this instance the focus is more on color texture and less on geometry, so a slight degradation of the surface geometry is undetectable. Within Blender, the model of the portrait, with its contemporary color information (fig. 4b), was assigned properties to match the actual marble material of in 821. Ascribing a marble material to the 3D model gave it marble's distinct qualities of subsurface scattering (fig. 6). Light is absorbed by, scattered within, and reflected from objects differently depending on the specific properties of their material of construction.[19] Allocating the correct properties to the model enables the model to react to light simulations in the same manner the subject reacts to light and yields a more realistic rendering for use in research and exhibitions.

SPECIFIC APPLICATIONS

The main objective of this case study was to create a model that could be used as a speculative and interpretative apparatus for archaeological research. Digital acquisition and the creation of 3D models ring in a new mode of studying statuary. They are not only means of gaining precise documentation, but also create a three-dimensional 'screen' upon which to experiment, theorize and visualize data related to polychromy studies. Here many different kinds of data can be amassed and visualized in relation to one another. Allowing for the projection and visualization of imagery in one place, models enable interplay of data three-dimensionally and create a new analytical arena for interpretation. The interactive nature of 3D models provides a manner of visually connecting and relating sculptor and painter with the portrait to a hitherto unprecedented degree. Models stand as three-dimensional screens upon which researchers can both explore and communicate their data within research communities and to the public. Outside of research, creation of 3D models of classical polychrome statuary also has many implications for conservation, dissemination and exhibition.

projection of technical imagery

Among the uses of 3D models, giving dimension to data is one of the most important. Advanced technical images derived from methods such as vil, uv-fl and infrared reflectography (irr) can be projected on the model to convey detection of organic or mineral substances and thus present a unique opportunity to explore data in three dimensions. Information obscured by the light of day, while on exhibit in a museum gallery, can be unlocked through special modes of photography. Projecting this information on a model enables researchers to experience it in a more realistic way than through two-dimensional photography.

Equipped with vil and uv-fl images provided by the Ny Carlsberg Glyptotek (fig. 7), the model was texture mapped to exhibit these images (fig. 8). The white specks of luminescence observable in vil images (fig. 7a and 8a) show the presence of Egyptian blue. Note the particles of Egyptian blue among the tufts of hair, under incrustations, as well as on the smooth skin surfaces. The uv-fl images (fig. 7b, 8b and 9) reveal the presence of organic compounds on the surface and within the pores of the marble's surface. These traces are seen as areas of orange red fluorescence.

19 Jensen and Butler, 2002.

The same issue of coverage as was experienced with the tungsten images (fig. 4b) was encountered. Despite the blank areas, the detail of the projections is quite exceptional, evinced in a side-by-side comparison of the eyes of the portrait as imaged (fig. 9a) and as modeled (fig. 9b). Both representations of the uv-fl information provide great detail as to the presence of organic compounds around the tear ducts. The projections in figure 8 can be opened together and visualized in layers for comparison.

mapping of pigment traces

Along with technical imagery, visual examination of portraits helps conservators to form a more complete picture of just how pigments constituted the polychromy of antiquity. Models can serve as 3D maps for pinpointing sources of color information detected with the aid of microscopy. These points of pigment are designated with distinct x, y, and z coordinates on the 3D model, making easier reference, discussion and comparison of pigment traces. This, in turn, leads to more accurate studies of the positions and interactions of pigments and tool marks.

The subject of this case study has been quite extensively examined for traces of polychromy. The areas of greatest interest to the Tracking Colour project are the skin surfaces that exhibit a high-gloss finish. On these surfaces, despite subsequent cleanings and handlings, evidence of pigments was found. The Ny Carlsberg Glyptotek provided the data related to source locations of pigmentation on in 821 in the form of images circumnavigating the portrait in 90° increments, taken at 0°, 90°, 180°, and 270° (fig. 10).

Numbers were assigned, grouped by feature and pigment color, to the 368 points detected on the sculpture. These points were then plotted on the 3D model using the PickPoints tool in MeshLab. The process of 3D mapping was painstakingly carried out over the course of a few afternoons. To avoid distortion or possible loss of information through texture mapping the images from figure 10, the points were plotted by eye with the previously prepared labeled images for reference (fig. 11). Descriptions of the locations of pigment traces on the portrait and of points plotted on the 3D model were compiled. The subsequent table[20] could be input into or serve as the basis for a sort of relational pigment trace database with statistics on color, feature, coordinates and related data obtained through technical imaging.

Within MeshLab, the PickPoints tool allows a cluster of points to be saved independently of the project and uploaded onto different 3D models. This is applicable to the case of in 821 in that the points can be visualized on the tungsten, uv-fl or vil 3D models to show correspondences between the presence and color of pigments detected visually and the advent of luminescence or fluorescence captured in imagery (fig. 12). Relation to surface geometry can also be visualized and explored, which is especially relevant for evaluating areas of fine detailing (fig. 13).

These 3D maps can be used for reference, analysis and comparison. The advantage of this type of mapping is the spatial component, which enables researchers to interact with and experience the data in a different way. Generally pigment traces are discovered by eye under microscopy and mapped two-dimensionally. Three-dimensional mapping allows the pigment points from regions in close proximity from separate images to be visualized together and under different radiation. The correspondence of the data to surface geometry is also of great importance. On any model, color information can be turned off and on to explore the relationship between surface geometry, pigment pinpoints, and luminous phenomena. Points of interest can in turn be compared to micrographs or imaged accordingly.

20 Graham, 2012, Appendix H.

Fig. 4: Color projection strategies. *a. vertex attribute transfer in MeshLab, b. texture mapping in MeshLab.*

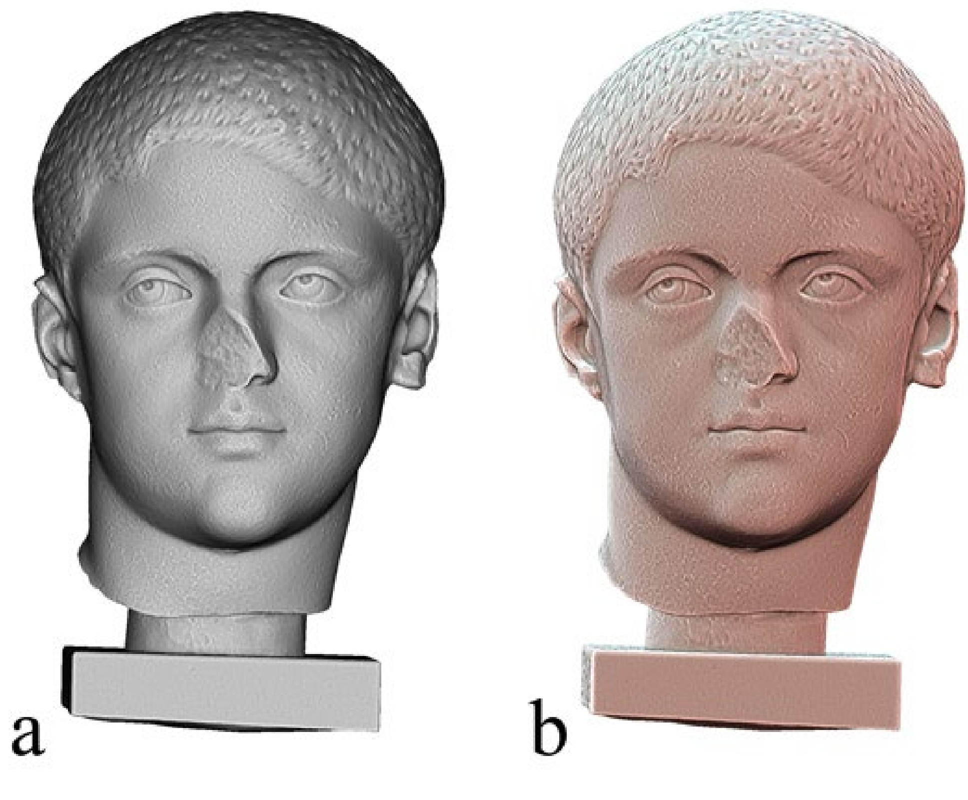

Fig. 5: Visualizing geometry in MeshLab with shaders.

a. Lambertian radiance scaling.

b. Lit sphere radiance scaling.

Fig. 6:
Marble
surfaces as
visualized in
Blender.

