



Technè

La science au service de l'histoire de l'art et des civilisations

57 | 2024

Des choses et des mots : dire, penser, analyser la matérialité

Initial investigations of rubricated inscriptions from Roman Sicily: Comparing the material evidence with ancient writers' ideals

Études préliminaires des inscriptions rubriquées de la Sicile romaine : comparer les preuves matérielles et les perceptions des auteurs anciens

Alessia Coccato, Germana Barone, Paolo Mazzoleni and Jonathan Prag



Electronic version

URL: <https://journals.openedition.org/technè/22202>

DOI: 10.4000/12cw2

ISSN: 2750-6185

Publisher

C2RMF

Printed version

Date of publication: September 26, 2024

Number of pages: 38-47

ISBN: 978-2-11-167441-7

ISSN: 1254-7867

Provided by Bodleian Libraries of the University of Oxford



Electronic reference

Alessia Coccato, Germana Barone, Paolo Mazzoleni and Jonathan Prag, "Initial investigations of rubricated inscriptions from Roman Sicily: Comparing the material evidence with ancient writers' ideals", *Technè* [Online], 57 | 2024, Online since 26 September 2025, connection on 05 February 2026. URL: <http://journals.openedition.org/technè/22202> ; DOI: <https://doi.org/10.4000/12cw2>



The text only may be used under licence CC BY-NC-ND 4.0. All other elements (illustrations, imported files) may be subject to specific use terms.

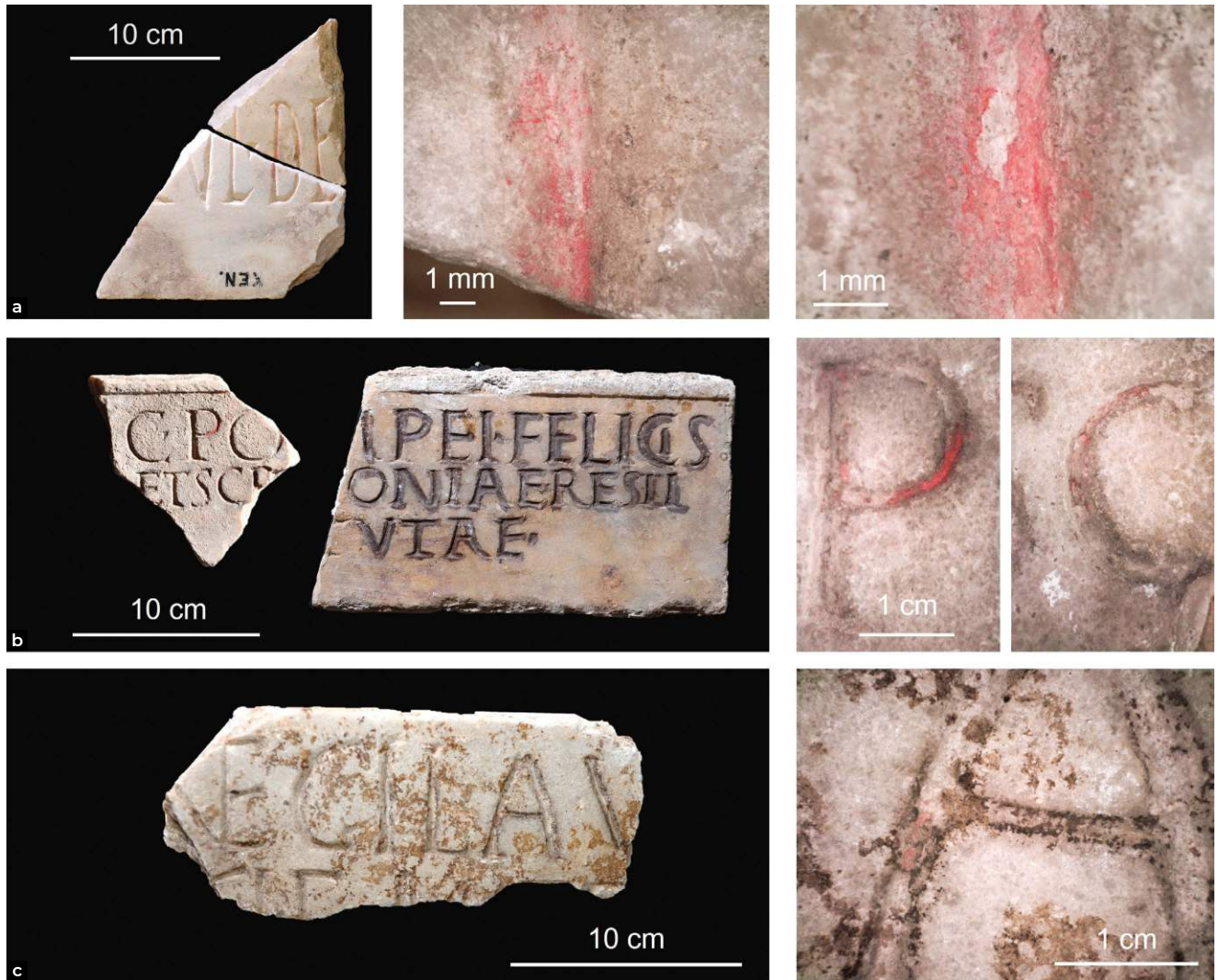


Fig. 1 a-c. Images of selected inscriptions from Centuripe and Catania. a. ISic001822; b. ISic000366; c. ISic003300. For further details, refer to table 1. © Photographs by J. R. W. Prag, microphotographs by A. Coccato. With the permission of the Parco Archeologico e Paesaggistico di Siracusa, Eloro, Villa del Tellaro e Akrai (a) and Museo Civico Castello Ursino (b, c); reproduction not permitted.

Alessia Coccato
Germana Barone
Paolo Mazzoleni
Jonathan Prag

Initial investigations of rubricated inscriptions from Roman Sicily: Comparing the material evidence with ancient writers' ideals

Études préliminaires des inscriptions rubriquées de la Sicile romaine : comparer les preuves matérielles et les perceptions des auteurs anciens

Abstract. *Although the polychromy of ancient statuary has become a regular topic in archaeological discussions, in part thanks to archaeometrical analyses, little attention has been given to such aspects in the field of epigraphy. The aim of this paper is to identify analytically the red pigments employed in inscriptions from southeastern Sicily in the Roman period (1st-6th c. CE), and to investigate the relationship between actual material practice and ancient terminology. Minimally invasive identification of cinnabar (mercuric sulphide) on some funerary and honorific inscriptions aligns with Pliny's statement on the use of "minium". However, other less expensive lead-containing pigments were detected, suggesting that different materials were used in different contexts and according to various practices. It appears from this preliminary study that choices of ancient red pigments can provide additional information for understanding epigraphic cultures.*

Keywords. *Epigraphy, polychromy, minimally invasive analyses, rubrication, ancient red pigments.*

