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MATERIALS SCIENCE APPLIED TO TRACE ANCIENT TECHNOLOGIES IN THE AEGEAN WORLD

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MARINA PANAGIOTAKI, ILIAS TOMAZOS AND FOTIOS PAPADIMITRAKOPOULOS


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Painting biographies

Ann Brysbaert

Introduction
Past and recent scientific analyses of plaster and pigments by means of a wide range of techniques have enabled the study of Aegean wall paintings in a more detailed and contextualised way, so that archaeologists no longer need to rely solely on stylistic studies to argue matters of chronology, origins (if this is indeed a valid question) and workshops. This paper aims to provide a brief critical overview of technological studies while also emphasising their contextualisation beyond their purely scientific studies in order to avoid approaching this rich material from a singular perspective. As argued a decade ago, both archaeological scientists and archaeological theorists attempt to understand past societies by means of investigating material culture, so both approaches should go hand in hand; thus also in painted plaster studies. It seems, however, that scientists emphasise the behaviour and properties of objects while the theorists are more concerned with the study of subjects through the study of objects, while both deal with material culture. Therefore, it is useful to investigate why artefacts (or ‘features’ when less portable) are socially and culturally constructed and to consider the physico-chemical and biological construction and properties of these artefacts or features (Jones 2004, 327, 329). While scientific analyses of painted plaster contribute to a broader understanding of socio-economic and political issues at play in the regions under study, these results only become useful when integrated with iconographic, stylistic and contextual studies of this material, and when discussed from a social theory perspective. From an iconographic perspective, the work, by F. Blakolmer, on Aegean prehistoric painted plaster stands out. ‘In the Aegean Bronze Age, architectonic walls, pottery, seals, figurines, dresses as well as the human body could have functioned as bearers of distinct information and thus underline the complexity of the artistic construction of images. [The symbolic marks on these] … demonstrate the close interrelation of this vocabulary of signs, as well as a symbolism, “working” on different levels of semantic meanings’ (Blakolmer 2012, 332). A rich source of information is out there in the shape of these paintings and the more varied ways these are approached, and especially also combined, the more messages will come towards us and hopefully be understood. It is necessary to integrate technological but also scientific analyses into iconographic and stylistic studies on the large, rich and varied LBA repertoire of painted plaster of the Aegean and surrounding regions with which contacts of many types were clear (Brysbaert 2008, 160–185). Such trends are becoming more common even though the more traditional approach that carries out scientific analyses as an end in itself still exists, and the same applies for iconographic overviews without the integration of technological data in a social-theoretically informed discussion. The latter type of studies whether purely technological/scientific or purely iconographic, however, may not forward archaeological enquiry into the rich complexity of the human past and may not answer wider questions about these paintings’ biographies, which essentially turn them into social actors themselves. Questions about why specific materials and techniques were chosen and by whom, how they developed or changed over time, what the socio-economic and cultural drivers were for these changes, if any took place, whether any influences from beyond the Aegean were noticeable on Aegean paintings and vice versa, how this was implemented, and why such craft forms eventually disappeared, are not addressed by scientific analysis per se. These questions, however, reach out to the core of what people were doing and how they were living their daily lives; and as archaeologists, that remains our main line of interest. Such
traditional scientific analyses may contribute to the al fresco-al secco debate – and it has done so over the last decade and earlier – but not always in a very constructive way beyond the strict debate. Therefore, analytical results need full integration into a wider theoretical discussion, addressing the archaeological questions, which in themselves are based on specific research debates that motivate these analyses (see Jones 2004). Only then will multidisciplinary approaches to painted plaster, based on both scientific approaches and theoretical frameworks of analyses, provide the relational aspects of the material qualities and properties, how these may have shaped past people’s views of their own cosmos, and how such views of their world may, in turn, have shaped these paintings.