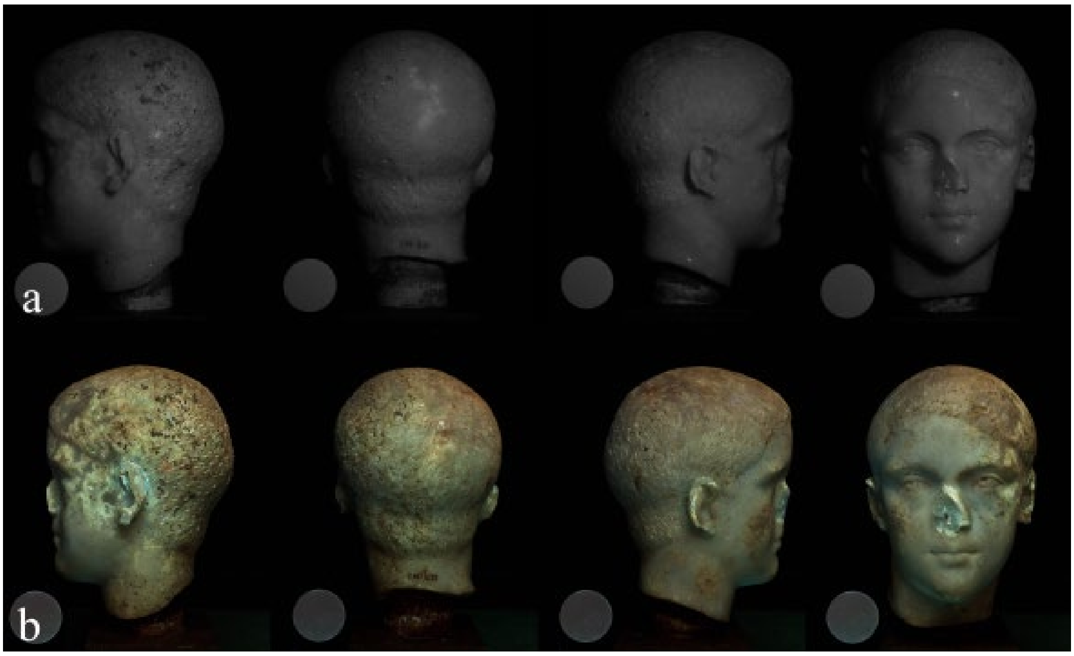

Fig. 7: Technical imagery of in 821. Images taken by R.H. Therkildsen and provided courtesy of the Ny Carlsberg Glyptotek.

a. visible-induced luminescence (VIL).

b. Ultraviolet fluorescence (UV-FL).

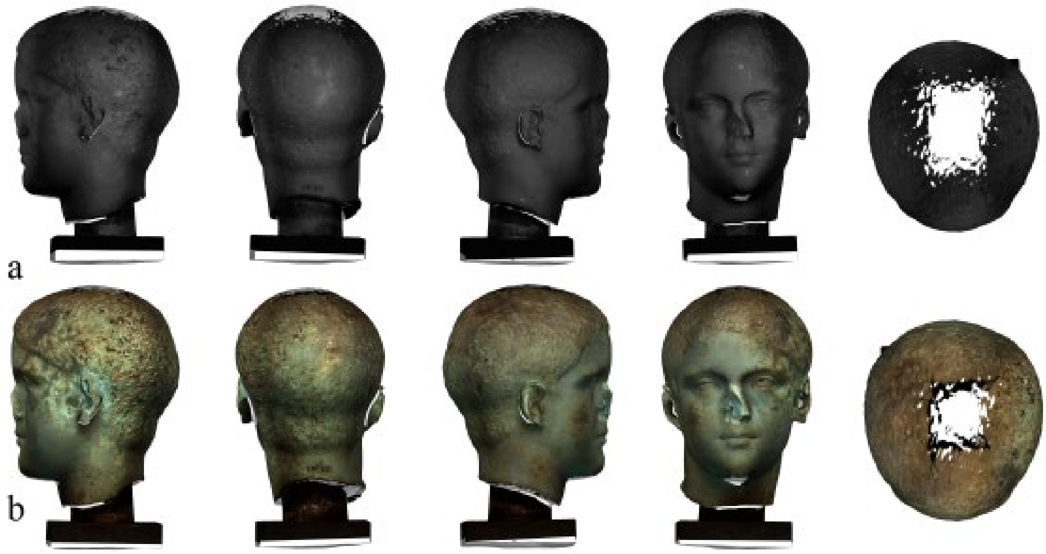

Fig. 8: Technical imagery texture mapped on the model with MeshLab.

a. Visible-induced luminescence.

b. Ultraviolet fluorescence.


a
b

Fig. 9: Comparison of an area of detail.

a. UV-FL image taken by R.H. Therkildsen and provided courtesy of the Ny Carlsberg Glyptotek.

b. 3D model with UV-FL data texture mapped.

Fig. 10:
Pigment traces on IN 821
Mapped in 2D. *Images prepared by R.H. Therkildsen and provided courtesy of the Ny Carlsberg Glyptotek.*

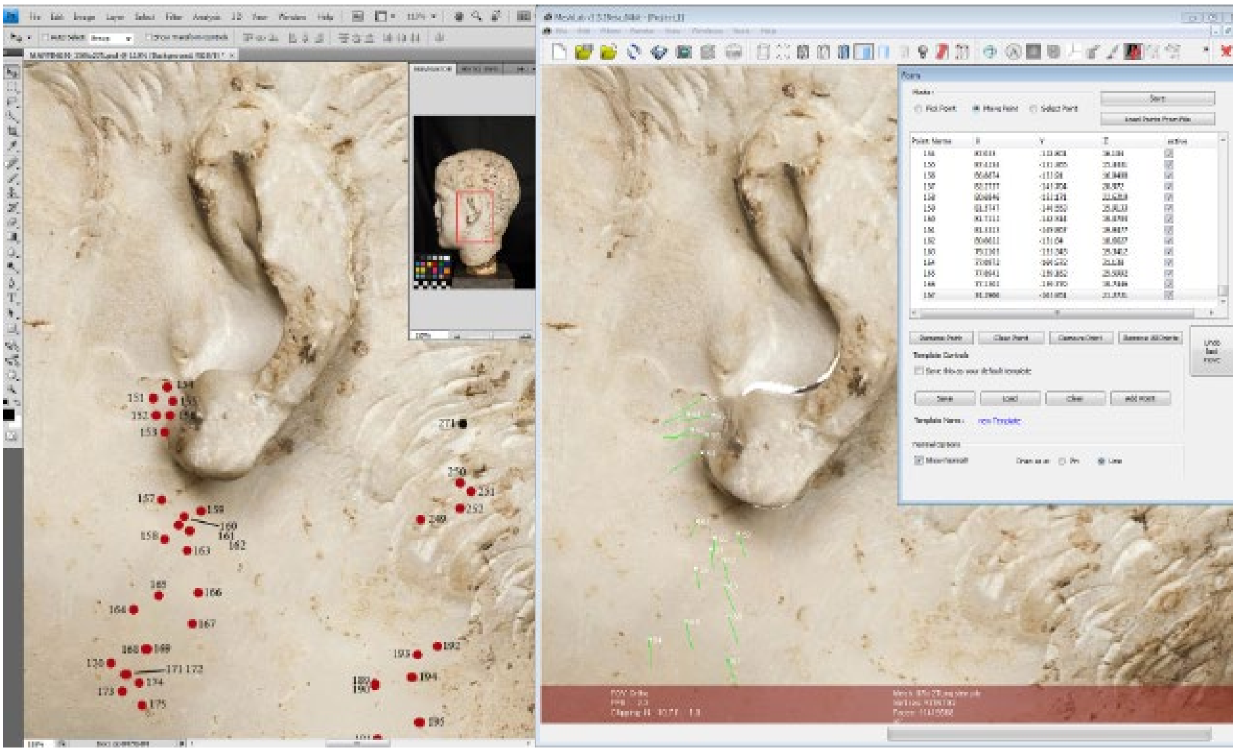

Fig. 11:
Mapping pigment traces three-dimensionally in MeshLab. Screenshot:

l. labeled image of IN 821 taken at 90° (portrait's left side) in Adobe Photoshop,

r. points plotted on the model with MeshLab tool PickPoints.

