Reviewed Article:

Reproducing the Wall Painting of the Abduction of Persephone (Vergina-Macedonia): Conditions and Restrictions for a Successful Archaeological Experiment

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Author(s): Manolis I. Stefanakis [1], Antonis Vlavogilakis [2] ✉

[1] Department of Mediterranean Studies, School of Humanities, University of the Aegean "7th March", Rhodes, Greece.

[2] Department of Mediterranean Studies of the School of Humanities of the University of the Aegean, 10 Ariadnis Street, Kalamaki Neas Kydonias, 73100, Chania, Crete, Greece.

Research on the technique of fresco painting in Macedonian tombs of the late classical period, is currently in progress through the experimental reproduction of the mural the Tomb of Persephone in the Grand Tumulus of Vergina. The purpose of the research is to identify the techniques used by ancient craftspeople, their tools, materials and working conditions, as well as the time required to complete this type of work. Examples of experimental archaeology projects that have taken place in Greece, the conditions and restrictions of this particular experiment and problems arising from this kind of research are presented, while some of the misconceptions about the nature of lime plaster-based wall painting techniques are also pinpointed. The requirements for such an undertaking include a) in situ observation, b) comparison of the artwork with artworks of earlier and later periods, c) the production of reconstructions and graphs, d) comparison of literature from different scientific disciplines, e) numerous experiments, and f) the acquirement of hands-on technical know-how.

Demonstrating the approach methodology used in this research, several ways of approaching the actual experience of the ancient craftsman-painter are suggested. Different forms of preparatory work are proposed, including practice with different materials. Finally, two types of supports suitable for large scale lime-based painting are introduced.

> “ Ancient Greek monumental painting is an area where experiments have not yet been attempted, at least not in the form of reproduction of the artwork with tools, materials and conditions of its time.

Experimentalarchaeology and the reproduction of a mural

Experimental archaeology is a branch of contemporary archaeological science that is concerned with conducting carefully controlled experiments in an attempt to reproduce objects, events, activities and situations anding and interpretation of archaeological testimony.

In fact experimental archaeology is a very practical method of archaeological interpretation, where the archaeologist observes the creation of an environment and situations or reconstructions or replicas of ancient sites and objects - always based on findings from the archaeological horizon - in a controlled environment. During the experiment an attempt is madeto reproduce the exact conditions of antiquity using only materials that were available in a particular ancient society. During this reconstruction, the researcher can repeatedly scrutinize scientific theories on the society under examination, through a variety of techniques, methods and approaches. Given the wide scope and variety of test subjects, archaeological experiments differ as to the nature, the purpose and the time required for their completion (Ascher 1961; Ascher 1970; Yellen and Macdonald 1977; Tringham 1978; Reynolds 1999; Stone and Planel 1999; Ingersoll and Mathieu 2002; Coles 2010; Kelterborn 1987).

In Greece experimental archaeology has taken great steps in recent decades. It is worth mentioning, as an indication only, that the systematic work, done since 1992, at Dikili Tash, in Philippi (Macedonia) (Koukouli-Chryssanthaki, Treuil and Malamidou 1996; Darcque et al. 2007; Koukouli-Chryssanthaki et Treuil 2008), where through a series of experimental projects attempts were made to verify observations made in the archaeological material. The experiments focused, among others, on the building techniques of the various parts of a house (walls, ceiling, floor) and the various structures and objects (ovens, hobs, storage containers) found in houses of the Neolithic era(Martinez et Prévost-Dermarkar 2003; Papadopoulou et Prévost-Dermarkar 2007; Prévost-Dermarkar 2003; Tsirtsoni and Yiouni 2002). Numerous other archaeological experiments are known, which relate either to reconstructions of simple daily mobile artefacts, for example pottery (Noble 1988, 24-36, figs. 7-64, for the detailed photographic mapping of the process of modelling an Attic kylix by the potter Fong Chow. Also, Yon 1981, 88-92, for the construction of modern vases using traditional methods), or the testing of techniques, for example stone working (Stocks 2003), or technological achievements of antiquity, for example the Athenian trireme (Rankov 2012; Morrisson, Coates and Rankov2000;Welsh 1988;Goodburn 1993) and other machines (*Ancient Greek Technology* 2000; Kotsanas 2007. For ancient Greek technology in general see, Coulton 1974;Humphrey, Oleson and Sherwood1997; *Ancient Greek Technology*1997; Wilson 2002; *Ancient Greek Technology* 2006; Cuomo 2007; Oleson 2009). Also, to specific processes of decay and reconstitution of materials, where modern replicas of artefacts and ecodata are buried, for a specific time period, in order to observe and analyse after their internmentthe impact of the environment on them and to verify former theories formulated by the archaeological findings, for example the cremation of Eleutherna in Crete (Stampolidis 2008, 174; *Eleutherna* 1996) et cetera.