Résumé. *Bien que la polychromie de la statuaire antique soit un sujet désormais régulièrement abordé dans les débats archéologiques, grâce notamment aux analyses archéométriques, ces aspects n'ont bénéficié que de peu d'attention dans le domaine de l'épigraphie. Le présent article a pour objet l'identification analytique des pigments rouges utilisés dans les inscriptions de la Sicile sud-orientale à l'époque romaine (I^{er}-VI^{es} siècles de notre ère) et l'étude des relations existant entre la pratique matérielle réelle et la terminologie ancienne. L'identification très peu invasive du cinabre (sulfure de mercure) présent sur certaines inscriptions funéraires et honorifiques est conforme aux descriptions de Pline l'Ancien relatives aux usages du « minium ». Toutefois, d'autres pigments moins onéreux contenant du plomb ont été détectés, ce qui suggère que différents matériaux ont été utilisés dans différents contextes et selon des pratiques variées. Il ressort de cette étude préliminaire que les choix de pigments rouges anciens peuvent fournir des informations complémentaires facilitant la compréhension des cultures épigraphiques.*

Mots-clés. *Épigraphie, polychromie, analyses très peu invasives, rubrication, pigments rouges anciens.*

Ancient inorganic red pigments in the historical sources and in archaeometry

The comparison of surviving texts on pigment manufacture and use in Antiquity with accurate chemical, molecular and mineralogical data from archaeological finds is not always straightforward¹. Becker has recently discussed in detail the pigment nomenclature in Greece and Rome as presented in ancient sources, particularly Theophrastus in the 4th-3rd centuries BC, Vitruvius in the 1st century BC, Pliny

the Elder and Dioscorides in the 1st century CE². In fact, the general palette (in terms of substances) available in Antiquity has been defined³ and cross-checked with the ancient sources⁴, revealing categories and perceptions that do not always correspond to current understanding of materials and practices. Essential as this work is, it highlights the fact that, without a correct identification of compounds on analytical bases, an accurate understanding of ancient practices as represented in the literary sources cannot be achieved. With reference to epigraphic practice in the Roman

Alessia Coccato, Research Associate in Petrography, Faculty of Classics, University of Oxford, United Kingdom (alessia.coccato@classics.ox.ac.uk). **Germana Barone**, Professor in Applied Geology, Department of Biological, Geological and Environmental Sciences, University of Catania, Italy (germana.barone@unict.it). **Paolo Mazzoleni**, Professor in Applied Geology, Department of Biological, Geological and Environmental Sciences, University of Catania, Italy (paolo.mazzoleni@unict.it). **Jonathan Prag**, Professor of Ancient History, Faculty of Classics, University of Oxford, United Kingdom (jonathan.prag@merton.ox.ac.uk).

period, red pigments predominate; and Pliny the Elder is the principal ancient literary source on this. Consequently, the following discussion focuses on the analysis of red pigments and Pliny's assessment of them.

Inorganic red pigments based on haematite ($\alpha\text{-Fe}_2\text{O}_3$, iron oxide, available both pure and in earth pigments, i.e. ochres), red lead (Pb_3O_4 , tetragonal lead oxide) and cinnabar (HgS , mercuric sulphide) have been widely used since Antiquity⁵. Nomenclature issues in this area were recorded already by Pliny himself, who aimed to provide additional information for a precise identification of the materials. His approach enabled clarification of potential misinterpretations resulting from overlapping names, and is directly relevant to the focus of this paper, as both *cinnabar* and *minium* were used to describe more than two substances⁶, while red ochres could be of different types or provenance, but still fall under umbrella terms such as *rubrica*, or *ochra*⁷.

Summarizing, Pliny is explicit that Latin *minium* corresponds to the mineral cinnabar, while the pigment red lead, i.e. the mineral minium, is distinguished by Pliny as *minium secundarium*⁸ or artificial *sandaraca* (whose colour resembles the real *sandaraca*, the mineral realgar As_4S_4) or even *cerussa usta* as it was obtained by roasting *cerussa*, the artificial pigment lead white $2\text{PbCO}_3\cdot\text{Pb(OH)}_2$ ⁹. *Usta*, as an adjective indicating a material that has been heated, can be also applied to artificial haematite, obtained by roasting yellow ochre¹⁰. Pliny also reports the possibility of adulterating real *minium* with *minium secundarium*¹¹, as well as on the existence of two artificial mixtures, often used to substitute *minium* proper (i.e. cinnabar): *sandyx*¹², obtained by heating equal proportions of *sandaraca* and *rubrica* (see below), and *syricum*¹³, a mixture of *sandyx* and *sinopis* red earth, also used as a preparatory layer for cinnabar. This last term highlights the commercial role of the port of Sinope, where different ochres, described by Pliny according to their hue, were traded. It seems that a wide variety of haematite-containing substances fall under this umbrella term *sinopis*, displaying a range of different colours, while *rubrica* indicates lower quality materials, also chromatically different. Once again, it should be emphasised that Pliny knew well that some pigment names could be misunderstood, and took care in describing individual materials to avoid this: it is only some modern writers who have in fact confused the issue.

The fact that current mineralogical nomenclature does not map directly to ancient usage has implications in turn for modern usage of terms from historical sources. In the field of epigraphy, with reference to the use of red pigments, this is exemplified in confusion over the word “minium” and its frequent misuse. Even recent scholarship (e.g. Burman and Leatherbury, both following Gordon¹⁴) still makes the assumption that the Latin term “*minium*” simply corresponds to the current mineralogical meaning, which is lead oxide Pb_3O_4 , the pigment red lead.

The recent rediscovery of the materiality of ancient inscriptions

Compared to other archaeological remains such as ancient statuary, inscriptions have not been the object of many archaeometrical studies¹⁵. In epigraphy, both the stones themselves and pigment traces have frequently been disregarded in favour of text transcription, edition, and publication. The so-called “material turn” in epigraphy has concentrated more on archaeological context and monumental form¹⁶. A generalized indifference towards materials is accompanied by terminology adopted from colloquial language, or borrowed from the natural sciences with minimal concern for accuracy and consistency (e.g. the careless and generic use of “marble¹⁷”). This attitude is exemplified by the only partially deprecated practice of making squeezes, through the application of damp filter paper to the surface of the stone, to extract a three-dimensional reproduction of the surface. In a great many cases, the associated cleaning and wetting of the surface removed surviving traces of pigment¹⁸. For this and other reasons, epigraphers have frequently either ignored or seriously underestimated the role of colour (and of pigments) in epigraphy¹⁹. Rebuffat²⁰ is one of several to highlight and try to redress the general indifference to colour in epigraphy, albeit with a primary focus on letters painted on a surface, rather than on “rubrication” (the application of pigment to carved letters). Even though X-ray fluorescence is a powerful tool for the identification of pigments based on the presence of key elements in the spectra, XRF has on occasion been deployed solely for the purpose of recovering texts from poorly preserved inscriptions through XRF imaging, disregarding the identification of colouring materials from such analyses²¹. However, both material supports and pigments represent an additional and irreplaceable source of information²², and one that is no less applicable to epigraphy.