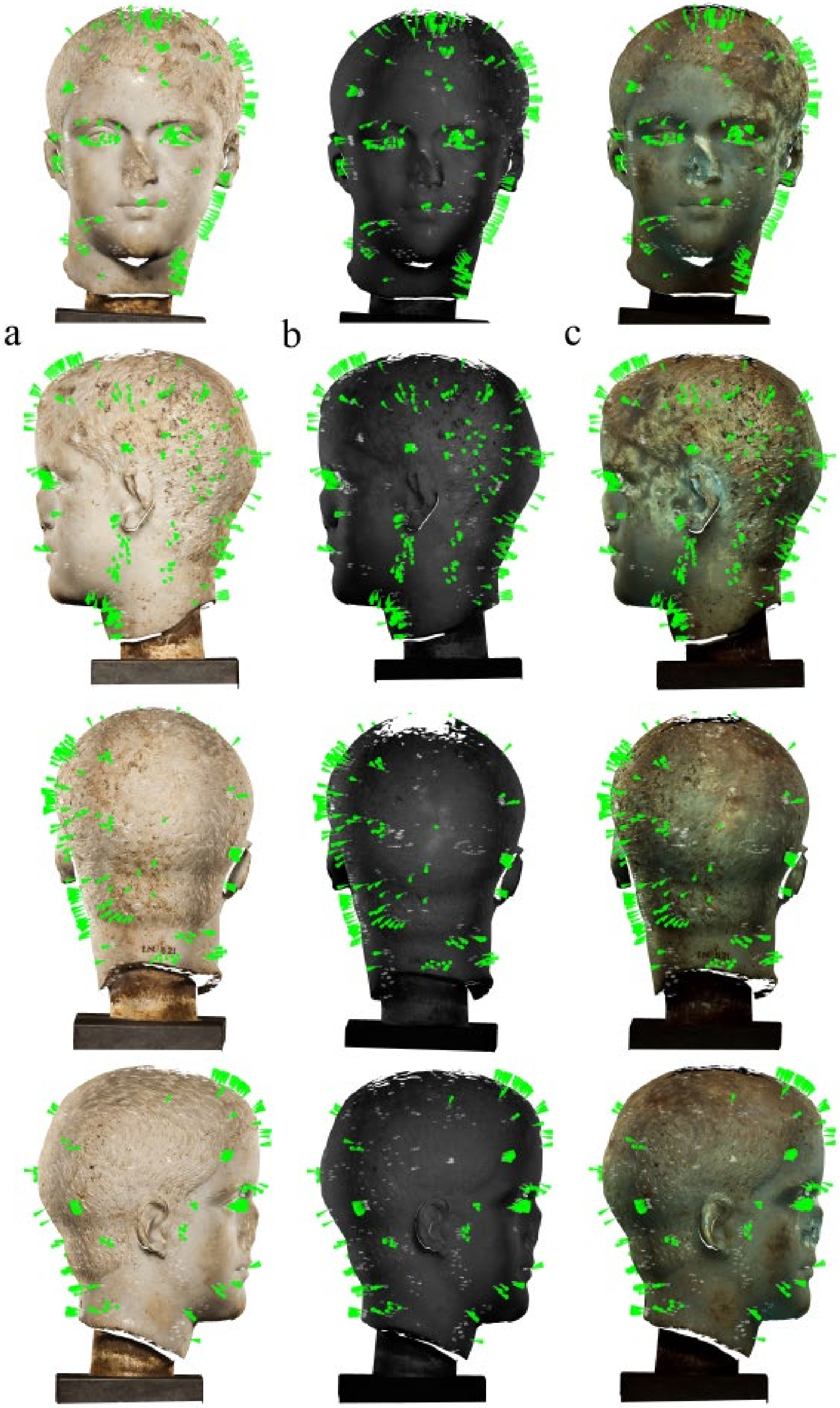

Fig. 12: Pigment traces on IN 821 mapped in 3D in MeshLab.

a. Tungsten.

b. Visible-induced luminescence.

c. Ultraviolet fluorescence models.

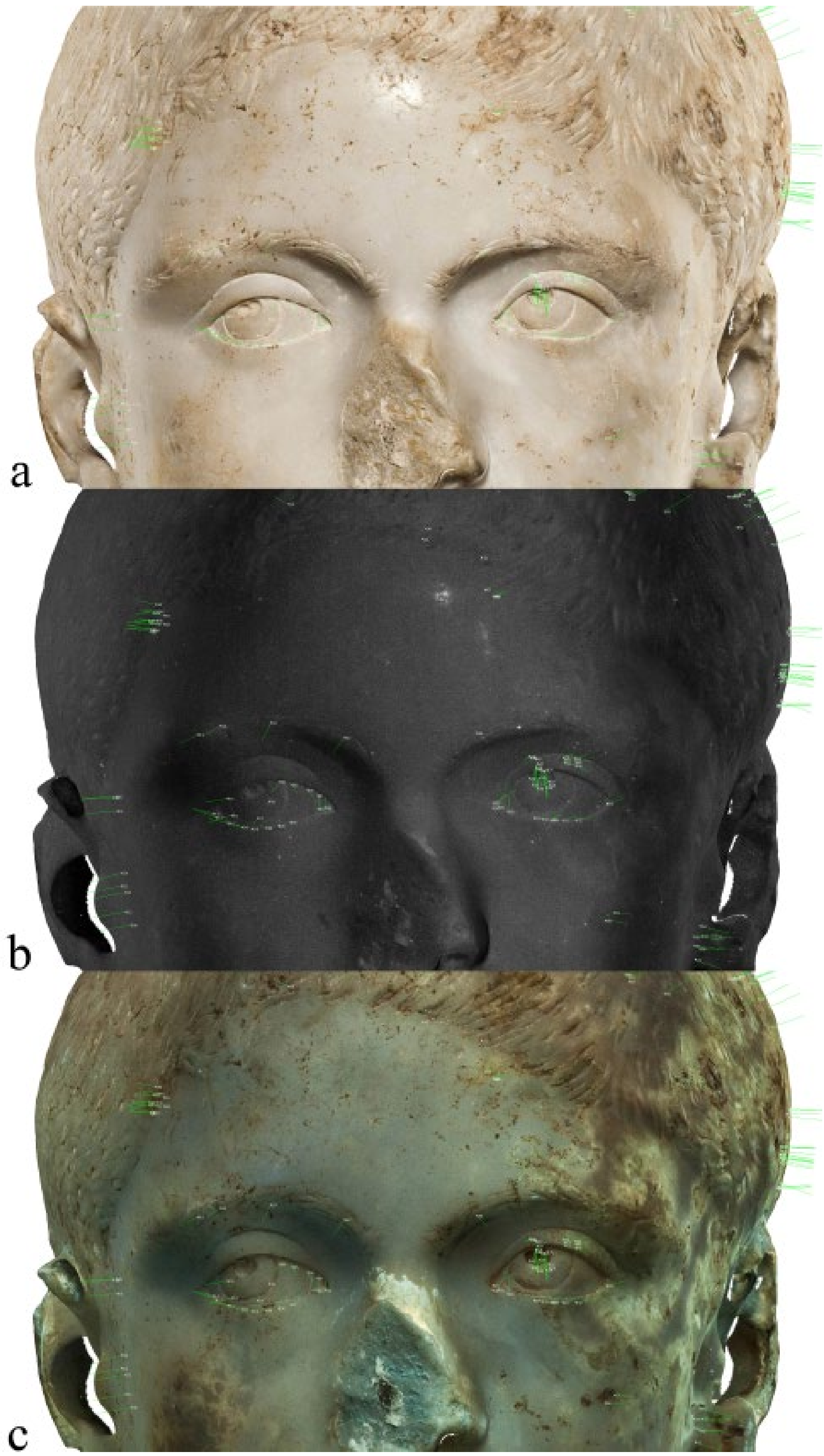

Fig. 13: Correspondence of plotted points to technical imagery

a. Tungsten.

b. Visible-induced luminescence.

c. Ultraviolet fluorescence models.

Fig. 14: Digital color interpretation of the Roman boy (IN 821). *Created and rendered in Blender.*

Optimally, the process of mapping pigment traces in three dimensions would occur at the same time as visual examinations, instead of transferred from two-dimensional photographs. The x, y, and z values for points would also be incorporated into relational databases and saved along with models, images and other media related to sculptures. This case study serves as an example of a possible outcome of using a 3D model in mapping in the context of polychromy studies. It is, however, important to consider that the margin of error experienced would be lower and the results even more precise if this technique were used as a primary documentation method. Beyond the scope of this case study, 3D mapping has quite broad applications in digital cultural heritage.

experimentation with the interplay and layering of pigments

Mapping of pigment information on 3D models opens the door for the visualization of color information in many forms with implications far beyond traditional exhibition. Such mapping lends itself nicely to digital color reconstruction, perhaps better referred to as color interpretation. Researchers may aim to achieve a vision that reflects the special optical qualities created by the interplay of marble, thin paint layers, varying binding media and gilding in computer software.[21] Directly on a 3D model, researchers can apply layers of colors corresponding to the pigments from antiquity to different degrees of translucency in an attempt to visualize the effects which classical sculpture painters may have aimed for – one of which was perhaps a convincingly lifelike rendering of the subject.

In the case of IN 821, through fine detail texturing of the portrait's surface, a sculptor crafted a specific canvas for a painter to work upon. The differences in texture combined with paint created optical effects whereby the marble materiality was drawn through the translucent layers of paint and accentuated by shading and gilding. Another factor in the appearance of the Roman boy (IN 821) is binding medium, which had a distinct impact on the color, concentration and transparency of paint layers. Although no traces of binding medium were found on IN 821, it can be assumed from contemporaneous subjects that egg tempera was among the media that served this purpose. When using egg tempera, paint layers appeared more shiny and opaque.[22] Other binding media were likely also used on the portrait to give certain areas a more matte finish. Due to the minute original presence and poor preservation of their natural elements, binding mediums are difficult to detect. Binding medium and the subtle color nuances created by sculptor and painter are difficult to trace back from a statue's current condition.

As a result all color reconstructions, while rooted in thorough research, are highly hypothetical and often hotly debated. Creating digital color interpretations is a newer practice that presents viable alternatives to physical reconstructions.[23] It is a subject worthy of quite in-depth research and experimentation, especially in classical polychromy.

The skilled surface manipulations of IN 821 set it apart from many other sculptures that have previously been the subjects of physical color reconstructions. These surface treatments were painstakingly created with small chisels, picks and smoothing techniques to create a life-like appearance. Viewed in plain white, the understated textures do not appear to have great depth. With the aid of color shading and highlighting, however, they gained realistic dimension. The sculptor and painter of IN 821 collaborated to create an accurate vision of the Roman boy without exaggerated geometry and presumably without excessive

21 There are many suitable computer graphics software in which a 3D model may be uploaded and painted upon. MeshLab (see note 11) and Blender (see note 18) are two free and open source examples.