Ancient Greek monumental painting is an area where experiments have not yet been attempted, at least not in the form of reproduction of the artwork with tools, materials and conditions of its time. Studies of samples based on physicochemical (Alexopoulou-Agoranou and Chryssoulakis 1993) analytical methods, micro-spectroscopy (FTIR) (Siapkas, Zorba and Paraskevopoulos 2000; Bikiaris et al. 1999), scanning electron microscopy with microprobe ray (SEM-EDS) (Komninou 2006. Genestar and Pons 2005) and optical microscopy (OM) (Chalmin *et al.* 2003; Dredge, Wuhrer and Phillips 2003), have often been used, mainly on Byzantine monuments (Zorba et al. 2006;Pavlidou et al. 2006;Zorba et al. 2002), in order to detect and identify the use of specific pigments, the composition of colours, as well as the painting technique. They cannot, however, answer questions such as "what sort of preparation work was needed", "how much time was required to complete the work", "what were the problems encountered by the artist and how were they resolved" and many others, which today would be extremely useful for the researcher of ancient monumental painting.

Recognizing this gap in the research, the Department of Mediterranean Studies of the University of the Aegean, appointed Mr Vlavogilakis, in 2011, to take over doctoral research

focussing on the investigation of the technique of fresco painting in Macedonian funerary painting (for the ancient funerary painting in general see, Barbet 2001; Blanc 1998) of the late classical period, from the phase of the coating of the painting surface until the final result, through the experimental reproduction of the mural the Tomb of Persephone, also known as 'small tomb A' in the Grand Tumulus of Vergina. Although Macedonian funerary wall painting in general has been thoroughly studied from the point of the history of art (Brecoulaki 2006a; Brecoulaki 2006b; Saatsoglou-Paliadeli 2004; Andronikos 1994.), very few attempts have been made as to investigate the techniques and the painting procedure in depth.

The mural of the Tomb of Persephone (See Figure 1), which dates from the mid- fourth century BC, is a composition based primarily on drawing, with incised under drawings of the figures, and limited but extremely sensitive use of colours (Andronikos 1977, 6-10, 33; Andronikos 1994; Saatsoglou-Paliadeli 2002, 98-101). It was chosen as a study case because it offers the opportunity to study:

1. numerous figures (dressed, nude, male and female) with diverse poses (from the most intense of the abduction, to the more static such as that of Demeter);
2. variations in the painting style of one ancient painter (such as hatching in the nude parts, colour gradations on the wheels of the chariot and the garment of Okeanis, a linear painting style in the garb of Demeter);
3. depiction of horses and chariot (a favourite theme for the ancient Greeks);
4. imaginary creatures (griffins) and flowers in a decorative pattern;
5. optical foreshortening (figures, horses, chariot);
6. a mural that utilizes three of the four walls of the construction.

Through the study of this mural and a long and arduous series of experiments, we are attempting to confirm or refute the hitherto formulated hypotheses concerning the preparation and the type of equipment used in the fresco, the selection of materials and the preparation stages of the mural. The purpose is to investigate the technical preparation of the walls and elucidate the successive stages of the work until the final result. Different types of tools and ways of using them are investigated, tools involved both in the handling of the painting surface, and the application of the colours.