Past painted plaster studies, a short overview

Technological studies on Aegean painted plaster are as old as its first finds. People such as Evans’ earliest material scientist, N. Heaton (1910), studied the Knossian pigments and painting technologies, and later also the material found at Tiryns and Orchomenos (Heaton 1912). The latter results were published as addenda in the wall painting volume by Rodenwaldt (1912). In 1942 Duel and Gettens published a synthesising paper about what was hitherto known on the technologies and materials of Aegean paintings. In terms of pigment studies, a new wave of laboratory studies started in the 1960s in the Dimokritos laboratory by a strong collaboration between S. Philippakis, R. Jones, V. Perdikatsis and M. Cameron (e.g. Philippakis et al. 1976 and many more). V. Perdikatsis continued this line of study through the IGME laboratories, first, and subsequently, at the University of Crete at Chania. Around the same time, the work on the plaster from the Pylos excavations was published (Lang 1969), and M. Cameron’s PhD (1975) formed a monument to his work done at Knossos. A scientific paper resulted from the laboratory analyses conducted on these fragments and is still one of the main papers to consult on Knossian analyses of plaster and pigments (Cameron et al. 1977). Not only had these early studies recognised most of the mineral-based pigments but they also asserted, in my view correctly, that various painting techniques were likely combined in executing most of the painted scenes on these lime plaster surfaces. They suggested that al fresco was the attempted or intended technique and formed the majority of the painted surface. When the plaster became too dry, the artists would continue with adding on paint via al secco methods.

The 1990s saw another concentration of plaster studies by the scientific work done on the Mallia materials (for example Dandraw 1999; 2000; 2001; Jones 1999), while V. Perdikatsis wrote an updated synthetic paper in 1998, and R. Jones another update in 2005. More work was now also carried out and published from the site of Akrotiri where decades of great conservation work had been undertaken (e.g. Perdikatsis et al. 2000). L. Chryssikopoulou and her team were the first to analyse murex purple applied as an organic material on the lime plaster surfaces there (Chryssikopoulou and Sotiropoulou 2003). Moreover, she carried out very insightful experimental trials in the environment in which these paintings would have been carried out originally (Chryssikopoulou et al. 2000) and this was a useful improvement of the experimental work earlier carried out by M. Cameron back in Canada. Other relevant experiments were carried out by Hatton and team (2008) at Oxford where he reproduced the Egyptian blue pigment, one of the most common blue pigments in Aegean painted plaster next to Riebeckite. Since this was a synthetic or man-made pigment rather than a mineral-based one, insights in this technology aids in understanding the level of efforts that people went through to reach the colours they wanted to employ, and what these may have meant, both the pigment and its composition, and the efforts needed to produce it (see earlier: Philippakis et al. 1976; Kakouli 2002; Brysbaert 2011b; Vlachopoulos and Sotiropoulou 2012).

Very recently, a useful experimental study was carried out by Angelidis et al. (2018, esp. 365) which indicated that the sinopie or underdrawings at Akrotiri, also known from the much later Renaissance paintings, for example, were carried out on damp plaster. A thin white lime layer/wash was then applied to cover the sinopie but this wash was likely still transparent (because it was still damp) while the final scene was painted, and, as such, it left the sinopie visible under the thin white damp plaster layer. In effect, this strongly suggests al fresco painting for at least the scenes that show evidence for sinopie presence (Brysbaert 2008, 116). Finally, the experimental work by A. Vlavogilakis (2017) has taken on specific small-scale experiments on plaster and its fillers and was carried out in the correct environment again. In asking questions about the technology itself but also on the practice of carrying out the individual steps of the painted plaster chaîne opératoire takes the study of experimentation to yet another level and such work can only be encouraged since it also may help to provide insights in the practices and processes that the artisans themselves came across while at work (see also Brysbaert 2004; 2008 with refs).