22 Kakoulli, 2002, 58.

23 Pintilie, 2011.

color. It was created in a time when colors were used more adeptly and intricately than they had in the past.[24]

This type of portrait necessitates a different approach than has been taken to create other color reconstructions, one that takes surface texture into consideration with as much weight as pigment mapping. A digital color reconstruction was created in Blender (fig. 14) based on general advice from experts at the Ny Carlsberg Glyptotek and with inspiration drawn from the Treu Head[25] and Sciarra Amazon[26]. The contemporary surface – both geometry and color texture – served as the basis for thin layers of paint. To bring the process of creating a color digital reconstruction closer to the techniques used in antiquity, a tablet and stylus[27] were used to mimic the brush strokes of the painting process and imitate pigment concentration produced by pressure exerted. Painting was done directly on the 3D model through texture painting. Subsurface scattering and specular maps were employed to create the hypothetical reflective properties of marble, paint with different binding media and gilding. This part of the case study aimed to experiment and create a far from definitive digital color interpretation in the hope of generating discussion on the subject of digital color reconstruction. Painters have long been the invisible face of classical sculpture. While they were no doubt exceptionally adroit artists, their identity has worn away with their pigments, so it is interesting to think of re-establishing their presence.

cost and competences

Having designed this case study within the context of museum digitization, the equipment used is as cost-effective as possible. Even though more precise scanners and graphics software may be on the market, the equipment featured in this case study gives great quality for its value and is affordable. The biggest expense is acquisition equipment with the 3D laser scanner currently retailing for a reasonable $2995 and the scanning software for $995. While the rest of the software used in this case study was free and open source, the hardware driving it was not. The size of the initial scans required an advanced processor (for example, a computer running 64-bit Windows and with 16 gb working memory), which comes at varying expense. The tablet and stylus used in the color interpretation retail for $999, although cheaper versions are capable of doing the trick.

Also of importance are the entwined issues of manpower and time. A person trained in and familiar with the above means and methods is capable of carrying out a similar digitization for the most part alone. Training is a worthy investment as experience plays a big role in the digitization process. Once one has carried out a similar digitization project, much of the time lost in trial and error can easily be reclaimed. Although formal training is the best, much of the software related to digitization is user friendly and has an extensive online presence with communities and tutorials to help straighten the learning curve. The amount of time that needs to be devoted to digitization depends on these competences. Acquisition can take a few hours, depending on the number of scans captured. Post processing also depends heavily on the number of scans captured, with many scans requiring perhaps a few workdays for model creation and refinement. Using the model to hypothesize color interpretations can require an amount of time parallel to the depth of detail to which one

24 Claridge, 2011.

25 rgb values for remnant skin pigments found on the 'Treu Head' were discovered using an eyedropper tool on Verri *et al.*, 2010: fig. 1 in Adobe Photoshop. Skin tones with these distinct rgb values were then recreated and applied via thin paint layers on the 3D model in Blender.

26 Images of the Sciarra Amazon inspired eyelash styling on the 3D model.

27 http://www.wacom.com/en/products/pen-displays/cintiq/cintiq-12wx

cares to descend. The color interpretation in this case study was executed over the course of approximately four days.

exhibition and dissemination

3D visualizations make it possible to create and disseminate research information as well as projections of what statuary may have looked like in color. 3D models allow for different levels of experimentation. They can be duplicated and made to represent many different interpretations along the lines of color placement, concentration, and vividness. These are also more easily changed and manipulated than physical reconstructions with a much wider potential audience.

Color reconstructions, while slightly divisive in the archaeological community give a new face to classical sculpture. They have the potential to market scientific research to possible sponsors, thereby gaining polychromy projects more funding, or target a wider audience, thus bringing in more visitors to a museum. Many exhibition techniques are conceivable. It has been proposed that the color from 3D models can be projected on an original sculpture via video projector to create an interesting exhibition effect.[28] In this way, the evolution of polychromy research can be represented with traditional and opposing views on old and new hypotheses alternating every few minutes.

Incorporation of 3D models in museum exhibition can provide the public with more than just a vision of a sculpture in color, but also a depiction of the research that led to those conclusions. Visualizations have the potential to contribute a clearer understanding of how polychromy from antiquity is studied and how it relates to the geometry and finish of the white marble sculptures that line the halls of museums today.

Inclusion of 3D models of polychromy subjects in 'universal collections' can further bring the subjects of polychromy studies to the attention of the public. Models can also be manipulated, for featuring in virtual reality systems, from marble museum artifacts to animated living storytellers and legacy bearers. Within museums, combining virtual reality systems with collections in special exhibits has great potential. A virtual environment of the workshop of a sculptor would be another effective way of transporting a user into the culture of classical sculpture and acquainting them with the atmosphere, artisans, raw materials, stages of production, and tools of the trade. A precedent in the aim of conveying artistic handicraft through virtual environments has been set by the Virtual Museum of Sculpture.[29] It is a great mode of diffusion for the intangible aspects of sculpture – artistic techniques, workshop dynamics and the division of labor behind the creation of Roman portraits. Such a virtual environment could be based on archaeological excavation and analysis. Contemporary sculptor, Peter Rockwell's[30] interpretations of the working processes of artisans at Aphrodisias, based on their unfinished statuary, give one such example. Along these lines, the presence and processes of painters could be hypothesized as well.

Interaction through virtual reality systems and apps can help draw an audience and bring recognition to the subject matter, the institution and its research. For the public, 3D models and virtualizations have the ability to influence perceptions, change preconceived notions and encourage the formation of new interpretations of classical sculpture. Without a doubt, this interest can only have positive effects in the realm of funding needed for new research.

The inclusion of 3D models and data, as the ones herein presented, into a relational or digital database is another step that could be taken to encourage scientific discussion and

28 Dellepiane *et al.*, 2011, 54.

29 Carrozzino *et al.*, 2011.

30 Rockwell, 1991.

research. Making models available within an online collections database could give easy access to scholars and institutions for use in inclusion in their collections, research and virtual or physical exhibition.

With high quality surface geometry plotted in three dimensions, 3D printing has become a reality. With a 'click of the mouse,' via email or online collections database, models could be delivered and printed anywhere in the world. Scaled models of both the negative of the model as a mold and the positive of the model as a cast are possible to print.[31] This provides a non-contact method of creating copies of the original portrait, which is leaps and bounds from the damaging methods that have been used to document and replicate previously.[32] Copies could be used for exhibition (on site or as part of a traveling exhibition), research or in the context of repatriation. In terms of repatriation, hypothetically, a museum could request a digital copy of a sculpture. They could certainly use the 3D model for research and exhibition, however they could also make a 3D print of the model or commission a replica cut from marble based on the geometry of the model. In the event that a museum would have to repatriate a portrait, they could have replicas made for the purposes of exhibition and research and then send the portrait arranged in custom packaging created from the 3D negative to those with the claim.

These are just some of the many possibilities generated from digital acquisition and 3D model creation of a museum specimen. All of the aforementioned applications of digitization promote artifacts and serve to safeguard the important places they hold in both our general cultural understanding and the development of polychromy studies.

ANALYTICAL DISCUSSION

Polychromy studies are an important facet of classical archaeological research as they endeavor to document, interpret and preserve quickly eroding archaeological information. These studies foster a better understanding of classical sculptural polychromy that brings archaeologists closer to the actions of their subjects: the painter, the sculptor.

Through digitization, the presence of painters of classical sculpture that has eroded with their pigments may be reestablished.

Since the mid-nineteenth century, champions of sculptural polychromy have attempted to give scholars and the public some idea of what ancient statues looked like by producing colored plaster casts, but for all their efforts they have failed to make a lasting impression.[33]

3D models and virtualizations have the potential to reanimate classical statuary for the public and generate a compelling presence for sculptural polychromy within the broader research community. The heuristic value of 3D models, especially in this context, is without measure.

They are active agents of research upon which data from many interdisciplinary studies may be projected and with which researchers and the public can interact in a variety of new ways. The inherent accessibility of 3D models cultivates a collaborative environment. To this end, 3D models can serve the polychromy research community, which seeks to create a forum for interdisciplinary and international research collaboration and hopes to achieve this through making scholarship on the subject accessible.[34] This project, for example, has spurred mutually beneficial cooperation between Lunds universitet and the Ny Carlsberg

31 For a recent example of a large-scale 3D printing project at the Smithsonian Institution, please see Pfeifle, 2012.

32 Dellepiane *et al.*, 2011, 49–50.

33 Brinkmann, 2008: 23.

34 Østergaard, 2011.

Glyptotek. Here, sound scientific research and digital know-how have met to give ancient sculptural polychromy a virtual presence. The result is a progressive collaboration that continues to develop.

Although 3D visualizations can serve as powerful tools for investigation, they are often regarded as merely for exhibition purposes.[35] It is through research that specimens may contribute to our worldly understanding. It is through research that specimens may be appreciated for their true value. And it is through research that specimens may gain the attention necessary to fund their preservation. Accordingly, the specific applications of the model created in this case study focus on scientific research. They seek not to simply reiterate previous documentation in a different form, but to present documentation in new manners and associations, that stimulate the drawing of new interpretations and parallels between data. In this case, projection of data on the 3D model highlights the manner in which virtual study can extend research methods and forge new relationships between researcher and subject.

It is an aim of this case study to illustrate the ways in which an adoption of digital methods of documentation and research can help create new knowledge and perspectives. The capacity of 3D models to engage users, incite critical thought and create feedback make them imperative in the trajectory of polychromy studies as an archaeological science.

The blank spots visible on the models in figure 4b and 8 demonstrate how 3D models can provide a new scope through which to view data. The white spots highlight a deficiency of two-dimensional documentation and underscore the strength of a 3D model as a tool of scientific research. 3D models present the opportunity for researchers to visualize data in an all-encompassing manner and experience data spatially in state of the art ways. Documentation strategies simply need be adapted to suit 3D models in the future. More extensive photography of the portrait, for example, would have the ability to provide a complete texture mapping devoid of any blank spots or areas of reflection from tungsten lights. This is an example of how the introduction of 3D models can create cybernetic feedback and incite changes in research approach. Along the same lines, 3D mapping executed at the time of investigation would both save time and yield results with the highest fidelity.

