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PIGMENT ANALYSIS OF ROMAN WALL PAINTINGS FROM TWO VILLAE RUSTICAE IN SLOVENIA

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ABSTRACT

The study deals with the characterisation of paint layers from the wall paintings that decorated two excavated Roman villae rusticae in Slovenia. The villa in Mošnje, located in the NW of Slovenia, was built in the 1st half of the 1st century AD and was in use until the end of the 2nd century AD, while the coastal villa in Školarice, built in the second quarter of the 1st century AD, remained in use until the mid-5th century. Stratigraphy and painting techniques were studied using optical microscopy, with pigments identified via Raman microspectroscopy supported by FTIR microspectroscopy and SEM/EDS. The results of this analysis revealed that whereas the Školarice wall paintings were mainly executed using the fresco technique and some areas with the secco technique, both techniques were identified equally in the Mošnje paintings. Red ochre, lime white and carbon black pigments were identified in both the Mošnje and Školarice paintings, although the latter were also characterised by the use of yellow ochre and green earth.

KEYWORDS: Roman pigments, wall paintings, paint layers, villa rustica, painting technique, Raman microspectroscopy

1. INTRODUCTION

One of the most important issues in the study of ancient wall paintings is the identification of the pigments used. Such analysis can provide useful information regarding the palette of pigments available at local, regional or even wider scales, as well as increasing our understanding of the techniques of colour preparation and application. In addition, through the study of pigments, it is possible to discover the associated lines of communication and trade (Mazzocchin et al., 2003).

Some of the earliest and most valuable sources of information regarding the use of pigments in wall paintings in Roman times are ancient works such as De Architectura by Vitruvius (written during the Augustan period) and Naturalis Historia by Pliny the Elder (first century AD). According to Pliny the Elder (Plin. HN 35.11), both natural and artificial pigments could be divided into two categories: "florid" pigments, which included rare and expensive materials, and more common pigments, which he called "austere" or "sombre". Whereas "florid" pigments, which Pliny lists as comprising, for instance, vermillion, azurite, malachite and indigo, were purchased and provided by patrons at their own expense, "austere" pigments were provided by the artist within the cost of the commission and included ochres, green earth, chalks and Egyptian blue. Vitruvius also wrote about pigments (Vitr. De arch. 7), although he was not so precise about dividing pigments into "florid" and "sombre". His work De Architectura provides some information regarding the provenance of certain natural pigments, as well as explaining the processes of obtaining pigments such as Egyptian blue.

Pigments used in Roman wall paintings at various sites have been studied by means of several techniques that enable the identification of both the pigments and the painting technique used (Bearat, 1996; Kakoulli, 1996; Fermo et al., 2013; Villar, Edwards, 2005; Edwards et al., 2003; Edwards et al., 2009). The pigment palette, mostly identified via Raman microspectroscopy, SEM/EDS, FTIR spectroscopy and x-ray powder diffraction, includes commonly identified pigments such as red and yellow ochre, green earth, carbon black, lime white and Egyptian blue, as well as less frequently identified pigments including red lead, verdigris, viridian, lead white, jarosite, volcanic yellow-brown glass and the more expensive cinnabar, malachite, lazurite and caput mortuum (Smith, Barbet, 1999; Edreira et al., 2003; Villar, Edwards, 2005; Mazzochin et al., 2003; Edwards et al., 2003; Aliatis et al., 2009; Piovesan et al., 2011; Paradisi et al., 2012; Buzgar et al., 2011; Edwards et al., 2009). Especially effective are in this regard spectroscopy methods, including SEM-EDS, EDXRF, FTIR, IR-PAS, Raman spectroscopy, GC–MS and Py-GC-MS, which were applied in different combinations for the analysis of wall paintings of various periods (Edreira et al., 2001; Rampazzi et al., 2002; Liritzis, Polychroniadou, 2007; Osete Cortina et al., 2011-2012; Piovesan et al., 2016).

Roman wall paintings in Slovenia have been found in many larger Roman towns (Emona – modern Ljubljana, Celeia – modern Celje, Poetovio – modern Ptuj) (Plesničar–Gec, 1998), as well as in suburban, rural (Mošnje (Kramar et al., 2008), Školarice (Zanier, 2012)) and maritime villas (Izola (Stokin, Zanier, 2011)). However, although the pigments and/or mortar layers of wall paintings from Emona (Gutman et al., 2015a) and Celeia (Gutman et al., 2015b) have been studied, systematic analyses of the materials and techniques used at other locations have yet to be performed.