What is perhaps the most important in experimental and analytical work for archaeology is its reproducibility of the experiment or the analysis. Being thus fully informed by all scientific and archaeological data concerning these materials, but also each step in their experiment or analysis, while being firmly placed within their context, is essential conduct for this type of research. All too often, and specifically in considering Aegean painted plaster, statements such as potential Egyptian (implied by Brecoulaki et al. 2012, 2874, 2876; and repeated by Vlachopoulos 2020, 408) and other cultural influences are rather decontextualised if these cannot be corroborated by other substantial evidence, or
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if other similar material from the local traditions already indicated that specific techniques existed in earlier times anyway (Brysbaert 2008 on the MBA materials analysed indicating that no al fresco seemed to have existed then).

In early 2000, a PhD started under the direction of R. Jones and B. Knapp at Glasgow University resulted in a large comparative technological study of painted plaster material from 17 sites from the Aegean (10: Knossos, Myrtos-Pyrgos, Palaikastro, Monastiraki-Amarious, Phylakopi, Mycenae, Tiryns, Thebes, Gla, Orchomenos) and the east Mediterranean (7: Miletus, Hattusha, Alalakh, Tel Kabri, Qatna, Tell Sakka and Tell-el Dab’a) where similar iconography and stylistic themes were recognised (for Tell-el Dab’a: Brysbaert 2002 on pigments and technical considerations). The drive of the study was based on these premises but the methods employed were scientific analysis and small-scale experimentations, combined with a strong theoretical framework. This PhD study did not aim to add to the volume of already known analytical data from many sites, but to explain the results in terms of various phenomena of social interconnections between elites and artisans in the LBA east Mediterranean. This work (Brysbaert 2004; 2008 both with full references) thus employed a more holistic combined approach that comprised scientific analysis, replicative experiments, social-anthropological theory and contextual-iconographic/stylistic selection of the material. It discussed issues of crafting and producing, and aspects of travelling craftspeople, then hotly debated (e.g. Hitchcock 2005). Networks of interlinked social actors and relationships were recognised while painted plaster chaînes opératoires were no longer presented as lists of analytical results. Such holistic approaches were already achieved by the very good work carried out, e.g. at the Fitch laboratory for ceramic studies earlier on. As such, the obtained results became fully integrated in theoretical debates that tackled social questions. Work on painted plaster continued in the 2000s with material studied from Greece and beyond (e.g. the Menelaion (Jones 2009); Plakes House at Mycenae (Brysbaert 2013); Pylos (Brecoulaki et al. 2008; 2012); Akrotiri (Sotiropoulou et al. 2016); Qatna in Syria (Brysbaert 2011a; von Rüden et al. 2018); Tel Burak in Lebanon (Bertsch 2019)). These studies offered insights in organic pigments (murex at Pylos) and traces of organic binding media, suggesting the use of al secco painting techniques on various groups of material, and while doing so, unfortunately also denoting that the al fresco technique was also employed as many, earlier on, testified. Often in scientific work, one has to react first by promoting the complete opposite before a middle way is found and accepted. As a result this debate, therefore, has been a dead end for some time as it forms the only topic discussed, together with more data presentation, rather than taking up the archaeological questions, beyond a materialist perspective. Finally, in an otherwise very useful iconographic overview of painted plaster, Vlachopoulos (2020) used several technological terms wrongly (‘frescoes’: e.g. 407–409, 420, ‘fresco technique’: 421, ‘fresco painters’: 422, ‘EIA frescoes’: 422), while Brysbaert emphasised already in 2000 to avoid the use of the term ‘frescoes’ because it implies a specific technology applied on a specifically prepared surface (wet lime plaster only). Instead, she suggested ‘painted plaster’ because this would be in line with the ICCROM terminology of ‘architectural surfaces’ and would avoid pitfalls over ‘floor’ or ‘wall paintings’ and painted objects (offering tables, sarcophagi, or plastered heads, all of which are known from Aegean Bronze Age contexts).