Technology though, as any man or machine, does have limits. Brinkmann[36] asks, “How would one reproduce the refinement of the brocade or the lustrous gilding from a few fragments of color in out-of-the-way spots, not to mention the subtleties of the flesh tone?” Even if a deluge of information were preserved, neither man nor machine would be able to reproduce the exact artful nuances created by the skilled painters of antiquity. The complexities of color use on classical statuary make research and representation a tricky field with or without digital involvement. Most often, only microscopic traces of pigment are found. These small clues do not provide much to evince the styles and individual characteristics of the classical sculptural painters. Still, digital techniques provide researchers with the best methods of studying, documenting, and understanding their data in conjunction. Digital methods also enable researchers to virtually experiment with hypothetical painting techniques. As a result, researchers may also make as many digital interpretative reconstructions as they need. The tools and possibilities digital methods of documentation and research bring to the table are innumerable.

35 Flynn, 2007, 86; Dellepiane *et al.*, 2011, 38.

36 Brinkmann, 2008, 23.

ACKNOWLEDGEMENTS

Much gratitude is due to many at the Ny Carlsberg Glyptotek, as well as Institutionen för arkeologi och antikens historia and Humanistlaboratoriet both at Lunds universitet. I would particularly like to acknowledge and thank Jan Stubbe Østergaard, research curator at the Glyptotek and director of the Tracking Colour project, for allowing me the opportunity to digitally acquire IN 821 and for remaining so giving of his time and expertise.

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J.S. Østergaard
"Antik skulpturel polykromi i Ny Carlsberg Glyptotek"
Aarhus Seminars in Classical Studies, University of Aarhus, 8.3.2012

J.S. Østergaard
"Ancient sculptural polychromy in the Ny Carlsberg Glyptotek: Research and recent results"
Institut für Klassische Archäologie der Universität Heidelberg. Internationale Fachtagung, 12.05.12

A. Skovmøller, R. Therkildsen, J.S. Østergaard (presenter)
"The polychromy of some highly polished Roman portraits in the Ny Carlsberg Glyptotek"
ASMOSIA X. The Association for the Study of Marbles & Other Stones in Antiquity. X International Conference. Rome, May 21–26, 2012

At the 4th international Round Table on ancient sculptural and architectural polychromy. Liebieghaus Skulpturensammlung, Frankfurt an Main, 13–14 September 2012:

J.S. Østergaard
"Tracking Colour 2011–2012: activities and perspectives"

A. Skovmøller (presenter) and R. Therkildsen
"Painting on the high gloss polish on a group of Roman white marble portraits"

Chelsea Alene Graham (presented by J.S. Østergaard)
"3D digitization in an applied context: polychromy research"

The 4th International Round Table on Ancient Sculptural and Architectural Polychromy

At the Liebieghaus Skulpturensammlung, Frankfurt am Main, 13–14 September 2012

LIST OF PARTICIPANTS

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Jan Stubbe Østergaard: Research Curator, Ancient art, Ny Carlsberg Glyptotek

thursday, 13 september 2012

12.00 Get together/Lunch (Städel Café)

13.00 Welcome

13.15 – 13.35
Vinzenz Brinkmann
New projects in Frankfurt
A brief survey of activities and plans.

13.35 – 13.55
Heinrich Piening
A summary from current projects
The presentation will summarise the aims and first results of three current projects in progress. These are:

1. A joint project with Vinzenz Brinkmann and Ulrike Koch-Brinkmann which aims to compare the polychromy of the Artemis from Pompeii (Naples man 6008) with an Artemis from Rome.
2. The second project is on the polychromy of the Arch of Titus in Rome which has been carried out in collaboration with the Yeshiva University. It is planned to continue the work in collaboration with Vinzenz Brinkmann and Ulrike Koch-Brinkmann.
3. A project with the University of Munich (lmu) on the polychromy of the Villa of Augustus on the Palatine Hill in Rome which brought to light interesting observations on the handling with white stucco decoration.

13.55 – 14.40
Hariclia Brecoulaki[1] (presenter), Giovanni Verri[2], Giorgos Kavvadias[3]
The marble painted vases from the National Archaeological Museum at Athens (5th century bce): new evidence from the examination with imaging techniques
A brief discussion of the new data obtained from the examination of the painted vases from the nam with imaging techniques. This extraordinary group of painted classical vases was presented already in the London workshop in 2011. Of particular interest is the identification of Egyptian blue on one of the vases, where no traces were visible with naked eye and the evidence for new iconographic elements of the badly preserved figural composition (fig. 1). In addition, the identification of the lapis lazuli pigment on one of the vases, was further confirmed with imaging techniques.

1 National Hellenic Research Foundation (nhrf), Institute of Greek and Roman Antiquity (kera), Athens, Greece.
2 Conservation of Wall Paintings Department, The Courtauld Institute of Art, Somerset House, London, UK.
3 National Archaeological Museum, Athens, Greece.

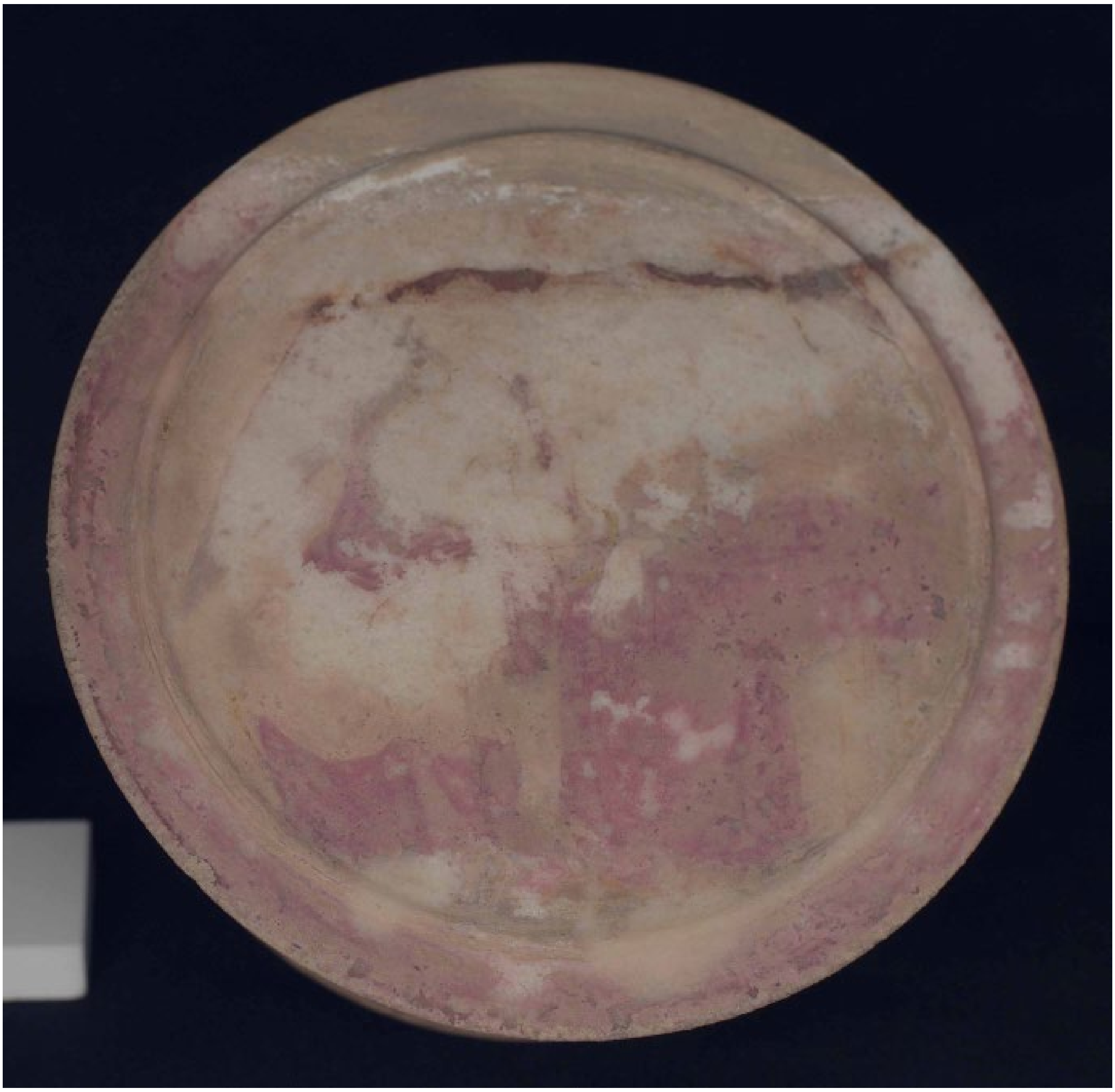

Fig. 1:
Painted marble vase showing showing two seated women in the foreground and a standing woman in the background (National Archaeological Museum in Athens).