The experiment will cover two distinct aspects of experimental archaeology:

1. historical re-enactment, with the technical reproduction of the tools and materials of the mural according to data from the era (fourth century BC) and test the existing theories for this painting technique, using only materials, techniques and manufacturing processes that are historically and archaeologically attested, and
2. the revival of history (living history), which requires the archaeologist and the specialized scientist, in our case the painter, to live and work under the same conditions as the

ancient craftsman and artist, in order to study how the ancient painter of the abduction of Persephone worked in that grave, but also the time necessary for this work, information that does not appear on the archaeological horizon.

For the more accurate reconstruction of the wall painting of the tomb of the abduction of Persephone, we must, however, take into account a number of conditions and restrictions, as presented below.

M.I.S.

Conditions and restrictions

1. *In situ* observation is of primaryimportance, as the description of a published work always differs from direct observation: 'reading' the dimensions is totally different to experiencing it within that space. In an artwork such as the abduction of Persephone, where there are many parameters toinvestigate, *in situ* observation has to focus on gaps in the current state of research, with emphasis on 'what one sees' and not 'what one knows that he sees'. Only then the descriptions of researchers and the various scientific assumptions canbe confirmed or corrected. It is alsoessential to photograph the work, focusing on details. The photos should be taken from different angles (See Figure 2) focusing on details that require special observation, since the project as a whole is well-known and documented. The processing of these images with image editing software must be non-invasive, for example, must not alter the character of the colours.
2. It is also necessary to compare the work either directly or through photographs and pictures, with other works of art from earlier, contemporary and later periods, in order to identify iconographic parallels as to the attitudes of the figures and the use of colour, as well as to evaluate other versions of the same composition. This process will eventually assist in viewing figures of the mural which are very damaged, such as the Fates (Moirai) and the horses. In order to approach the way the ancient painter wasthinking and to compare the choices he had during the composition, it is also useful to look at artworks with the same subject from the later - post-classical andpre-modern - History of Art. It should be noted here that knowledge of image editing programs is required, in order to create graphs, pseudo-three-dimensional and three-dimensional reconstructions (See Figure 3). All these, of course, do not exempt the researcher from the classic construction of a small scale model (See Figure 4), for the study of the working conditions of the ancient craftsman.
3. Even though the research in progress is in fact a technical experiment, archaeological literature is the starting point of the study, as it provides all necessary background on the social perceptions of the era, the technological level, the techniques and the artwork itself. Equally important is the contribution of ancient sources, which refer either to the techniques and practices of the craftsmen, or to the subject of the artwork, such as the

treatise *Poetics* of Aristotle, the *Natural History* of Pliny, or the Homeric *Hymn to Demeter*. The study of the ancient sources and the archaeological publications on experimental archaeology assist the modern artist-researcher to understand the time period better - to 'live' inthat period - without projecting it to modern concepts and technical knowledge on it.

However, this being anarchaeological experiment, one should focus in the literature on technical issues: it is quite different to approach a piece of art theoretically orto analyse sections and fragments of it by 'laying one's hands on lime plaster'. Studies, analyses and texts by craftspeople of fresco painting are required, such as those of Alberti (Merrifield 1846, 19-23), Cennini (1933), Nordmark (1947), Dionysius of Fourna (1883; 1989), Plakotaris (1969) and many others. These handbooks or texts contain "recipes", descriptions and details of this technique. Also particularly useful is the literature relating to the conservation of works of art, since - apart from the detailed analysis of artworks and fragments - 'recipes' are often contained therein, with detailed proportions of the materials used.