Fortunately, new technologies also brought about new ways of looking at and studying the material itself and removed the attention from the (still) ongoing al fresco-al secco debate a little. C. Papaodysseus and team (Papaodysseus et al. 2008, 403, 407) investigated the geometry of several curves that had been observed on the figures of the Akrotiri material. They postulated that these were likely drawn and painted with the aid of premade templates, therefore suggesting that artisans were familiar with a high level of geometric design and that they strived to produce a well understood level of symmetry in the figures they depicted. What is not clear to the current author is whether the team has also studied such potential phenomena beyond Akrotiri itself. This would be a very worthwhile exercise to carry out so that meaningful comparative studies of technical transfer and skill transfer can follow. Through the investigation of potential technological transfers between sites we may obtain further insights in the travelling aspects of artisans, a concept now much more accepted, even for earlier periods too (Muhly, this volume).

Both 2D and 3D scanning and modelling recently also made an entrance in the study of painted plaster with some fabulous results, not only for publication (see e.g. Bietak et al. 2007 for Tell el-Dab’a for an early example) but also to be able to use the high resolution imagery towards the reconstruction of fragments that joined, purely on the basis of the matching algorithms (Brown et al. 2008; Toler-Franklin et al. 2010). The advantages of such work have been discussed elsewhere (Brysbaert in press) and are clear, especially when the minute details of production technology traces can now be studied to a much larger extent, over prolonged periods of time away from the material, and without having to handle it constantly. An additional use of 3D recording of painted plaster scenes will allow the study of the social functions of such painted scenes, provided that these are large enough to work with. Again, Akrotiri proved a useful case study in applying a combined 3D modelling and GIS method for their socio-symbolic reading of the painted plaster within its architectural urban context. It highlights the potential relationship between spatial relationships in the town of Akrotiri through the communicative power of the paintings which may have enhanced the widespread
production of such painted murals all over the site (Paliou 2011). As such, these paintings in fact play an active role in their environment where people and things interact with each other on a constant basis (see Brysbaert 2008). A similar conclusion, and much more, was also reached by the team of J. Maran, A. Papadimitriou and U. Thaler when working with the well conserved fragments of painted plaster from Tiryns that were originally both located in the Tiryns apothiki and in the National Archaeological Museum in Athens (Maran et al. 2015).

Finally, the conservation of painted plaster found its way into the literature in the form of separately published papers (Tsitsa 2013) and this is a very positive and welcome development since most of this work, unfortunately, remains under the radar of academia. Far too long, conservators who were often highly trained scientifically, were seen as technical handmaiden to excavators. If their work received any attention in publications, it usually sat tucked away in large appendices. Therefore, Tsitsa’s paper on her work done on the Heraklion Museum painted plaster, clearly indicates the amount of observations one can reach by working so closely to these paintings. As a science-based archaeologist and conservator, I hope this is a fast-moving forward trend and not just one that is concerned with groups of high profile materials (such as Knossos, Akrotiri).

However, conservation work still has some way to go in the right direction concerning some of its hands-on practices. For example, too many surfaces of painted plaster fragments found in older excavations are embedded in (sometimes equally) old plaster-of-Paris blocks (materials from Knossos, Mycenae, Tiryns, Orchomenos, Tell el-Daba, and many more), and even more recent ones seem to have been consolidated this way. The point of embedding fragments into the blocks is clear: the frail fragments are set solidly in place as the intended material. The work carried out at Akrotiri seems to be the notable exception since they use a softer mixture which is required after all fragments are scanned. Changing displays are possible and no continuous handling is required after all fragments are scanned.