In the present work, wall paintings from villas in the Roman countryside from Slovenia are characterised, with the aim of providing information regarding the pigments and painting techniques used. Two excavated villae rusticae were selected for this purpose, located on the SW coast and in the NW of Slovenia.

2. ARCHAEOLOGICAL BACKGROUND

2.1. VILLA RUSTICA IN ŠKOLARICE

The Roman villa in Školarice is located not far from the south-western coast of Slovenia on the very northern edge of the Mediterranean. During the archaeological excavation of the site in 2002, which covered a surface area of 6136 m^2, several rooms were discovered, mostly in the productive part of the villa but also including a thermal complex. However, the area explored represents only a fraction of the entire ancient villa complex. Due to the site's sloping terrain the complex was built on terraces descending towards the southwest (Fig. 1). On the lower terrace, large portions of which were unfortunately removed during construction work in the 1960s, a small part of the residential area and baths were discovered, preserved only at the foundation level. The upper terrace was used as a production area, with various open courtyards completing the complex. The villa was erected over an earlier building in the second quarter or towards the middle of the 1st century AD, remaining in use until the mid-5th century AD (Trenz, Novšak, 2004; Novšak, Žerjal, 2008; Sakara Sučević et al., 2015).

Figure 1. Školarice: Roman villa, 2002 excavations (archive of the Institute for the Protection of Cultural Heritage of Slovenia, Piran Regional Office).

Circumstances related to the destruction and damage of the southern residential area of the villa at Školarice resulted in a consistent loss of floors and wall paintings. As a consequence, the collected wall painting fragments include only a few pieces of better quality and with more refined decorative motifs, such as those exhibiting stucco decoration (Zanier, 2012).

Special attention should be paid to certain fragments found in the area of the baths: white plaster characterised by incised lines (Fig. 2a; cf. sample ASO6) that probably refer to a decoration imitating white ashlar masonry. This type of decoration is mostly used within the upper part of wall-decorations relating to the so-called First Pompeian Style, i.e. within "structural" decorative systems (cf. Salvadori, 2012), and dates back to the late Republican period. The fragments from Školarice may therefore relate to the earlier building found under the structures of the thermal area and which was obliterated by the construction of the villa during the imperial era. Also noteworthy are fragments of stucco-decoration, which were also found in the thermal area. Similarly decorated stucco cornices are typical of the final Third and especially the Fourth Pompeian Style of the second half of the 1st century AD (Riemenschneider, 1986; Fröhlich, 1995).

Across the entire complex at Školarice were found also large groups of wall painting fragments, with fairly homogeneous preparations characterised by very simple decorations (Fig. 2b and 2c) including yellow, red, burgundy red, green and black panels, sometimes bounded by white stripes, as well as white panels bordered by broad red bands. These patterns reflect the wide spectrum of plain decorations based on chromatic and modular strings of panels of interchanging colours, which were especially in use from the second half of the 1st through the 2nd century AD (Salvadori, 2012).

Figure 2. (a) Wall painting fragments with incised lines from the Roman villa of Školarice. (b) Wall painting fragments with yellow and burgundy red panels bordered by white stripes. (c) Wall painting fragments with yellow and green panels bordered by white stripes. (d) Monochrome black wall painting fragments.

2.2. VILLA RUSTICA IN MOŠNJE

The Roman villa rustica located near Mošnje in the north-west of Slovenia was discovered during archaeological excavation of the site in 2006 and 2007 (Fig. 3).