Hariclia Brecoulaki[1] (presenter), Sophia Sotiropoulou[4], Christos Katsifas[5], Manthos Besios[6]
The polychromy on the small scale ivory sculptures from the decoration of funerary wooden couches from Macedonia (Pydna, Vergina, 4th century BCE)

In this paper will be presented the results of the first systematic examination of the polychromy on ivory sculptures, used to decorate wooden funerary couches in monumental tombs dated to the second half of the 4th century BCE. The ivory sculptures from the tomb of Pydna (Korinos) preserve remarkable traces of polychromy on the faces and hair of the male and female figures, with a particular interest in indicating details of the eyes. The ivory sculptures from Vergina preserve bright colours that were used to ornate the garments of the figures and the background of the composition. For the examination of the artefacts non-destructive XRF and Imaging Techniques were used at the Archaeological Museum of Thessaloniki. Further analysis using micro-samples included XRD, RAMAN, SEM and HPLC. An extensive use of lead white was attested on the ivories from Pydna, with cinnabar, Egyptian blue, carbon black, iron based ochres and gold leaf, as the major painting materials. At Vergina, the same pigments were used, with two new pigments added in the usual palette: the bright green conichalcite and a copper based black.

14.40 – 15.10
Clarissa Blume
The Polychromy of Pergamene Sculptures

Being a metropolis in Hellenistic times, Pergamum has produced a number of high quality sculptures. In the context of my research of the polychromy of Hellenistic sculptures in general, I examined some of these Pergamene sculptures in the Staatlichen Antikensammlungen zu Berlin. Most of the portraits and statues studied show characteristics which are typical of Hellenistic times, such as the painting of hair with strands in different colours or the painting of the eyes with a red or red-brown outline. However, one sculpture, AvP VII 23 (fig. 2–3, 4), stands out because of its Classicising appearance which is realised in the statue type, in the carving as well as in the polychromy.

The female statue, probably showing a goddess, wears a peplos in light reddish pink colour, which has been decorated with an ornamental band of Classicising patterns and a Classicising colour, which follows the hem with great accuracy (fig. 5–6, 7).

The ornament basically consists of pairs of two mirrored almost S-shaped lines in red and green (fig. 9) embracing a yellow cone as a base for a palmette as well as a blue sickle with two blue drops (fig. 10) beneath, both of which might come from further palmettes that had been painted here but are now lost. A similar but less complex ornament was painted along the hem of the apoptygma.

Among the several colours remaining on the sculpture, blue lines decorating the soles of the sandals can be partially seen with the naked eye and well seen in VIL-images.

15.10 – 15.25 Coffee break (Städel Café)

4 Ormylia Art Diagnosis Center, The Ormylia Foundation, Ormylia, Greece.

5 The Archaeological Museum of Thessaloniki, Greece.

6 27th (KZ’) Ephorate of Prehistoric and Classical Antiquities, Katerini, Greece.

Fig. 2:
Berlin Antikensammlung
AvP VII 23.

Fig. 3:
Berlin Antikensammlung
AvP VII 23.

Fig. 4:
Reconstruction of the sculpture in fig. 1–2 by Clarissa Blume and the draughtsman Erich Strauch.

Fig 5:
Detail of the ornamental band of the peplos.

Fig. 6:
Same detail as in fig. 4. Reconstruction of the colour remains of one section of the ornamental band still visible on the peplos.

Fig. 7: uv-image of the area seen in fig. 4.

Fig. 8: vil-image of the area seen in fig. 4.

Fig. 9:
Detail of blue remains in the ornamental band of the peplos.

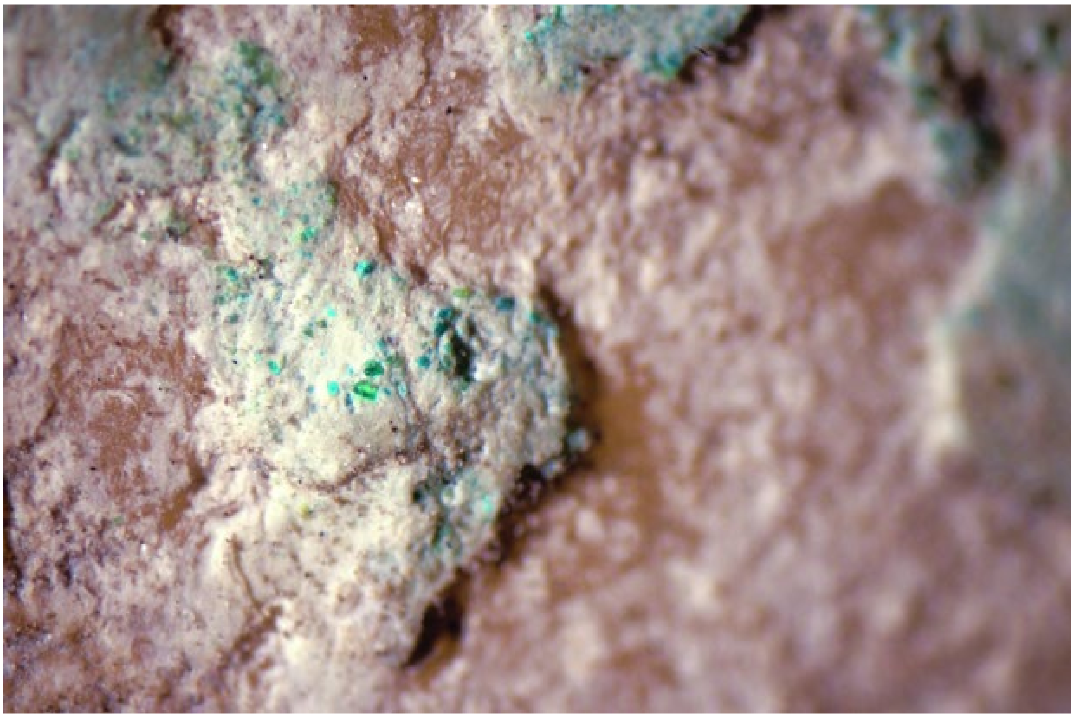

Fig. 10:
Detail of green remains in the ornamental band of the peplos.

15.25 – 16.10
Joanne Dyer[7] (presenter) and Sophia Sotiropoulou[8]
A study of the polychromy of a group of Hellenistic terracottas in the British Museum collections

In this study, three Hellenistic terracottas; two from Canosa di Puglia, Italy (270–200 bce) (fig. 11) and one from Myrina, Turkey (c. 100 bce) all of which are characterised by large well-preserved areas of decoration in Egyptian blue and red lake, were studied in order to trial a novel approach, combining the use of visible-induced infrared luminescence to locate Egyptian blue and visible-induced visible luminescence to map the lake pigments. As the sources of illumination in both cases are leds, the set up has the advantage of requiring only minor filter changes between luminescence modes. Comparisons were made with the more standard techniques of visible-induced luminescence (vil) and uv-induced luminescence (uvl), where an additional uv light source is required.

Additionally, based on the data from visual examination with the aid of magnification and the technical images, small samples of each area of interest were taken and analysed using ftir and Raman spectroscopy in order to identify the pigments present. Samples were taken for gcms analysis for the investigation of binding media used. Samples of the red lake for hplc analysis were also taken, as the relationship between luminescence properties and molecular composition of the lake pigment is also an important strand of research in our current projects.

Fig. 11:
Visible-reflected image (left) and combined image (right) showing visible-induced infrared (800–1000 nm) luminescence (vil) and visible-induced visible (540–700 nm) luminescence (vivl) of the front of a terracotta statuette of a woman with duck and conch shell (1846,0925.34) from Canosa di Puglia, 270 bce–200 bce (circa). Height 40.64 cm.

7 Conservation & Scientific Research,The British Museum, London, UK.
8 Ormylia Art Diagnosis Center,The Ormylia Foundation, Ormylia, Greece.

16.10 – 16.55
Brigitte Bourgeois
Tracking ganôsis. Further remarks on ancient and modern wax coatings on marble sculpture

At the British Museum workshop in 2011, a first report was given on the discovery of a beeswax coating on the polychrome marble head of a Ptolemaic queen, said to be Berenike II, kept in the Royal Museum of Mariemont (inv. number B 264). The present talk will summarize the main results of the scientific investigation conducted so far. It is hoped that a radiocarbon dating (AMS method) of a wax sample can be performed. In the meantime, a number of clues have been collected in favour of an ancient wax coating, evocative of the Greek ganôsis treatment. The results of this investigation will be published in a forthcoming volume of Cahiers de Mariemont.

16.55 – 17.30
Stephan Zink
A new project on Roman architectural surface rendering: scope, methods, and goals

The Institute of Historic Building Research and Conservation at the Swiss Federal Institute of Technology in Zurich (ETH) recently launched a new research project to investigate the surface treatment and exterior rending of Roman architecture. At the focus of this project are the exterior facades of several marble temples in Rome, which will be investigated for traces of colouring, gilding, coating, and polishing. In my contribution, I will give a brief overview on the setup of this project, which aims at enhancing our knowledge on both strategies and meanings of architectural surface manipulation.

17.30 – 20.00
Guided tours of “Jeff Koons: The Sculptor” (Liebieghaus) and “Contemporary Art” (Städel)

20.00 Dinner (Restaurant ‘Parthenon’)

FRIDAY 14 SEPTEMBER 2012

09.00 – 09.45
Paolo Liverani
First results from the study of the Augusteum of Rusellae

The Augusteum of Rusellae (near Grosseto, Tuscany) was excavated in the years 1962–63 but never fully published. An important group of 17 imperial statues – some of them only partially preserved – were discovered and later put on display in the Museum of Grosseto.