In terms of the destructive nature of research through sampling, conservation plays another role as well. For example, the paper by Papliaka et al. (2015) discussed the continuously improving sampling strategies in relation to past conservation treatments. Often such treatments mask past original organic compounds and degradation products, while more recent consolidation materials take the possibilities of past organic materials into account, and even that is a great way forward. It also suggests that past studies on organic materials should be read and understood with caution when reporting past organic materials easily (Sotiropoulou et al. 2015). This latter study on the implications of finding metal oxalates in painted plaster from the LBA until Roman times also considered ageing binders in fragments that were also submitted to conservation materials, confirming the care taken in investigating and subsequently accepting the results of organic binding media detection, a point I already made in 2008. As I suggested then, organic binding media were very likely used – we knew that the al secco method was already in vogue in the MBA on Crete since no signs of al fresco was seen on those much earlier materials (Brysbaert 2008, 150, group 1, table 7.1). The issue, therefore, did not sit with the acceptance of the partial use of al secco techniques (many did before me), but with how we go about finding unadulterated evidence for it. It seems now that Sotiropoulou and her team have achieved exactly this care in their sampling, methods of investigation and thoughtful presentation of their results, something which ends in taking a great middle-ground between al fresco and al secco and something that can and should be accepted by all parties in this debate (but see still the resistance against this: Vlachopoulos 2020, 408). Only time will tell if the discussion has finally moved on, that al fresco as a technique can also be accepted (either with pure water or limewater), and perhaps can, in some cases, take up its place as the intended (see many signs already outlined by Cameron’s former work), but perhaps not always achieved, technique of painting. Denying any al fresco presence in these paintings despite century-long work by Bronze Age painting experts, s.a. Duel and Gettens (1940s), M. Cameron, M. Lang at Pylos, L. Chryssakopoulou at Akrotiri, and even Heaton much earlier on, in which everyone, including myself, accepted a combination of al fresco and al secco painting techniques, testifies of a lack of insights in
what are the important questions that need to be asked (see
Introduction). The context of the paintings, however, and
their socio-symbolic locations, presence and performative
power will, no doubt, tell us a much more exciting story
about how people went about their daily lives, whether as
an elite person or as an artisan, or in any other social role.

The way forward: studies integrating paintings in
their multiple contexts

Despite the abovementioned studies which form far from a
complete overview (see more in Brysbaert 2008; in press;
also von Rüden et al. 2018), there is still a lack of studies
on materials found outside the pure elite contexts of palaces,
villas and large complexes, in other words, the high profile
sites, while these materials do exist outside these locales.
Unfortunately, these materials are still misconceived as
of secondary importance (see recently Vlachopoulos
2020, 419). Such necessarily collaborative work and its
compulsory comparisons with the much better known
elite-context materials is crucial in order to understand if
there are different technical and social uses for plaster in
different social contexts; the emphasis cannot just remain
on elite iconography. Such work was suggested 15 years
ago (Brysbaert 2004; 2008) and while it has not yet been
taken up, despite such material being present in various
evacuation and museum archives all over Greece, it would
form a very useful and necessary PhD topic. Many more
conservation-related projects need to be brought to the
attention of both archaeologists and scientific investigators
of technological practices alike. A clear example of how
much such work can reveal, due to the year-long experience
of close observations, is the work by Angelidis et al. (2018).
No one but conservators will have the luxury (perhaps) of
studying the material in such great detail, so the time has
come that we fully integrate such observations and that
conservators take the initiative to publish their work (see
also Tsitsa 2013). Another point already mentioned in 2008
is the lack of comparative work carried out between painted
plaster scenes of large size versus miniature scenes in terms
of the underlying technological practices of the chaîne
opératoire of plaster production and subsequent painting.
Are there differences in the plaster composition and pigment
processing between both types of scenes? And what about
the 3D or relief scenes we know from Knossos (e.g. Kaiser
1976), Palaikastro, Gla and Tell el-Dab’a (Brysbaert 2008)?