Although epigraphers do sometimes note traces of paint, the general lack of interest has both encouraged and been perpetuated by inconsistent terminology. References simply to “painted letters” commonly obscure the distinction between a text created purely by painting and one with rubrication. A similar tendency to generalisation, following an often-quoted sentence in Pliny the Elder's *Natural History*²³, has led to the use of “minium” to refer to almost any red pigment applied to text.

Practices in the study of epigraphy stand therefore in strong contrast with what can be observed for other ancient documentary traditions, such as manuscripts and papyri²⁴, for which the pioneering use of archaeometry has promoted the development of fully non-destructive and minimally invasive approaches. At the same time, a widespread effort is ongoing²⁵ to detect and identify what is left of ancient polychromy on sculptures and architectural elements, where the ubiquitous presence of paint is now recognized, as well as the surprising variety of

materials sourced and produced in Antiquity for this purpose.

The lack of analytical data on ancient polychromy on inscriptions, compared to sculptural and architectural elements²⁶ becomes even more surprising if one considers the wide range of available analytical techniques that can yield reliable results with high capabilities of detecting even minute traces, with high specificity and in a fully non-destructive way. Of course, the technical skills required to operate advanced instrumentation and to interpret the outcomes of such analyses are not to be expected from epigraphers. Likewise, their specific expertise should not be ignored by the archaeometrist. A synergistic approach to the subject should be planned and exploited in the framework of interdisciplinary collaborations. With this in mind, the interdisciplinary ERC-funded “Crossreads” project dedicates a whole work-package to the study of the materiality of ancient inscriptions in Sicily from the 8th century BC to the 8th century CE²⁷. Here, we only report on red pigments used for rubrication in some Roman inscriptions in southeastern Sicily, as the petrographic identification of the stone supports is still ongoing.

A focus on the analysis of red pigments on inscriptions is particularly attractive, for two main reasons. First, red appears to be the most widely used colour in epigraphy, although there is some circularity here, in the adoption of the term “rubrication” (which is not found in Antiquity and derives from the highlighting of headings, especially in legal texts, specifically in red²⁸), and in the post-antique practice of repainting inscriptions almost always in red. Red is in fact far from the only colour employed, but manuals rarely reference or illustrate alternatives²⁹. Secondly, red pigments’ prices and symbolic values in Roman times are known and show a marked difference between haematite-containing ochres, red lead and cinnabar, and the sources reference the existence of materials (or mixtures) with similar appearances³⁰. Pliny is also explicit that in his day cinnabar principally came from Spain and that it was re-distributed through Rome³¹. It also appears from archaeometrical analyses that the expensive cinnabar was used in specific social contexts and even hierarchically within a single room³². Moreover, it appears that cinnabar became less available from the middle of the 1st century CE in some Roman provinces³³.

Archaeometry of red pigments

The mineralogical identification of pigments in archaeological objects can be achieved through well-established techniques in the field of archaeometry, which can be used individually or in combination. Among the techniques applied for the study of pigments in cultural heritage, X-ray fluorescence (XRF, often using portable devices: pXRF) is widely used. Although safety measures must be put in place for performing this type of analysis³⁴, it

provides information on the chemical elements which are present. Many historical pigments are characterized by specific key-elements (such as Hg for cinnabar) which are easily detected by XRF. Although Fe (in ochres) and Pb (in red lead) can be successfully identified, the lack of information on the complete compound, and the fact that different materials of similar colour contain those elements, does not allow for a full understanding of the pigments employed. Raman spectroscopy, on the other hand, is a molecular technique which provides a signature specific to each compound (more specifically, to its molecular bonds), and so it allows to discriminate among the different Fe- or Pb-containing minerals (different iron oxides and hydroxides present in ochres; oxides such as massicot, litharge, red lead, and carbonates of lead, such as lead white), and to confirm cinnabar, by comparison with reference libraries³⁵. Micro-sampling for laboratory Raman analyses can be done with a cotton swab or scalpel³⁶. These two techniques are both available as portable devices, which can be transported to museums and archaeological sites for a fast and reliable identification of ancient pigments³⁷. Both XRF and Raman are well suited to identify cinnabar, while Raman spectroscopy should be used for clarifying the composition of ochres and of lead pigments. Imaging based on multispectral techniques is an additional powerful tool for preliminary study of pigments based on their behaviour under different illuminations (mainly visible and ultraviolet sources³⁸); individual reflectance spectra from selected spots can also be acquired and compared with reference libraries.

Use of pXRF has successfully identified Fe-pigments in the lettering of an Attic stele³⁹, in the lettering on an Etruscan urn⁴⁰ and in two *tituli picti* (painted texts on walls) from Pompeii⁴¹, as well as a Pb-pigment in a sculpted distance marker from the Antonine Wall⁴². Raman spectroscopy confirmed that the *tituli picti* were actually painted with haematite-rich ochre⁴³; it moreover revealed two different lead compounds in a twice-carved milestone from Calabria, namely massicot (orthorhombic lead oxide) in the early 4th-century inscription, and red lead in the later one⁴⁴. Ongoing studies on inscriptions from Roman Britain⁴⁵ by combined pXRF and Raman analyses reveal a complex palette used for rubrication, where different pigments and mixtures are used in different contexts: madder and realgar in Antonine Wall distance markers, cinnabar in altars from the area of Hadrian’s Wall⁴⁶. Finally, it is worth mentioning the occurrence of cinnabar, identified by visible reflectance spectroscopy, in an inscription from villa A in Oplontis⁴⁷.

From such limited analytical results, it is extremely hard to verify if the use of pigments in epigraphy corresponds to what we know about ancient polychromy. Yet, as inscriptions were produced both for public and private purposes, it appears that red pigments should have been used hierarchically, and somehow reflect wealth and power, similarly to what has been observed in sculpture

and architecture, and as the results on Roman inscriptions from Britain seem to suggest.

Nevertheless, as has been highlighted in sculptures⁴⁸, the conservation history of objects has an impact on the surviving materials, which can then be a mixture of original pigments, alteration products, and later overpaints. This applies no less to inscriptions: alteration processes from burial are observed, while texts have been re-painted for clarity⁴⁹ or following current fashion and practices⁵⁰, and have sometimes been re-traced with a pencil for studying⁵¹. The correct identification of materials can then lead to improved understanding of both the creation of the inscription and its history⁵², to comparison with other polychrome objects, and to interpretation within a specific chronological, geographical and cultural context.

42

Identification of rubrication by means of a multi-analytical, minimally invasive approach

A Bruker Tracer IV-SD pXRF device equipped with a Rh tube, Pd slits and a SDD detector was operated at 40 kV and 17.2 μ A for 60 seconds to detect the pigments' key elements. Spectra were acquired both on the pigmented areas and on the stone. A portable B&W-Tek i-Raman with a 785 nm laser source and a Peltier-cooled CCD detector was used *in situ*, while a Jasco NRS 3100 confocal micro-Raman has been used in the laboratory (785 nm laser, Peltier-cooled CCD) on cotton swab samples. Two DinoLite

digital microscopes have been used *in situ* to acquire high magnification images under visible, IR (940 nm) and UV illumination (400 nm).