Of course the few existing notes on the statues were devoted exclusively to the identification of the portraits. Recently Maurizio Menichetti and I took up the study for the publication of the complex. One of the first results was the observation of traces of pigments; they are neither so extensive nor so well preserved, but in spite of that they are quite interesting for several reasons:

- we can study the colours of an entire group of portraits from the Julio-Claudian period to the age of Domitian;
- there are evident traces of a substantial ancient restoration of the group, tentatively dated in the second half of the second century;
- albeit with strong limits due to the poor documentation of the archaeological excavation and of the first modern restoration, we can study the sculptures in their monumental and urban context.

Some minor observations concern a second group of sculpture discovered in the eighties of the last century, in the so-called Aula of Bassus, on the northern side of the Roman forum of Rusellae. The group consists of six portrait statues of private citizen of the Trajanic period. Despite a strong cleaning of the surfaces, some traces of red remain on the togae of the male portraits, putting the question of the meaning of the red toga out of the imperial family or of the Roman elite.

09.45 – 10.30
Giovanni Verri[9] (presenter), Hariclia Brekulaki[10], Ioanna Mennega[11] and Sharon Cather[9]
The portrait of Psyche, a young Greek girl at the National Archaeological Museum in Athens

A Roman marble portrait of a young girl named Psyche (EAM 426, fig. 12) from the National Archaeological Museum in Athens was preliminary investigated using the following techniques: visible-reflected, infrared-reflected, visible-induced luminescence and ultraviolet-induced luminescence imaging.

The portrait was probably executed in a workshop in Melos during the reign of Tiberius (14–37 CE). The workshop was well in line with the sculptural production of the period in Rome. The family of Psyche, with this monument set in a built family grave, declares her wealth and social status; they wanted to be perceived as Romans. Were they liberti?

The upper-right side of the sculpture is severely abraded and the surface is now missing altogether. However, the left side and the lower parts of the sculpture are very well preserved and show a very high level of polish. Obvious traces of a black pigment can be observed on the proper right eye, eyelashes, eyebrow and hair. The black pigment is applied in a very 'simple' or 'line drawing' style, without any apparent attempt to modulate the strokes with shadows or highlights. In most areas, the skin of Psyche is very well preserved and shows a slightly warmer tone than the abraded surface, which has a distinct white

9 Conservation of Wall Paintings Department, The Courtauld Institute of Art, Somerset House, London, UK.

10 National Hellenic Research Foundation (NHRF), Institute of Greek and Roman Antiquity (KERA), Athens, Greece.

11 National Archaeological Museum, Athens, Greece.

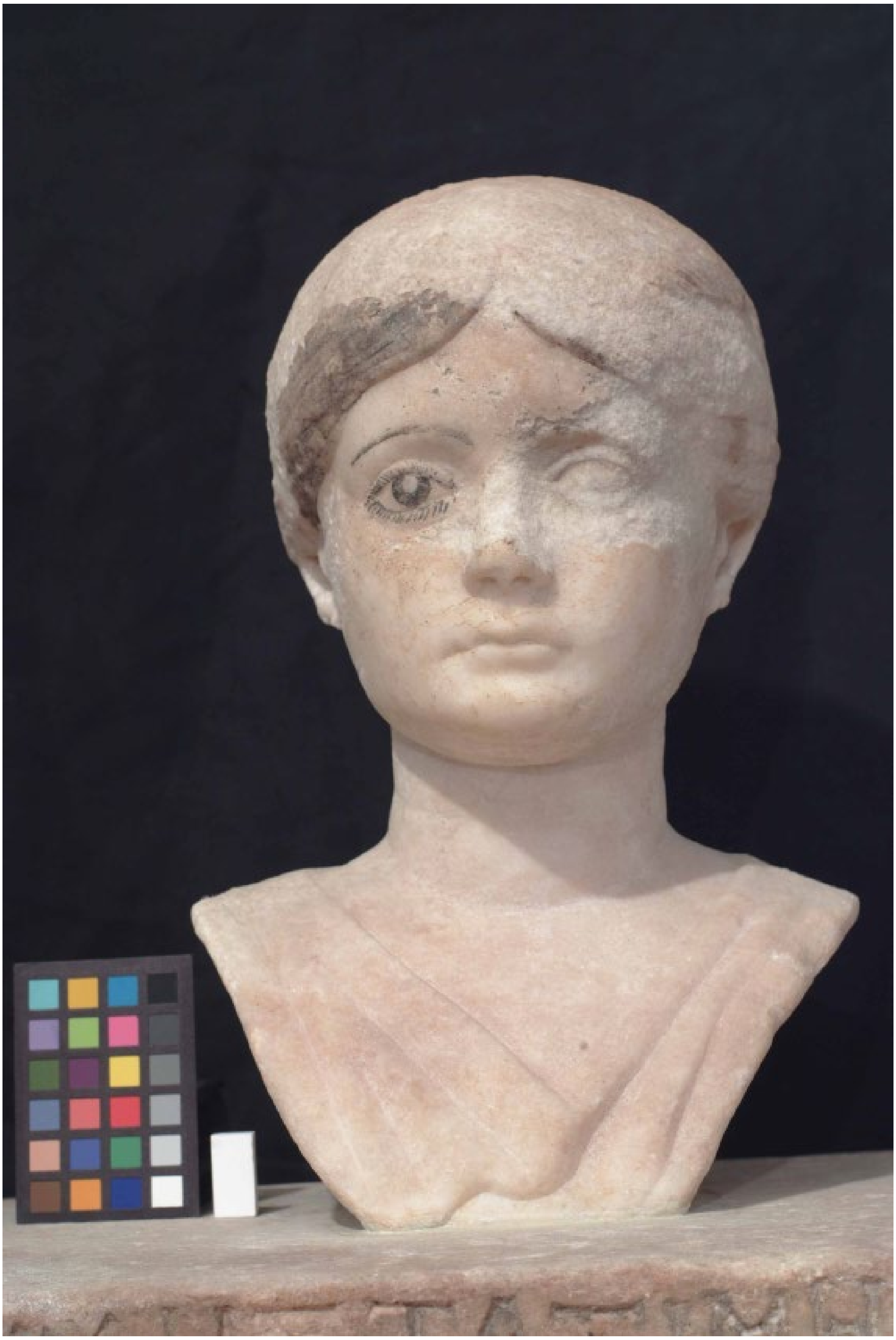

Fig. 12: Portrait of the girl Psyche from the National Archaeological Museum, Athens. Inv. no. 426, marble, h. 33 cm. From Melos. 1st century ce.

appearance. However, no obvious trace of painted skin tones can be seen with the naked eye or under magnification.

The investigations in the infrared range revealed the presence of a black pigment with optical properties compatible with those of a carbon-based black.

When irradiated with ultraviolet radiation, the sculpture showed a generous use of a luminescent material with an 'orange-red' emission – likely an organic colourant, such as madder. The luminescent pigment was used in the garment and in many anatomical details, now invisible to the naked eye. The subtle and unique application technique and use of the organic pigment will be described and further avenues of investigation suggested.

10.30 – 10.45 Coffee break

10.45 – 11.30
Sara Lenzi
Preliminary report on so-called Monochromes on marble and their polychromy

This is a brief and a very preliminary introduction to a work in progress on twelve painted marble slabs, the so-called Monochromes on marble, now in the Museo Archeologico Nazionale in Naples and in the Kunsthistorisches Museum in Vienna.

These marble pinakes decorated the walls of public and private roman buildings in Pompeii, Herculaneum and, probably, Rome, and they are characterized by mythological and athletic subjects, such as the Niobides' Death or the "apobasis" game. Their name, Monochromes, was chosen between the 18th and the 19th century after the red colour visible on the surface, but that term was in fact inappropriate: the slabs show a very rich polychromy, still visible to the naked eye. Moreover, two paintings, now located in the Kunsthistorisches Museum in Vienna, have a very rich gilding on the painted surface and UV fluorescence and X-ray fluorescence offer new data about subjects, pigments and painting technique of these pinakes.

This paper is a first step of a wider research, whose aim is a more complete knowledge about painting on white marble slabs, their origin and their production.

11.30 – 12.15
Jan Stubbe Østergaard
Tracking colour and the Copenhagen Polychromy Network in 2011–2012: a brief survey of activities and plans.

Amalie Skovmøller (presenter) and Rikke Therkildsen
Painting on the high gloss polish on a group of Roman white marble portraits

The Roman high gloss polish on white marble sculptures has long been known by scholars as an extraordinary surface finish and therefore taken to be the aesthetic end goal, spared for any paint or polychromy additions. But in the case of a group of 3rd century CE portraits in the Ny Carlsberg Glyptotek this seems not to have been the case.

This paper represents an introduction to a three year research project, currently in its initial phase, which seeks to bridge the growing research field of sculptural polychromy with the well-established field of marble provenance studies and marble materiality. It will discuss the purpose of the material and aesthetic qualities of white marble as a base for additional polychromy by taking a closer look at the surface texturing, detailing and painting on high gloss polished portraits from the 3rd century CE, which has been examined by the Tracking Colour team in 2012.

See also Therkildsen's article in this Report.