The villa was built in the 1st half or at the latest in the middle of the 1st century AD (Lux, Sagadin, 2012) on a terrace of the Sava River. On the north side the retaining wall of the villa was partially cut into the terrace above. This wall extended along the western side of the complex, but on the eastern side was later destroyed by local road construction. Most probably the villa complex was square in plan and measured 120 × 100–120 m. Five masonry buildings have been excavated, with the best preserved being the residential block (dimensions: 37 × 17 m) located in the eastern part of the villa compound, with walls surviving to a height of almost three metres. The western side of the villa comprised three smaller rooms lined in a row, representing the baths or balneum. A form of sauna was present in the caldarium, a room on the northern side of the site with a semi-circular apsidal terminal and a hypocaust or central heating system. The floor was covered with a black and white mosaic with dolphin motifs (Lux, Kramar, 2011), while the lower parts of the walls were decorated with simple geometric motifs comprising black lines on a white or red surface (Fig. 4a, b). The balneum also included adjacent rooms in the southern part of the villa, known as the tepidarium and frigidarium. However, besides an abundance of wall painting fragments found in the rubble layer, as also recorded in the caldarium, the remains of wall paintings from the lower part of the walls were preserved only in the tepidarium (Fig. 4c), with the majority of fragments from this room being red. A number of white-coloured fragments with red decorative motifs were also found in building 3 near the western entrance of the villa (Fig. 4d). All the above room decorations were likely carried out at around the time of villa construction in the mid-1st century AD. The villa was abandoned by the second half of the 2nd century AD at the latest and gradually fell into ruin.

Figure 3. Aerophoto of the discovered northern part of the Roman villa near Mošnje (photo: J. Hanc, archive of the Institute for the Protection of Cultural Heritage of Slovenia).

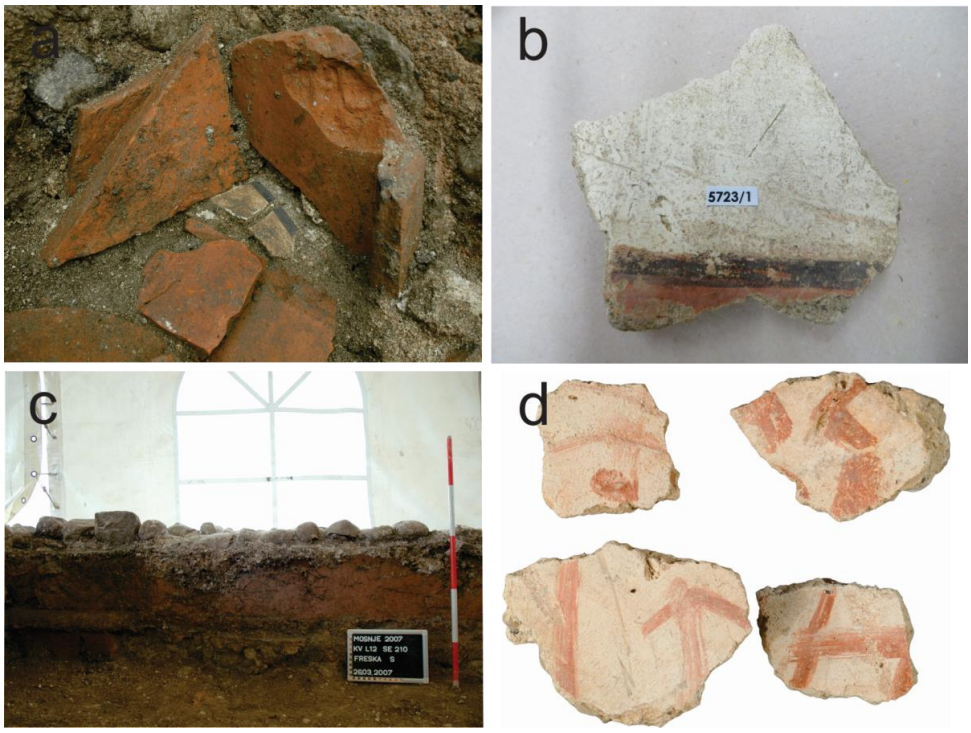

Figure 4. (a, b) Fragments of wall paintings in the rubble layer of the caldarium of the Roman villa near Mošnje (photo: M. Lavrič). (c) Red coloured wall painting in the lower part of the south wall of the tepidarium (photo: M. Lavrič). (d) Fragments of wall paintings from building 3 near the entrance of the villa (photo: A. Ogorelec, archive of the Institute for the Protection of Cultural Heritage of Slovenia).

3. EXPERIMENTAL

3.1. MATERIALS

Samples of paint layers were collected from among the fragments excavated during archaeological investigation of the villae rusticae at Školarice (SW Slovenia) and Mošnje (NW Slovenia). A total of 17 samples from both selected monuments were carefully collected, paying special attention to sampling the complete colour palette. Detailed information regarding samples of paint layers, together with the results, is provided in Tab. 1.