Such a multi-analytical approach has allowed the characterization of pigments on Roman Sicilian inscriptions in three sites: the Museo Civico Castello Ursino in Catania, the Museo Archeologico Regionale Paolo Orsi in Siracusa, and the Museo Archeologico Regionale in Centuripe.

So far, pXRF analyses have been carried out on five rubricated inscriptions from Catania and two from Centuripe, ranging from the second half of the 1st century BC to the 5th-6th centuries CE, i.e. the period of Roman imperial provincial rule in Sicily (table 1).

Different conservation states of the polychromy traces can be observed (fig. 1 a-c): ISic001822 (a) shows limited traces of red paint, and no traces of past conservation interventions; the left fragment of ISic000366 (b) shows a thick bright red material in the grooves while the right part has been sloppily repainted, with the underlying layer sometimes still visible; ISic003300 (c) shows a brownish patina on the stone surface and red specks in the deeper part of the groove, while its edges appear dark, likely for ongoing alteration processes of the pigment⁵³. Almost all of the inscriptions from Castello Ursino collections show extensive modern overpainting (as in fig. 1 b⁵⁴), which hampers identification of the original traces, and their analytical characterization.

The 3-18 keV range of the pXRF spectra on the rubrication (fig. 2) are shown for all the inscriptions, highlighting the presence of red pigments' key elements, as specified

Table 1. Overview of the inscriptions selected for this study

ISic number*	Object type	Type of inscription	Language	Place	Chronology	Museum
001831	Plaque	Honorific (dedication)**	Latin	Centuripe	2nd half 1st c. BC – beginning of 1st century CE	Museo Archeologico Regionale, Centuripe
000366	Plaque	Funerary (pagan) 2 fragments, incomplete	Latin	Catania	1st century CE	Museo Civico Castello Ursino, Catania
000368	Plaque	Funerary (pagan)	Latin	Catania	2nd half 1st c. – 2nd century CE	Museo Civico Castello Ursino, Catania
001822	Plaque	Funerary? 2 fragments, incomplete	Latin	Centuripe	Mid-2nd c. to 3rd century CE	Museo Archeologico Regionale Paolo Orsi, Siracusa
001299	Plaque	Funerary (pagan)	Greek	Catania	2nd c. – 1st half 3rd century CE	Museo Civico Castello Ursino, Catania
001323	Plaque	Honorific	Greek	Catania	2nd half 3rd c. – 4th century CE	Museo Civico Castello Ursino, Catania
003300	Plaque	Funerary (christian)	Latin	Catania	5th c. – 6th century CE	Museo Civico Castello Ursino, Catania

* ISic numbers can be resolved, with further information [<http://sicily.classics.ox.ac.uk/inscription/>].

** Prado, 2023, p. 214-220.

above. Fe, Hg and Pb were all identified in the different rubrications. The presence of Fe is ubiquitous, and in addition to haematite and ochres, it is likely due to natural impurities in the rocks and to the use of iron tools for quarrying, polishing, and carving the stones. Fe and Mn in sample ISic000368 are likely due to the overpaint. Hg was revealed in both inscriptions from Centuripe (ISic001822 and 001831), and in the four funerary epitaphs in Castello Ursino, indicating the presence of mercuric sulphide. The L-lines of Pb appear together with those of Hg (fig. 2), suggesting a mixture of pigments. The mass fractions of Hg and Pb obtained from semi-quantitative processing of the spectra⁵⁵ allow to determine different mixing proportions: one with low content of lead compounds (Hg/Pb > 100, for ISic001299 and ISic003300), while for all the other rubrications this ratio is < 50; the two analyses carried out on ISic000366 yielded both low and high Hg/Pb (table 2 and fig. 4 a and c). Unfortunately, Raman analyses could not be performed on these inscriptions. Finally, the honorific plaque in Greek letters (ISic001323, only studied by pXRF and digital microscopy) does not show traces of Hg, and only the L-lines of Pb.

Cinnabar was confirmed by Raman spectroscopy on the Centuripe fragmentary inscription (ISic001822) both *in situ* and in the lab (fig. 3 A and B), and in the lab on ISic000368 and ISic001299.

Figure 4 shows microphotographs of selected rubrications under UV and IR light. From the study of the reflectance spectra of cinnabar, red lead and red ochre⁵⁶, it is

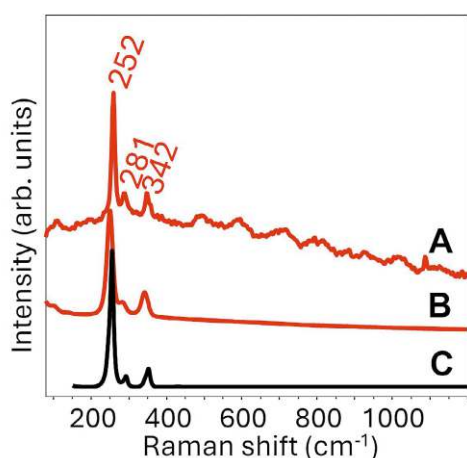


Fig. 3. Raman spectra acquired on ISic001822: A. *In situ*; B. In the laboratory; C. Reference spectrum of cinnabar R050072 (RRUFF/[<https://rruff.info/cinnabar/display=default/R050072>]).

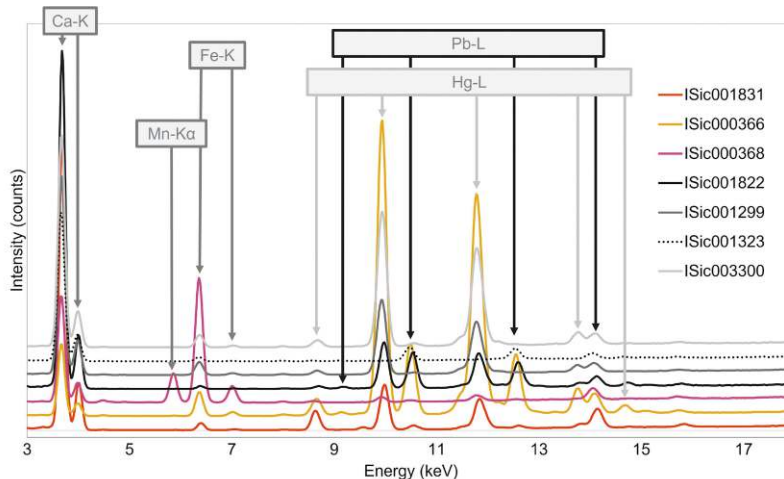


Fig. 2. pXRF spectra on the rubrication of all the inscriptions. For ISic000366, the spectrum is the average of two analyses. See table 1 for details.