12.15 – 13.15 Lunch (Städel Café)

13.15 – 13.45
Chelsea Alene Graham[12] (presented by Jan Stubbe Østergaard)
3D digitization in an applied context: polychromy research

The Roman boy (IN 821): digital acquisition of a classical polychrome portrait, is a case study rooted in the application of 3D technologies to museum collections management, research and accessibility. This case study especially highlights the usefulness of digitization and visualization in an applied context to classical polychromy research. In this case, the aim of digitization is to highlight the capacity for 3D models to make data more accessible, extend research methods and forge new relationships between researcher and subject.

Creation of a 3D model begins with the acquisition process. Using a triangulation laser scanner and computer software, surface geometry of portraits can be acquired and refined. Given the precision of these methods, surface geometry can be replicated with high fidelity, allowing polychromy to be studied in relation to the morphology of chisel marks and areas of polish. The final geometry of a digital replica serves as a blank canvas upon which to project and compare different data including contemporary 'texture' (colour information), technical imagery (VIL, UV-FL) and pigment traces (mapped in three dimensions).

Different models of a portrait can be created to exhibit technical imagery, allowing the unique opportunity for VIL and UV-FL to be visualized and studied in 3D. These models can be opened and visualized in layers for correspondence studies. Similarly mapping pigment traces discovered on a portrait onto a 3D model creates the opportunity to visualize these traces in relation to technical imagery and surface geometry. The 3D model stands as a point of confluence for data associated with polychromy studies and serves as an arena for fitting together the puzzle pieces to bring more understanding to painting methods and placement as well as the relationship between the work of painter and sculptor.

Such research lends itself nicely to colour reconstruction, perhaps better called colour interpretation. Importing a model into computer graphics software brings light into the equation. Here subsurface scattering values, light absorption and reflection, distinct to marble are possible to simulate and render digitally. In such software researchers may aim to achieve a vision that reflects the special optical qualities created by the interplay of marble, thin paint layers, varying binding media and gilding. Through digital colour interpretation and the discussion that it incites, the presence of painters of classical sculpture that has eroded with their pigments may be re-established.

3D applications in polychromy studies allow portraits to be documented, explored and shared in interactive ways that impel new discovery and correlation. Digital methods provide the opportunity to visualize data previously only available in two dimensions three dimensionally and while digital methods cannot replace portraits, they serve to supplement them by providing replicas for experimentation. Digital experimentation gives further value to the subjects of polychromy studies, as their potential to answer social and scientific questions is unlocked and accessed in a manner not possible in the physical world. Through digital methods, eroding and disappearing clues may be documented, interpreted, visualized and interacted with before they are lost.

See also the article by Graham in this Report.

12 Department of Archaeology and Ancient History and Humanities Lab, University of Lund.

13.45 – 14.30
Eliana Siotto
Preliminary report about the use of digital 3D model to study and reconstruct the polychromy of the Ulpia Domnina's sarcophagus

During this talk we show the results of the work done to document the current condition of the colour remains on a Roman sarcophagus and to present an hypothesis on its original state (fig. 13–15). The sarcophagus, dedicated to Ulpia Domnina, is dated to the mid 2nd – early 3rd century CE in the literature and it is kept in the Museo Nazionale Romano at Rome (inv. no. 125891). We explain how we digitized a high-resolution 3D digital model of the artifact and used it to document the present condition of polychromy. Moreover, we show how the potential of emerging technologies has helped us to clarify the pigments and techniques used. Initially the sarcophagus has been chosen because of the good state of preservation of its ancient colour, which could reveal the colouring techniques employed. Later it proved to be an interesting case study because we discovered that a first coat of colour was applied in mid-2nd century CE when the sarcophagus was not yet finished and a second when the piece was reused for the burial of Ulpia in the early 3rd century.

Fig. 13:
The sarcophagus of Ulpia Domnina. Museo Nazionale Romano inv. no. 125891. Length 2.21 m. Snapshot of the front of the digital model: the right half shows a hypothetical digital reconstruction of the 2nd stage of the original polychromy (half of the 3rd century CE).

Fig. 14:
Detail of the high-resolution
3D model (19M).

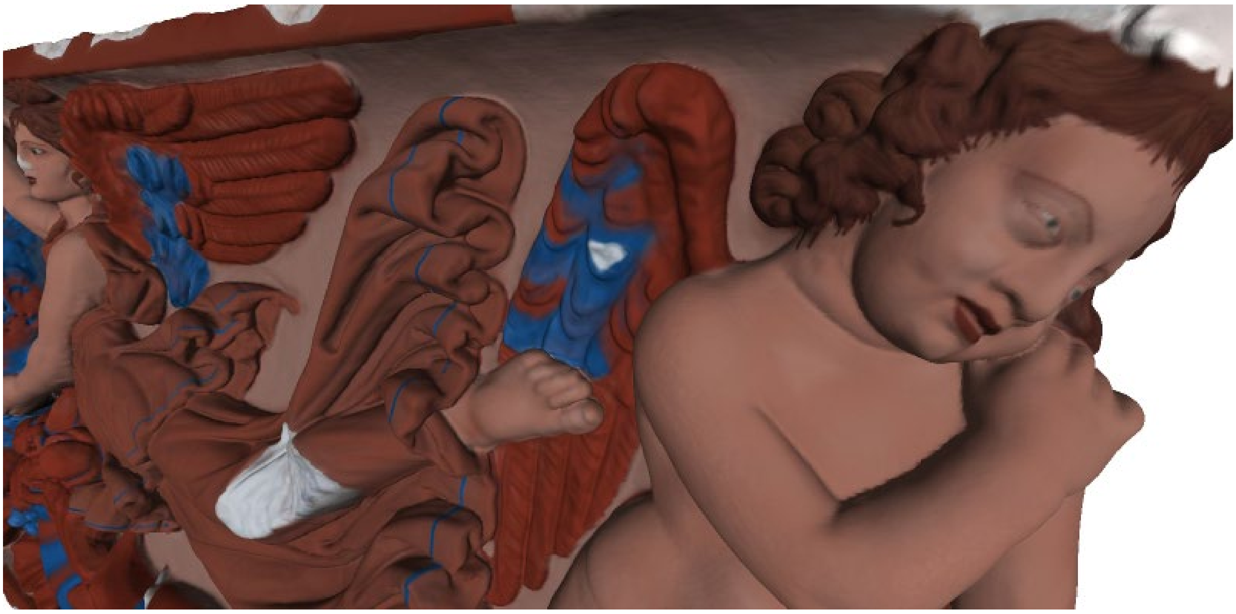

Fig. 15:
Hypothetical digital re-
construction of the same
detail as in fig. 2.

14.30 – 14.45 Coffee break (Städel Café)

14.45 – 15.15
Thorsten Opper
Charles Townley and the Polychromy of Classical Sculpture: fleeting glimpses of a hidden eighteenth-century debate

Charles Townley (1737–1805) was one of the leading collectors and antiquarian experts in eighteenth-century Britain, with direct knowledge of the excavations, restorers' workshops and the art market in Italy. His house museum in Park Street, Westminster became one of the key sights of London for domestic and international visitors.

The paper will discuss references to the polychromy of ancient marbles that can be gleaned from Townley's correspondence with dealers and excavators in Italy and the hand-written catalogues he provided for visitors of his collection in London. It appears that there was a clear interest in the role of colour where it directly aided antiquarian research, such as the identification of figures. A good example is a bust of Jupiter Serapis that could be linked to a passage in Pliny mentioning the role of minium in connection with the cult of Jupiter Capitolinus in Rome. Townley's approach to polychromy was therefore primarily led by iconographic rather than aesthetic considerations. The correspondence also alludes to allegations of 'whitewashing' levelled against some dealers and restorers, although this may refer to the general treatment of marble surfaces rather than specifically to the removal of pigment.

15.15 – 16.00
Final discussion: Conclusions and Perspectives

The 5th International Round Table on Ancient Sculptural and Architectural Polychromy will be held in Greece, from the 2nd to the 5th of October, 2013. Hariklia Brekoulaki generously offered to take the initiative in organizing this Round Table.

Various activities in 2012

CONTACT WITH PROJECTS IN DENMARK

Contact has been established with the Danish National Research Foundation's Centre for Textile Research (CTR) at the University of Copenhagen.

Amalie Skovmøller has written a contribution to a forthcoming anthology from the CTR and collaboration with the Centre will continue in 2013. Amalie Skovmøller, Mary Harlow and Ellen Harlizius-Klueck are exploring the possibilities of planning a workshop for students and colleagues on the use of texturing and colour on textiles in the antique cultures

CONTACT WITH PROJECTS ABROAD

Stiftung Archäologie, München[1]
J.S. Østergaard is a member of the Wissenschatfliches Beirat of the Stiftung.

PUBLICATIONS

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FILM

The project to produce a documentary film entitled 'Tracking Colour' on the NCG/CPN project still lives; but its scope has developed, becoming more international in its documentation.

The financial crisis is making it difficult to find funding of the production phase, but efforts continue.

1 http://www.stiftung-archaeologie.de/

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Jan Stubbe Østergaard
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A bibliography of publications on ancient sculptural and architectural polychromy in 2012[1]

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1 Some 2011 (and earlier) publications were overlooked in the bibliography given in our Preliminary Report 3, 2011, and are therefore included here. We are bound to have missed relevant publications and would greatly appreciate corrections and additions to the bibliography. These will be entered into the bibliographical database on the Tracking Colour website at www.trackingcolour.com.
The contact person is Amalie Skovmøller, project Ph.D. fellow, at amsk@glyptoteket.dk.

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NY CARLSBERG
GLYPTOTEK