3.2. METHODS

The analyses were performed on approximately millimetre-size samples taken from the surface of the wall paintings using a thin scalpel.

Polished cross-sections of the paint layers were studied via optical microscopy using an Olympus BX-60 equipped with a digital camera (Olympus JVC3-CCD).

Raman microspectroscopy was employed for the identification of the red, orange, black and white pigments. Raman spectra were obtained from the polished cross-sections of paint layers using a Horiba Jobin Yvon LabRAM HR800 Raman spectrometer equipped with an Olympus BXFM optical microscope. Measurements were made using a 785 nm laser excitation line and a Leica 100× objective. The spectral resolution was about 1 cm^{-1}.

Due to their strong luminescence when excited with a 785 nm laser beam, green pigments were identified via FT–IR microspectroscopy, with pigments collected using a fine needle under a stereomicroscope before being pressed into a cell fitted with diamond windows prior to analysis. The FT–IR spectra were recorded using a Perkin Elmer Spectrum 100 FTIR spectrometer at a spectral resolution of 4 cm^{-1} in the range of 4000–600 cm^{-1}; 64 signal-averaged scans of the samples were acquired.

In order to determine the type of binder employed in the paintings, paint layer samples that were determined to have been painted using the secco technique were subjected to solvent extraction (Derric et al., 1999). After their collection with a fine needle under a stereomicroscope, paint layers were placed in a micro test tube and covered with a few drops of solvent—in hexane, ethyl acetate, toluene and water, successively. Analyte spectra were recorded via FT–IR microspectroscopy, under the same recording conditions as for the pigments.

The chemical compositions of the polished cross-sections of paint layers were additionally examined using a JEOL 5500 LV Scanning Electron Microscope (SEM) equipped with an Energy Dispersive X-Ray spectrometer (EDS), in low vacuum mode (between 10 and 15 Pa) at an accelerating voltage of 20 kV and working distance of 20 mm. X-ray spectra were optimised for quantification via the cobalt optimisation standard, with the correction of EDS data performed based on the standard ZAF-correction procedure included in the INCA Energy software package.

4. RESULTS

4.1. VILLA RUSTICA IN ŠKOLARICE

The colour palette of the wall paintings from the villa rustica in Školarice included red, yellow, green, black and white (Tab. 1). According to stratigraphic analysis of the selected samples, the wall paintings largely consisted of a single paint layer, with the exception of a red layer (ASO7) and green layer (ASO5) under both of which a yellow layer was observed. As recognised under the optical microscope (Fig. 5), the wall paintings were executed using the fresco technique, with pigment applied as a suspension in water onto fresh plaster. Where two paint layers were applied, the underlying yellow colour was applied using the fresco technique, followed by the overlying layer using the secco technique (Fig. 6). Secco painting involves the application of pigments onto dry plaster (or a previously applied paint layer) and as such requires a binding medium in order to attach the pigments to the wall. This binder can be either organic, with pigments mixed with wheat, gums and oils (Corso et al., 2012), or inorganic (lime water), with the latter also known as lime paint (Piovesan et al., 2012) or lime secco (Weber et al., 2009). FTIR analysis of the binder used in the two secco samples revealed the presence of proteins in green sample ASO5 (Fig. 6c) and an absence of organic compounds in red sample ASO7, the latter indicating a lime technique, i.e. painting onto dried intonaco with pigments diluted in a lime solution. The presence of proteins in the green layer, potentially egg, casein or animal glue, might indicate tempera technique (Corso et al., 2012). In both samples the yellow pigment was used as a background onto which the red and green paint layers were applied.

The results of Raman microspectroscopic analysis of the different tonalities of the red paint layers indicated that the pigments used were either a mixture of red (hematite) and yellow ochre (goethite) (ASO3, ASO7), or hematite alone (ASO4) (Tab. 1). Raman bands at 226, 292, 406, and 611 cm^{-1} revealed hematite (red ochre) (Fig. 5b), while bands at 223, 297, 392, 484 and 564 cm^{-1} are indicative of goethite (yellow ochre) (Fig. 6d). The red layer in ASO7, which was applied onto a yellow paint layer comprising yellow ochre and a small amount of red ochre, is mainly composed of red ochre, followed by yellow ochre in small amounts. SEM/EDS analyses showed pigment grains of red pigment to be larger (up to 15 μm) and more abundant in samples ASO3 and ASO7, with those in sample ASO4 very rare and small (up to 5 μm in size). SEM/EDS analyses also confirmed the presence of iron and small amounts of silicon and aluminium. The presence of aluminium impurities in