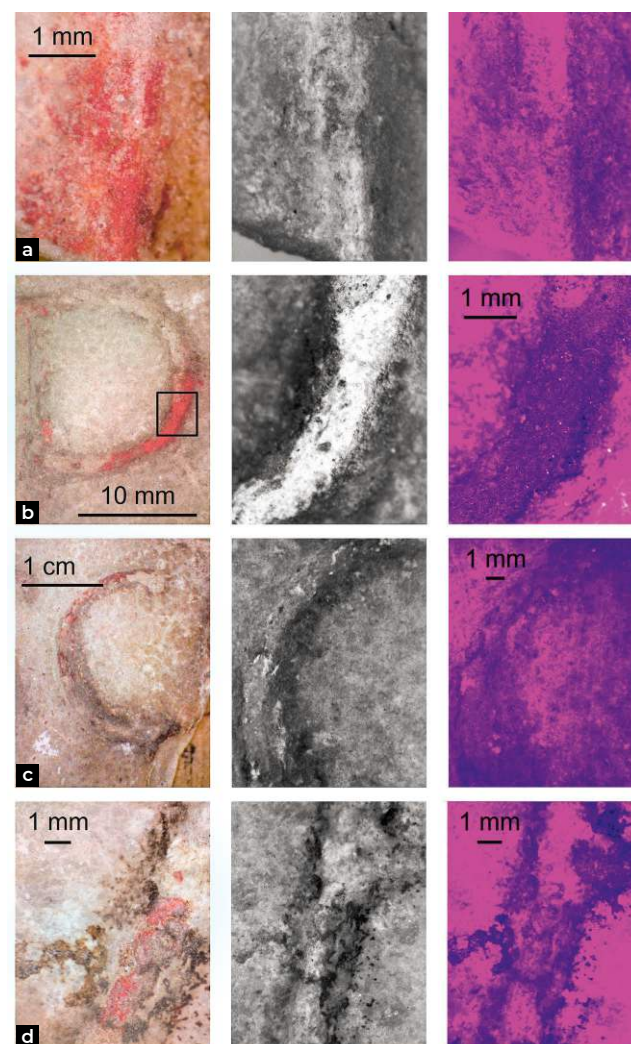


Fig. 4 a-d. Appearance under visible, infrared, and ultraviolet light of some rubrications. a. ISic001822; b and c. ISic000366; d. ISic003300. © Microphotographs by A. Coccato.

possible to estimate their behaviour: at 400 nm red ochre is the most reflective, while at 940 nm the highest reflectance is provided by red lead, closely followed by red earth and finally by cinnabar. The high reflectance of the paint in fig. 4 b is compatible with a high content of red lead, as confirmed by high levels of Pb from pXRF.

The key elements identified by pXRF, as well as the Raman results and behaviour under IR and UV are summarized in table 2.

Discussions and conclusions

44

Thus far, it appears that expensive cinnabar was indeed used in southeastern Sicily during Roman times (mid-1st c. BC to 6th c. CE). From fully non-destructive pXRF analyses, it appears it has been mixed with Pb-containing pigments in the early Imperial period, both for funerary (ISic000366) and honorific inscriptions (ISic001831), and used in funerary inscriptions with limited additives between the second half of the 1st century CE and the 6th century (ISic000368, ISic001822, ISic001299, ISic003300). The use of red lead for adulteration of (or as a base layer for) precious cinnabar is interesting, as it is mentioned by Pliny, but it has rarely been identified analytically⁵⁷. The use of Pb-pigments in ISic001323 has analytical correspondences with a milestone from Calabria showing two inscriptions both dated to the 4th century⁵⁸.

This preliminary study permits a number of observations concerning the study of pigments on inscriptions.

First, fully non-invasive analyses of pigments are nowadays possible and have minimal impact on the inscriptions themselves and on museum activities. Moreover, the acquisition of minute samples does not alter the appearance of the objects while allowing for a detailed

characterization of the materials in the laboratory. The acquisition of data and the interpretation of the analytical results should nevertheless be carried out with caution, especially considering the effects of previous restoration interventions⁵⁹. In the present paper, the presence of cinnabar has been demonstrated on both poorly preserved inscriptions and on restored ones, underneath a modern brown overpaint of unknown composition. Further examples of restoration interventions on ancient inscriptions have been reported and should act as cautionary tales, as for example Renaissance gold-gilding (detected through stratigraphic analyses) on inscriptions from the Antonine wall⁶⁰, and 19th-20th-century red overpaint containing vermilion, the synthetic analogue of cinnabar, reported on Roman inscriptions in a university collection⁶¹.

Secondly, these preliminary analyses reveal a variety of original materials and demonstrate that care should be taken when describing paint and rubrication traces, particularly refraining from assessing the pigment type from simple visual observations. The actual detection of elements indicative of ochre/haematite, red lead or cinnabar by pXRF, and/or of the corresponding mineral species through Raman analyses should become an additional tool for the study of ancient inscriptions, as the different pigments used for rubrication (or for painting the letters) are indicative of specific practices. The intrinsic hierarchical value associated with the different red pigments, combined with the easier confirmation of cinnabar (Pliny's *minium*) compared to that of other Fe- and Pb- pigments, should be considered as an essential part of studying an inscription. This is well illustrated by ISic001831, a newly published fragment, which careful study and argumentation has very plausibly shown to be part of an expensive and high status imperial honorific monument; the use of cinnabar simultaneously supports

Table 2. Overview of the results of pXRF and Raman analyses, and of infrared (IR) and ultraviolet (UV) imaging

ISic number	Hg detected (pXRF)?	Hg/Pb	HgS detected (Raman)?	UV	IR
001831	yes	++	n/a	Dark	Bright
000366	yes	+++ (see fig. 4 b), + (see fig. 4 c)	n/a	Dark	Bright/Very bright
000368	yes	++	yes	n/a	n/a
001822	yes	+	yes	Transparent	Bright
001299	yes	+++	yes	n/a	n/a
001323	no	0	n/a	Dark	Transparent
003300	yes	+++	n/a	Transparent	Bright

The sign + indicates a high proportion of Pb-pigments (Hg/Pb < 10) mixed with cinnabar; ++ indicates 10 < Hg/Pb < 50; +++ indicates the exclusive presence of cinnabar (Hg/Pb > 100); n/a = not analysed.

and confirms this analysis⁶². In the case of ISic001323, the divergence in pigment use from the other inscriptions studied aligns with the distinct place of this public Greek honorific within the late antique Sicilian epigraphic culture⁶³.

Finally, the comparison of analytical results with the existing archaeometrical literature on ancient polychromy could reveal specificities in the usage of pigments in epigraphy. Also, it could support further chronological studies on the availability of cinnabar in Roman provinces, as this became less available in Mauretania, Gallia and Britannia in the second half of the 1st century CE⁶⁴.

However, the current lack of systematic archaeometrical data both for the Sicilian context and elsewhere hinders the possibility of comparing traditions and drawing general conclusions on epigraphic practice in Antiquity. These initial results are nonetheless promising and will contribute to future archaeological, archaeometrical and historical discussion.

Acknowledgements

The Crossreads project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 885040).



European Research Council
Established by the European Commission

Personnel of the Regional Archaeological Museums Paolo Orsi in Siracusa and in Centuripe, and in the Museo Civico Castello Ursino in Catania are acknowledged for supporting the analytical fieldwork and for fruitful discussions. Images should not be further reproduced.