The scholar shouldbe very cautious, however, with the several misconceptions existing in literature. For example, sincea fresco can be executed evenon a single layer of lime mortar 1 cm thick (Mugnaini et al. 2006; Merrifield 1846, 61-68; Palladio 1733. Also, sample experiments of our research with only one layer 3-6 mm thick: 8512 Griffin, 8612 Middle Fate, και 11812 Horse.), the total thickness of the layers in the mural of the abduction of Persephone - approximately 3.5 cm - cannot be considered too thin for the fresco technique (Brecoulaki 2006a, v. 1, 94: "*Et si l'on considère l'épaisseur très faible des couches préparatoires sur la « tombe de Perséphone », on sera amené à mettre en doute l'exécution de ses peintures avec la technique de la fresque*" "And if we consider the very low thickness of the preparatory layers on the "tomb of Persephone", we shall be led to question the execution of these paintings with the fresco technique"). Myths concerning the technique should also be avoided, such as the claim that the artist does not know what the colours will look like when they dry. It is certain that he knows, either because he is experienced, or because he can experiment with the colours on a piece of gypsum, or on a piece of ceramic onto which a thin layer of lime was previously applied.

4. The collection and study of the literature leads inevitably to the creation of a 'recipe book', which includes earlier, pre-modern and modern'recipes'. Without the descriptions of the process and a 'recipe book' one can neither define the versions of the technique (in order to justify the application technique finally used), nor learn the proportions of materials (which are absolutely necessary and strictly adhered to). There are many ways to execute even the simplest 'recipe', so the choice of the final manner of execution used must be justified. The painter of the tomb of Persephone worked under different conditions (closed atmosphere, light and air only from above) from the painter of the tomb of Philip (Saatsoglou-Paliadeli 2006; Saatsoglou-Paliadeli 2004; Saatsoglou-Paliadeli 2002, 101-104; Andronikos 1984, 97-119; Andronikos 1977, 10-39), and the painter of the

tomb of Kazanlak (Shivkova 1974; Micoff 1954; Pollitt 2004, 245-246), who both worked in a completely different environment. Even if they all had used the same 'recipe', the application method and time they had to complete their work probably differed considerably.

After almost one and a half years of research, the 'recipe' of the mural of the abduction of Persephone (Brecoulaki 2006a, v. 1, 91) is not yet precisely defined in the 'recipe book' (See Table 1). It is the only 'recipe' that is updated on a weekly basis. Depending on the author, this kind of 'recipe' is called either *fresco*, *mezzo fresco*, *lime painting*, *secco a calce*, or *secco*. In all these versions, the painting is done on fresh lime plaster. As one realizes there is no fixed terminology for these techniques, as writers from the Middle Ages until today - craftspeople, conservators, theoreticians - do not completely agree on what is fresco, mezzo, lime painting and secco (Tsuji 1983, 219, n. 15). Maybe, in the end, the use of the Italian terminology is not the most appropriate for the techniques used in Macedonian tombs, despite the kinship between them.

Therefore, it is necessary toeither radically re-define the terminology used or, whenever a term is used, to provide a clear description of it. The collection of the 'recipes' of the Macedonian tombs may indicate how many craftsmen or painters' workshops toiled on them. But one needs to be careful, since the technique and its application are modified according to the wall, the time limit of the commission, and the technical training or experience of each creator.

5. In order to attempt the final experiment, knowledge about practical matters in painting and familiarity with the materials is required. For this reason, tests are made of different mixtures (See Figure 5) and a large number of experiments exploring the validity and outcome of the various "recipes", were conducted in order to gain experience. Measuring the time required to complete the samples is mostly necessary in the final experiment, to calculate the time that the craftsman worked.

   Experiments are also conducted with thecolours: both combinations of colours and pigment ratios in relation to the type of binder: such as boiled rain water, clear lime-water, lime emulsions (lime milk) et cetera.Additional experiments are also included, such as baking pigments and the construction of brushes, which bring the researcher closer to the actual experience of the ancient craftsman. The recording of all experiments must be done accurately and honestly.