hematite is quite common and is usually sedimentary in origin. However, highly substituted hematites are rarely found in nature. In contrast, iron hydroxides may contain very high quantities of aluminium and therefore it is common to find highly substituted aluminium hematite resulting from the heating of iron hydroxides (traditional ceramics, bricks, etc.) (Béarat, Pradell, 1997). In addition, the SEM/EDS spectra also reveal the presence of arsenic in sample ASO4, whose silicon and aluminium content is lower than that of the pigment grains found in samples ASO3 and ASO7. The purity of the pigment in this sample (which has not been mixed with any other mineral) and the very fine grain size could indicate the very expensive and desirable caput mortuum pigment, containing naturally occurring hematite (Villar, Edwards, 2005). This pigment origin is further suggested by the presence of grains composed of Ba and S in sample ASO4, as natural hematite often occurs together with barite ($BaSO_4$).

Raman analysis of pigments in the yellow paint layer (ASO1) revealed the presence of major amounts of yellow ochre (goethite) and rare red ochre (hematite), as identified based on the Raman bands at 206, 224, 300, 386, 418, 482 and 551 cm^{-1}, and 226, 292, 406 and 610 cm^{-1}, respectively. SEM/EDS analysis of pigment grains, which are however rather large (up to 50 μm), indicated the presence of iron, as well as small amounts of silicon and aluminium, further confirming the use of red and yellow ochre.

The green layer (ASO5), which was applied in secco on the underlying yellow fresco layer, was found to comprise green earth, based on the identification of celadonite FTIR bands at 3602, 3557, 3533, 1114, 1078, 960, 796 and 680 cm^{-1} (Fig. 6b). The EDS spectrum of the pigment grains show typical green earth elements: Si, Ca, Al, Fe, Mg and K. Green earth, a pigment that consists of the minerals glauconite and celadonite, was considered an "austere" (or "sombre") pigment and was used as a cheaper substitute for malachite. In the Roman period, green earth was found in Verona, Cyprus and Spain (Vitruvius, Pliny the Elder). Considering that »Verona Earth« comprises predominately celadonite and only rarely is glauconite present (Aliatis et al., 2009), this location is most likely the origin of the green earth pigment used in the Školarice wall paintings. The study of green paint layers is often limited to the identification of the generic class "green earth", without specific characterisation of the constituent mineralogical species (Piovesan et al., 2011; Paradisi et al., 2012). In those studies that do undertake such analysis, sometimes both celadonite and glauconite have been identified (Mazzocchin et al., 2004; Fermo et al., 2013), whereas in other green paint layers only glauconite (Duran et al., 2010) or celadonite have been detected (Gutman et al., 2015a).

White paint layer ASO6 contained lime white, based on the Raman bands at 156, 282, 713 and 1087 cm^{-1} corresponding to calcite. Furthermore, the Raman bands at 1315 and 1600 cm^{-1} indicate the use of carbon black in black paint layer ASO2.

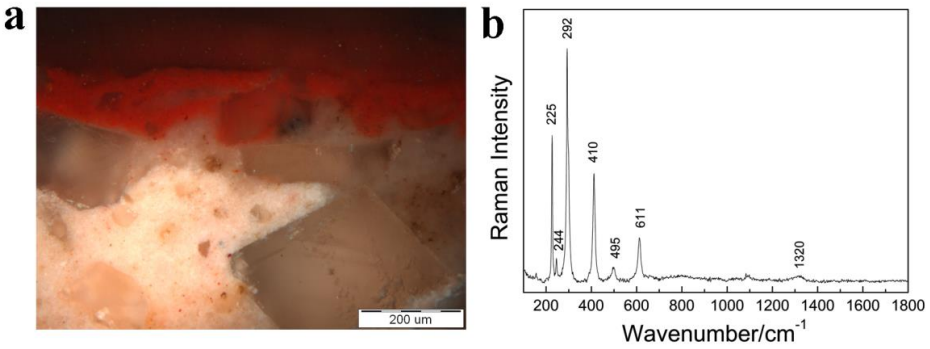

Figure 5. (a) Školarice wall paintings: Photomicrographs of red paint layer applied in secco (reflected light, parallel polars) - sample ASO3. (b) Raman spectrum of hematite.