45

Notes

1. Walsh, Eastaugh, 2006.
 2. Becker, 2022.
 3. Béarat, 1997.
 4. Béarat, 1997; Becker, 2022. Pliny's *Naturalis Historia* can be considered one of the most complete sources.
 5. Becker, 2022.
 6. Pliny, *NH* 33.38.116: "milton vocant Graeci miniumque cinnabarim. Unde natus error Indicae cinnabaris nomine. [...] illa cinnabaris antidotis medicamentisque utilissima est. at, Hercules, medici, quia cinnabarim vocant, utuntur hoc minio, quod venenum esse paulo mox docebimus." ("The Greeks call it (sc. *rubrica*) 'miltos', and they call 'minium' 'cinnabar'. From this has arisen a confusion, through the name 'Indian cinnabar' [which is applied to a different substance]. That (Indian) type of cinnabar is most useful for antidotes and medicines. But doctors, by heaven, because they call it cinnabar, use *minium*, which we shall shortly demonstrate to be a poison."). All translations by J. Prag.
- Both *minium* and *cinnabaris* (a resinous material extracted from plants of the genera *Daemonorops* and *Dracaena*, see Becker, 2022) belong to the pigments *floridi*, Pliny, *NH* 35.12.30: "Sunt autem

colores austeri aut floridi. utrumque natura aut mixtura evenit. floridi sunt—quos dominus pingenti praestat—minium, Armenium, cinnabaris, chrysocola, Indicum, purpurissum; ceteri austeri. ex omnibus alii nascuntur, alii fiunt. nascuntur Sinopis, rubrica, Paraetonium, Melinum, Eretria, auripigmentum; ceteri finguntur, primumque quos in metallis diximus, praeterea e vilioribus ochra, cerussa usta, sandaraca, sandyx, Syricum, atramentum." ("Colours are sombre or bright. The difference arises from either nature or composition. Bright colours, which the commissioner provides to the painter, are *minium*, Armenium, *cinnabaris*, chrysocola, Indigo, bright purple; the rest are sombre. Out of all these, some are natural, others artificial. Natural are Sinope, rubrica, Paraetonium, Melinum, Eretria, orpiment; the rest are artificial, in the first place those which we have described among the minerals, and particularly among the cheaper ones ochre, cerussa usta, sandaraca, sandyx, Syricum, and black.") In the Prices Edict of Diocletian, 301 CE, in the section on pigments (Lauffer, 1971, section 36, 120a; Crawford, Reynolds, 1979, section 34, 74-75), cinnabar is indicated as "ginnabareos Dardanici, hoc est mini" ("Dardanian cinnabar, that is *minium*"), at

500 denarii for one pound; and "ginnabareos secundi, hoc est mini" ("cinnabar of second quality, that is *minium*"), at 300 denarii for one pound.

7. Pliny, *NH* 35.13.31: "Sinopis inventa primum in Ponto est; inde nomen a Sinope urbe. nascitur et in Aegypto, Baliaribus, Africa, sed optima in Lemno et in Cappadocia, effossa e speluncis." ("Sinopis was first discovered in Pontus; consequently it was named after the city of Sinope. It is found also in Egypt, the Balearic islands, and Africa, but the best is found in Lemnos and Cappadocia, dug out of the caves.")

8. Pliny, *NH* 33.40.120: "hoc est secundarium minium perquam paucis notum, multum infra naturales illas harenas. hoc ergo adulteratur minium in officinis sociorum, et vilis Syrico." ("This is a second-rate *minium*, which however is known to few, and is much inferior to the natural sands described above. With this, then, *minium* is adulterated in the company workshops, and more cheaply still with Syricum.")

9. Béarat, 1997.

10. Pliny, *NH* 35.16.35: "Ea et fit ochra exusta in ollis novis luto circumlitis." ("That (*rubrica*) is also made through the burning of ochre in newly made jars sealed with clay.")

11. Pliny, *NH* 33.40.120: see note 8.

12. Pliny, *NH* 35.23.40: “*Haec si treareatur aequa parte rubrica admixta, sandycem facit.*” (“If this (sc. Sandaraca) is roasted when mixed in equal parts with rubrica, it makes Sandyx.”)

13. Pliny, *NH* 35.24.40: “*Inter facticios est et Syricum, quo minium sublini diximus. fit autem Sinopide et sandyce mixtis.*” (“Among the artificial colours there is also Syricum, with which, as we have said, minium can be primed. But it is made by mixing Sinopis and Sandyx.”)

14. Burman, 2023, p. 46; Leatherbury, 2019, p. 33.

15. Well illustrated by Taelman, 2022, where the accurate quantitative assessment of Roman marble objects whose provenance has been obtained with a multi-disciplinary method counts only 142 inscriptions out of a total of 8,722.

16. This shift was recognised in the epigraphic congress of 2012: Eck *et al.* (eds.), 2014.

17. From a geological point of view, marble is a rock obtained by metamorphism of carbonatic sediments, where the content of calcium and/or magnesium carbonates constitutes at least 95% of the whole rock.

18. Compare traditional descriptions of the process in Gordon, 1983, p. 30-32, with a critique of the practice in Duggan, 2016, p. 273-274, and a recent study of stained squeezes in Burman, 2023, p. 44-63.

19. e.g. Susini, 1973, p. 29, Di Stefano Manzella, 1987, p. 158.

20. Rebuffat, 1995.

21. Powers *et al.*, 2005; Powers *et al.*, 2009.

22. Gliozzo *et al.*, 2021, art. 193.

23. Pliny, *NH* 33.40.122: “*minium in voluminum quoque scriptura usurpatur clarioresque litteras vel in muro vel in marmore, etiam in sepulchris, facit.*” (“minium is employed also for writing in books; and it makes letters more distinct, whether on a wall or on marble, and also in tombs.”)

24. Burgio, 2021.

25. Starting from the pioneering Workshop on Roman Wall Painting (Béarat, 1997) to the Tracking Colour project (2005-2023). The International Round Table on polychromy in Ancient Sculpture and Architecture organizes meetings every 2 years [<https://www.polychromyroundtable.com/>].

26. Østergaard, 2017; Østergaard, 2018; Zink, 2019.

27. [<https://crossreads.web.ox.ac.uk/>].

28. Rebuffat, 1995, p. 23.

29. Rebuffat, 1995, Duggan, 2016 for examples, derived mostly from earlier summaries by e.g. Cagnat, 1900, p. 533 or Larfeld, 1907, p. 205 (blues, greens and yellows in Greek inscriptions).

30. Pliny, *NH* 35.14.33: “*Rubricae genus in ea voluere intellegi quidam secundae auctoritatis, palmam enim Lemniae dabant. minio proxima haec est [...]*” (“Some people have wanted it to be recognised that that type of rubrica (sc. Sinopis) is of secondary quality, since they award the

palm to Lemnian. The latter comes very close to cinnabar [...]); Pliny, *NH* 35.22.39: “*fit et adulterina ex cerussa in fornace cocta. color esse debet flammeus. pretium in libras asses quini.*” (“An adulterated version (sc. of Sandarach) is also made from roasting ceruse in a furnace. It ought to be flame-coloured. Its price is 5 asses per lb.”)