   The conductor of such a project can gain experience with the materials both through the construction of the samples-experiments andby practicing with a quantity of lime mortar (See Figure 6) onto plasterboard. This includes painting on a layer of dilute emulsion of lime on the same surface, to increase speed (dilute lime milk dries very quickly on plasterboard). Practicing with another material in order to get used to painting the figures of the mural is also included in the preparation. In our research we use a type of ink (stain), called *cassia* (See Figure 7), applied on a vertically placed but not well supported paper, in order for the hand of the artist to become accustomed with pressing

the brush more gently on the painting surface (sincecontemporary painting materials and supports encourage more 'harsh' applications of paint).
Lastly, experience can be gained by viewing filmed material: there are dozens of short films on the world wide net with practitioners of fresco painting, plasterers competing in speed, private schools that teach building techniques, the videos of the private Fresco School (for example http://www.youtube.com, with key words such as 'lime plastering' and 'fresco'), as well as documentaries (Seltzer 1936). It should be noted that modern materials are not the same as their ancient counterparts: the lime plaster available today is for modern building construction (Demetriades 2005), and the aged lime, which is made specifically for fresco, differs in composition from the ancient lime. Furthermore, several of the modern pigments are either made artificially or from combinations of raw materials from countries such as India and Morocco. Although contemporary pigments are not the same as the ones used by ancient artists, they are, however, suitable for our experiment.
The only colour that poses a problem for our experiment - if it was applied on fresh lime - is the purple used in garments (See Figure 8), which has been identified as inorganic natural dye, madder, and Laque de Garance (Brecoulaki 2006a, v. 1, 94, 98-99, v. 2, 157, table 3). Alizarin crimson, the modern synthetic replacement of madder is not used in fresco, because while it is red when applied, it turns into brown when dry, and blackens in time. The use of organic pigments and dyes is forbidden by all fresco painters because they either do not survive in lime, or change colour. It remains to test natural madder in lime both neat, and mixed with kaolin or other binders.
It is clear however that this purple colour can be produced by mixing colours: 52% red of the chariot and 48% blue of the griffins produces the purple of the folds of the drapery, which when mixed with white produces light mauve. The purple of the garments can also be replaced by Cyprusjarosite (Kremer pigment No.17000), a pale variety of yellow ochre, which when baked at 900-1100 degrees Celsius, becomes purple (Mastrotheodoros et al 2010, 46. Jarosite was used as a yellow in a fourth century BC marble basin, now in the J. Paul Getty Museum (85.AA.10). See Wallert 1995, 182-185). In the worst case, the purple of the garments can be replaced with a contemporary lime-proof violet pigment.
The ancient crafts man had experience with the laying of the mixtures of the substrate,which the modern researcher does not have the time to acquire on the same level. Even if the ancient painter did not apply the mixtures on the wall, he had to know how it was done properly. Therefore the painter needs a plasterer to apply the mixtures on the final surface, but always under the guidance of the painter. Of course the way the work will be executed must be recorded in detail. However, it must be acknowledged that the modern crafts man does not know the specific material in the manner his ancient colleague did: the modern mixtures that he is accustomed to handling are cement-based, with plenty of chemical additives to improve workability.

6. The final mural that will be the product of our experiment does not need to be - and cannot be - an exact replica of that of the tomb of the abduction of Persephone, since an artist cannot precisely imitate the style of another. The main objective is to explore and understand the process. Therefore, it is considered more appropriate to reproduce the mural in its entirety, including all four walls of the tomb. As the description of such an experiment in text is not enough, during the final undertakingtrained assistants will be required for data recording, as well as video recording from at least two different angles and viewpoints.
   Of course the surface, onto which the final experiment will take place, must be defined, as there is a difference whether it will be transportable or fixed. The surfaces that are commercially available or can be constructed for frescos include boxes (box frames) from three centimetres thick plywood with stainless mesh backing that can be used for both portable and stationary fresco on a base, and clay lath, stainless mesh covered with baked clay. Both options can work perfectly well in the case that a building is found to accept the mural on its walls. In both cases a mixture is required that will imitate or replace the poros stone of the walls of the tomb, which must be laid at least one month before the final project. Ideally (See Figure 9), the final fresco should be created in the same or similar climatic conditions to the tomb of Persephone, if not in the same geographical region.