Furthermore, contextual studies of painted plaster are also
on the rise and much needed. For example, many painted
plaster scenes did not collapse from their walls at a given
time in the past but, instead, they were purposefully stripped
off and deposited, possibly (but not necessarily) to allow
for a new painting programme on fresh plaster (e.g. plaster
‘stack’ found in House of the Frescoes in Knossos, and
deposit at Gla: both Brysbaert 2003, 170). More detailed
studies since 2003 seem to confirm these practices (Shaw
and Chapin 2006, 61–63 on the Knossian ‘stack’), but
how to match it with situations in which overplastering
and overpainting existed as well? What about the reuse/
recycling of materials of the same composition in new ones
(Brysaert 2003; also Viaglaklis 2017)? What was
the reasoning for one or the other choice? Were decisions
purely practical or was there more to them? Can we try,
virtually at least, to reconstruct deposited material to the
building/place in which it perhaps once belonged? And
what about material deposited in crevices (Gla: Iakovidis
1998, 268)? As mentioned in earlier studies, an agency
approach may help in at least thinking about these questions
in a more nuanced way, especially since people are closely
entangled (to use a hype term) not only with each other
but also with materials and objects in their daily lives.
Objects and features are crucial in forming, transforming,
and changing social processes and they change meaning
constantly through varied contexts, uses and handling.
As people change and are socially dynamic, so are the objects
entangled with these people. People shape objects that shape
people. Perhaps this expresses one of the most important
characteristics of object’s (or feature’s) biographies. At
the same time, objects and features also gather time, movement
and change. They gather meaning and value because of
their physical form which is in and of themselves via their
producers, their material make-up, or simply their ageing.
They also gather value and meaning over time through
enactment and acts of performing which is a relational
characteristic since people, in contact with such objects or
features, may gather meaning and status too, because of
their relation with these objects or features. That people
and the painted plaster scenes, materials, compositions and
values are entangled should be clear from a multitude
of publications and needs no further repetition here.
Further, there is still work to be done on the questions about
how, when, where, especially if future studies hopefully will
investigate non-palatial and non-elite materials too.

As may be clear from the above section, investigative
work on the actual material combined with asking meaningful
questions still has quite a way to go. There is always more
material to study and different methods to study it, with
different questions in mind. It is therefore delightful to see
that some more recent work confirms many of the strands of
my earlier work on the topic. For example, von Rüden
et al. (2018, 13, notes 33–37 and 39) study material from
several of the sites which I worked on over a decade ago and
come up with similar but improved results when compared
with Brysbaert (2004; 2007; 2008, 97–106). Also, my initial
use of the chaîne opératoire and cross-craft interaction
methodological approach combined with agency theory, has
finally caught on, and is fully integrated by von Rüden’s
team. A similar situation occurs in the recent proceedings
of a conference on painted plaster and ceramics in which
the first use of murex purple detected on painted plaster in Akrotiri was recognised as noted by E. Chryssikopoulos who had it analysed by S. Sotiropoulo (Chryssikopoulos and Sotirakopoulou 2003) over a decade ago. Brecoulaki et al. (2008, 380), who initially pulled into doubt the use of Raman spectroscopy, later on recognised its advantageous usage and employed it herself as well (Brecoulaki et al. 2017, 149). The point is that one does not need to agree on results. For example, Brecoulaki et al. (2017, 158) argue out the al fresco-al secco debate (still) on Tell-el Dab’a images made by myself rather than studying the material itself. This goes against Brecoulaki’s own point of studying material with multiple methods. In this specific case, no scientific method is employed on the material at all. Where I do argue for travelling craftspeople and artisans, I do not do this as lightly as she suggests: i.e. on the al fresco evidence only, even though it does play an important role, but it also confirms the concept of travelling artisans mentioned by plenty of other studies on style, iconography and other combined approaches. Finally, Becker (2019) refines the observations on al fresco versus al secco at Tell-el Dab’a and, with this, he may have the most correct answer if his observations on lime water (rather than pure water) was employed to apply the pigments onto the wall, and how that is supposed to be seen in cross-sections versus the effects of carbonation.

In the end, it is the disagreements in research outcomes that make scientific research exciting after all, and we all learn from new and fresh looks at the same materials. What is, however, a prerequisite to good scholarship is the completeness of a literature study and the full recognition of what people have carried out before you. That way, one gains familiarity with the literature and respect for what others have investigated. Moreover, one then also avoids repetitive statements or ‘short-cut’ readings of people’s statements which only confuses the reader who is fully familiar with the literature. Finally, reading ‘everything under the sun’ about a specific topic becomes harder and harder with the wealth of studies undertaken in the last decades. Gone are the days of Evans and Schliemann when one learns from new and fresh looks at the same materials.

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