31. Pliny, *NH* 33.40.118: “*Romam adfertur vena signata, ad bina milia fere pondo annua, Romae autem lavatur, in vendendo pretio statuta lege, ne modum excederet HS LXX in libras. sed adulteratur multis modis [...]*” (“Ore under seal is transported to Rome, in the region of 2,000 pounds per year, and is washed at Rome; the selling price is fixed by law, so that it should not surpass what is reasonable, at 70 sesterterii per pound. But it is adulterated in many ways [...].”)

32. Barone *et al.*, 2018, p. 402; Payne, Booms, 2014, p. 125.

33. For example in Gallia (Barbet, 1975) or in Roman Britain (Davey, Ling, 1982).

34. Bezur *et al.*, 2020.

35. [www.rruff.info]. Cosentino, 2014.

36. Berg, 2009.

37. Basso *et al.*, 2023; Østergaard, 2017; Coccato *et al.*, 2021.

38. A specific combination of filters is used for VIL, visible induced luminescence, which is the most effective in identifying even minimal traces of the synthetic pigment Egyptian blue, as for example in the lettering of a Cypriot funerary monument (Gasanova *et al.*, 2018).

39. Basso *et al.*, 2023.

40. [<https://www.trackingcolour.com/>].

41. Rovella *et al.*, 2018.

42. Campbell, Smith, 2022.

43. Rovella *et al.*, 2018.

44. Caridi *et al.*, 2020.

45. Campbell, 2020a; 2020b; Campbell, Smith, 2022.

46. Campbell, 2020b, p. 101. The name of the dedicator was painted in bright red cinnabar, while a blue copper-containing pigment was applied to the other letters (RIB I 1544).

47. Bonini *et al.*, 2019.

48. Campbell, 2020a; 2020b.

49. Keppie, 1991, p. 15 and p. 41; Richards, 2017.

50. Campbell, Smith, 2022.

51. Caridi *et al.*, 2020.

52. Caridi *et al.*, 2020 on the presence or absence of a preparation layer underneath the pigment and on the pencil marks left in the letters by epigraphers after the discovery of the milestone in 1913; Campbell, 2020a on the digital reconstruction of polychromy; Campbell, Smith, 2022 on Renaissance repainting of Roman inscriptions.

53. Coccato *et al.*, 2017.

54. Korhonen, 2004, p. 67 identifies this as an intervention of the 1930s, when the civic museum was established.

55. Processing was obtained in PyMCA (Solé *et al.*, 2007) using an appropriate configuration file.

56. Cosentino, 2014.

57. Walton, Trentelman, 2009, p. 846-847, reporting the identification of red lead in Roman-period Egyptian mummies; Paradisi *et al.*, 2012 reporting its identification in the Domus Aurea. Neither of these show evidence of mixing or layering of red lead and cinnabar.

58. Caridi *et al.*, 2020.

59. Including both cleaning (Campbell, 2020a, p. 181 and 2020a, p. 103) and re-painting, as in Campbell, Smith, 2022.

60. Campbell, Smith, 2022.

61. Richards, 2017.

62. Prado, 2023.

63. Korhonen, 2012, p. 350 for Greek public epigraphy in late Antique Sicily, including this text.

64. Gliozzo *et al.*, 2011; Barbet, 1975; Davey, Ling, 1982.

Bibliography

- Barbet A., 1975, « Recueil général des peintures murales de la Gaule. I : Province de Narbonnaise », 1, *Glanum* (Suppl. *Gallia* 27), Paris.
- Barone G., Mazzoleni P., Cecchini A., Russo A., 2018, “In situ Raman and pXRF spectroscopic study on the wall paintings of Etruscan Tarquinia tombs”, *Dyes and Pigments*, 150, p. 390-403.
- Basso E., Carò F., Abramitis D. H., 2023, “Polychromy in Ancient Greek sculpture: New scientific research on an attic funerary stele at the Metropolitan Museum of Art”, *Applied Sciences*, 13, art. 3102.
- Béarat H., 1997, “Quelle est la gamme exacte des pigments romains ? Confrontation des résultats d’analyse et des textes de Vitruve et de Pline”, in *Roman wall painting: materials, techniques, analysis and conservation, Proceedings of the International Workshop, Fribourg (7-9 March 1996)*, Institute of Mineralogy and Petrography, p. 11-34.
- Becker H., 2022, “Pigment nomenclature in the ancient Near East, Greece, and Rome”, *Archaeological and Anthropological Sciences*, 14, art. 20.
- Berg R. W., 2009, “Raman spectroscopy characterization of colored pigments in archaeological materials”, in Østergaard J. S. (ed.), *Tracking Colour – The polychromy of Greek and Roman sculpture in the Ny Carlsberg Glyptotek*, Ny Carlsberg Glyptotek, Copenhagen, p. 48-67.
- Bezur A., Lee L., Loubster M., Trentelman K., 2020, *Handheld XRF in Cultural Heritage: A practical workbook for conservators*, Getty Conservation Institute, Los Angeles.
- Bonini A., Bracci S., Liverani P., Bartolozzi G., Iannaccone R., Lenzi S., Magrini D., 2019, “Oplontis, 79 A.D.: colours on marble furnishing from the Villa of Poppaea”, *Techne*, 48,