A.V.

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Attachment(s)
Table 1 (93.1 KB)

Keywords painting
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Corresponding Author

Antonis Vlavogilakis
Department of Mediterranean Studies of the School of Humanities of the University of the Aegean
10 Ariadnis Street
Kalamaki Neas Kydonias
73100 Chania, Crete
Greece
E-mail Contact

Gallery Image

FIG 1. THE ABDUCTION OF PERSEPHONE, NORTH WALL OF THE TOMB OF PERSEPHONE IN VERGINA. COMPOSITE IMAGE OF KOTTARIDI 2007 FIG.7 P.31 AND 33. A COLOUR CORRECTION ON THE ORIGINAL IMAGES HAS BEEN MADE ON THE CLOTHING OF HERMES, PERSEPHONE AND OCEANIS (FROM PINK TO PURPLE) BASED ON PHOTOGRAPHS TAKEN IN SITU (SEE FIGURE 8).

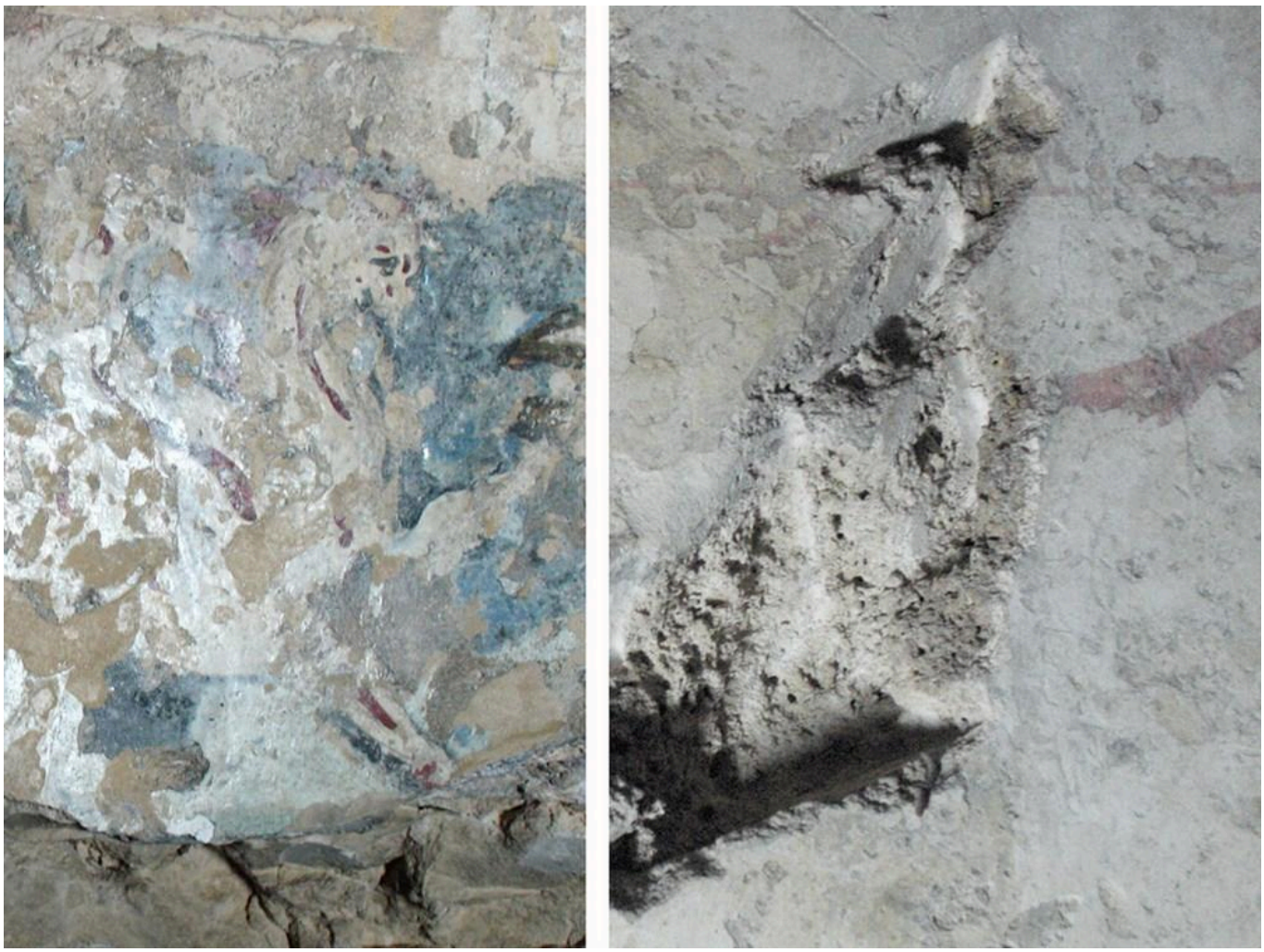

FIG 2. IN SITU PHOTOGRAPHS OF THE FRESCO. LEFT: DETAIL OF THE GRIFFIN AND FLOWER FRIEZE (NORTH WALL, BELLOW THE CHARIOT). RIGHT: DETAIL OF DAMAGE (NORTH WALL, BETWEEN THE NECK OF THE THIRD AND FOURTH HORSE) SHOWING THE MORTAR LAYERS.

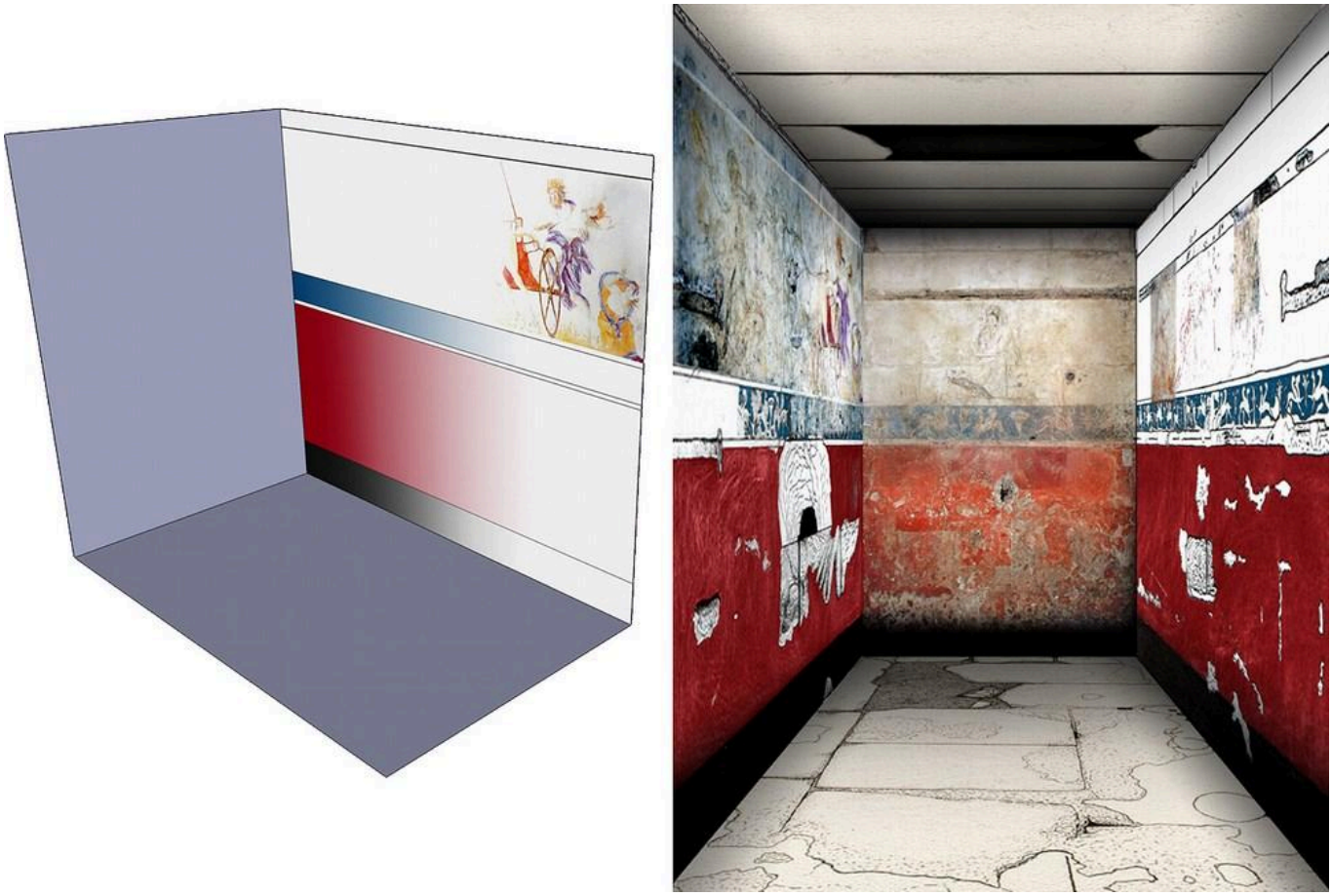

FIG 3. SOME OF THE RECONSTRUCTIONS PRODUCED DURING RESEARCH. LEFT: 3D GRAPH (UNDER CONSTRUCTION) OF THE INTERIOR OF THE GRAVE. RIGHT: PSEUDO-3D MODEL OF THE INTERIOR OF THE TOMB (FACING EAST WALL). COMPOSITE OF IMAGE OF ANDRONIKOS 1994 FIG. 6 (P.42), FIG. 7 (P.43), FIG. 8 (P.44), FIG. 9 (P.45), FIG. 12 (P.49) AND DROUGOU AND SAATSOGLOU-PALIADELI 2006 UNNUMBERED PICTURE, P.178.

FIG 4. SMALL SCALE MODEL OF THE INTERIOR OF THE TOMB.

FIG 5. EXAMPLE OF A MIXTURE.

FIG 6. EXAMPLES OF PREPARATION AND PRACTICE WORK. LEFT: PRACTICING LIME MIXTURE APPLICATION ON PLASTERBOARD. RIGHT: PRACTICING PAINTING ON A LAYER OF DILUTE MILK OF LIME ON PLASTERBOARD.