- p. 90-99 [https://doi.org/10.4000/techne.2482].
- Burgio L., 2021, "Pigments, dyes and inks: their analysis on manuscripts, scrolls and papyri", *Archaeological and Anthropological Sciences*, 13, art. 194.
- Burman A., 2023, "Paint pigment on epigraphic squeezes: A case-study from the Etruscological collections of Olof August Danielsson", *Etruscan and Italic Studies*, 26, 1-2, p. 44-63.
- Cagnat R., 1900, "Inscriptiones", in Daremberg C., Saglio E. (eds.), *Dictionnaire des antiquités grecques et romaines*, vol. 3.1, p. 528-545, Hachette, Paris.
- Campbell L., 2020a, "Polychromy on the Antonine wall distance sculptures: non-destructive identification of pigments on Roman reliefs", *Britannia*, 51, p. 175-201.
- Campbell L., 2020b, "8. Monuments on the margins of Empire: the Antonine wall sculptures", in Breeze D. J., Hanson W. S. (eds.), *The Antonine wall*, Archaeopress Roman Archaeology, 64, Oxford, UK.
- Campbell L., Smith M., 2022, "Multi-technique analysis of pigments on sandstone sculptures: Renaissance re-painting of a Roman relief", *Heritage Science*, 10, art. 156.
- Caridi F., Testagrossa B., Faenza P., Aciri G., 2020, "Spectroscopic investigations of pigments on a late Roman milestone from Calabria, Southern Italy", *SCIRES-IT-Scientific REsearch and Information Technology*, 10, 2, p. 81-88.
- Coccato A., Mazzoleni P., Spinola G., Barone G., 2021, "Two centuries of painted plasters from the Lateran suburban villa (Rome): investigating supply routes and manufacturing of pigments", *Journal of Cultural Heritage*, 48, p. 171-185.
- Coccato A., Moens L., Vandenabeele P., 2017, "On the stability of mediaeval inorganic pigments: a literature review of the effect of climate, material selection, biological activity, analysis and conservation treatments", *Heritage Science*, 5, p. 1-25.
- Cosentino A., 2014, "FORS spectral database of historical pigments in different binders", *e-conservation Journal*, 2, p. 57-68.
- Crawford M. H., Reynolds J. M., 1979, "The Aezani Copy of the Prices Edict", *Zeitschrift für Papyrologie und Epigraphik*, 34, p. 163-210.
- Davey N., Ling R., 1982, *Wall painting in Roman Britain*, *Britannia Monograph Series*, 3, Society for the promotion of Roman Studies, London.
- Di Stefano Manzella I., 1987, *Mestiere di epigrafista. Guida alla schedatura del materiale epigrafico lapideo*, Quasar, Rome.
- Duggan T. M. P., 2016, "Not just the shadows on the stone: the Greek, Lycian and Roman craft of encaustica and the polishing of coloured inscriptions, that is of grapho and its study – epigraphy", *Phaselis*, II, p. 269-283.
- Eck W., Funke P., Dohnicht M., Hallof K., Heil M., Schmidt M. G. (eds.), 2014, *Öffentlichkeit-Monument-Text. XIV Congressus Internationalis Epigraphiae Graecae et Latinae (27-31 Augusti MMXII, Akten)*, De Gruyter, Berlin.
- Gasanova S., Pagès-Camagna S., Andriotti M., Hermon S., 2018, "Non-destructive in situ analysis of polychromy on ancient Cypriot sculptures", *Archaeological and Anthropological Sciences*, 10, p. 83-95.
- Gliozzo E., Cavari F., Damiani D., Memmi I., 2011, "Pigments and plasters from the Roman settlement of *Thamusida* (Rabat, Morocco)", *Archaeometry*, 54, 2, p. 278-293.
- Gliozzo E., Pizzo A., La Russa M. F., 2021, "Mortars, plasters and pigments-research questions and sampling criteria", *Archaeological and Anthropological Sciences*, 13, art. 193.
- Gordon A. E., 1983, *Illustrated Introduction to Latin Epigraphy*, University of California Press, Oakland.
- Keppie L. J. F., 1991, *Understanding Roman inscriptions*, Johns Hopkins University Press, Baltimore.
- Korhonen K., 2004, *Le iscrizioni del Museo civico di Catania : storia delle collezioni, cultura epigrafica, edizione*, Societas Scientiarum Fennica, Helsinki.
- Korhonen K., 2012, "Sicily in the Roman Imperial Period", in Tribulato O. (ed.), *Language and Linguistic Contact in Ancient Sicily*, Cambridge University Press, Cambridge, p. 326-369.
- Larfeld W., 1907, *Handbuch der griechischen Epigraphik*, O. R. Reisland, Leipzig.
- Lauffer S. (ed.), 1971, *Diokletians Preisedikt*, series Texte und Kommentare, 5, De Gruyter, Berlin.
- Leatherbury S. V., 2019, *Inscribing faith in Late Antiquity*, Routledge, New York/Abingdon.
- Østergaard J. S., 2017, "Colour shifts: On methodologies in research on the polychromy of Greek and Roman sculpture", *Proceedings of the Danish Institute at Athens*, 8, p. 149-176.
- Østergaard J. S., 2018, "Polychromy, sculptural, Greek and Roman", in *Oxford Research Encyclopedia of Classics*, Oxford University Press.
- Paradisi A., Sodo A., Artioli D., Botti A., Cavezzali D., Giovagnoli A., Polidoro C., Ricci M. A., 2012, "Domus Aurea, the 'Sala delle maschere': Chemical and spectroscopic investigations on the fresco paintings", *Archaeometry*, 54, 6, p. 1060-1075.
- Payne E., Booms D., 2014, "Analysis of pigment palettes as evidence for room status in Nero's Golden House", *Technical Research Bulletin*, 8, p. 117-126.
- Pliny the Elder, 1938-1963, *Natural history, with an English translation*, trans. H. Rackham, 10 vols., Loeb Classical Library, Cambridge, MA, Harvard University.
- Powers J., Dimitrova N., Huang R., Smilgies D. M., Bilderback D. H., Clinton K., Thorne R. E., 2005, "X-ray fluorescence recovers writing from ancient inscriptions", *Zeitschrift für Papyrologie und Epigraphik*, 152, p. 221-227.
- Powers J., Smilgies D. M., Geil E. C., Clinton K., Dimitrova N., Peachin M., Thorne R. E., 2009, "X-ray fluorescence imaging analysis of inscription provenance", *Journal of Archaeological Science*, 36, p. 343-350.
- Prado F., 2023, "Culto della Domus Augusta in un frammento di iscrizione da Centuripe", *Zeitschrift für Papyrologie und Epigraphik*, 226, p. 214-220.
- Rebuffat R., 1995, "Peinture et inscriptions", *Revue archéologique de Picardie. Numéro spécial*, 10, p. 23-31.
- Richards C., 2017, "Personal touch : Engaging students with Roman funerary inscriptions", *Journal of the History Teachers' Association of NSW*, 51, p. 7-13.
- Rovella N., Arcudi A., Crupi V., La Russa M. F., Majolino D., Osanna M., Pace R., Ruffolo S. A., Ricca M., Ruggieri N., Venuti V., 2018, "Tituli Picti in the archaeological site of Pompeii: diagnostic analysis and conservation strategies", *European Physical Journal Plus*, 133, 12, art. 539.
- Solé V. A., Papillon E., Cotte M., Walter P., Susini J., 2007, "A multiplatform code for the analysis of energy-dispersive X-ray fluorescence spectra", *Spectrochimica Acta Part B: Atomic Spectroscopy*, 62, 1, p. 63-68.
- Susini G., 1973, *The Roman Stonecutter: An Introduction to Latin Epigraphy*, Blackwell Publishing Inc, Oxford.
- Taelman D., 2022, "Marble trade in the Roman Mediterranean: a quantitative and diachronic study", *Journal of Roman Archaeology*, 35, 2, p. 848-875.
- Walsh V., Eastaugh N., 2006, "Historical pigment research: the work of the Pigmentum Project", *infocus Magazine*, p. 38-57.
- Walton M. S., Trentelman K., 2009, "Romano-Egyptian red lead pigment: A subsidiary commodity of Spanish silver mining and refinement", *Archaeometry*, p. 845-860.
- Zink S., 2019, "Polychromy, architectural, Greek and Roman", in *Oxford Research Encyclopedia of Classics*, Oxford University Press.

Reference sites

- [https://www.trackingcolour.com/].
 [https://rruff.info/].
 [http://sicily.classics.ox.ac.uk].
 [https://crossreads.web.ox.ac.uk/].
 [https://www.polychromyroundtable.com/].