FIG 7. EXAMPLES OF THE USE OF CASSIA FOR THE PURPOSES OF THE RESEARCH.

FIG 8. THE PURPLE COLOUR IN THE FRESCO. LEFT: DETAIL OF THE RECONSTRUCTION OF THE PAINTING ON THE NORTH WALL BY G. MILTSAKAKIS FROM ANDRONIKOS 1994 PLATE V P.21. RIGHT: IN SITU PHOTOGRAPHS OF DETAILS FROM THE CLOTHING OF PLUTO AND PERSEPHONE.

FIG 9. ONE OF THE SAMPLES-EXPERIMENTS OF THE RESEARSCH, 031212 OKEANIS. LEFT: PHOTOGRAPH TAKEN LESS THAN 2 MINUTES FROM THE LAST BRUSHSTROKE. RIGHT: PHOTOGRAPH TAKEN TWENTY DAYS LATER. THE NAME OF EACH SAMPLE REFERS TO THE DATE OF CREATION (DAY – MONTH – YEAR) AND THE NAME OF THE FIGURE IN THE ORIGINAL FRESCO (IF APPLICABLE). NO FLASH IS USED WHEN PHOTOGRAPHING SAMPLES, IN ORDER TO COMPARE CHANGES IN COLOUR ACCURATELY.