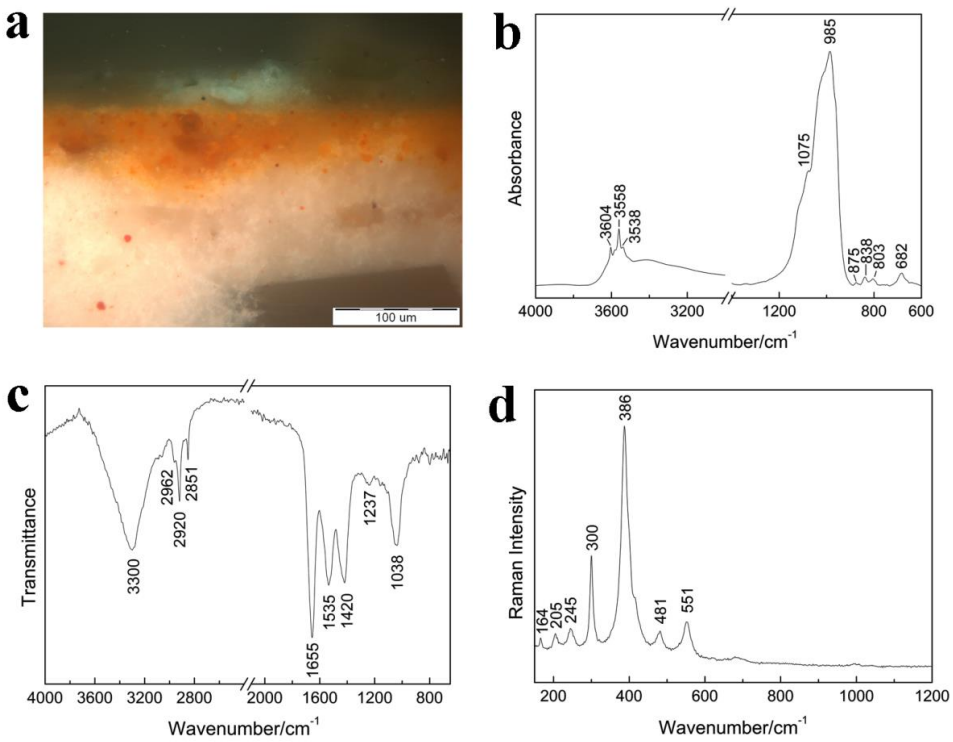

Figure 6. (a) Školarice wall paintings: Photomicrograph of green paint layer with yellow underpaint (reflected light, parallel polars) – sample ASO5. (b) FTIR spectrum of green earth (celadonite). (c) FTIR spectrum of ASO5 paint layer revealing the use of a proteinaceous binder at Školarice. (d) Raman spectrum of yellow ochre (goethite).

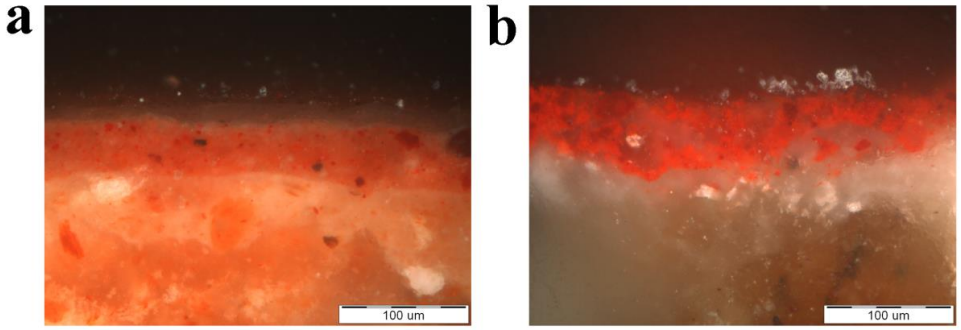

Figure 7. (a) Mošne wall paintings: Photomicrograph of red paint layer in secco technique – sample ANM212 (reflected light, parallel polars). (b) Photomicrograph of red paint layer in fresco technique – sample ANM216 (reflected light, parallel polars).

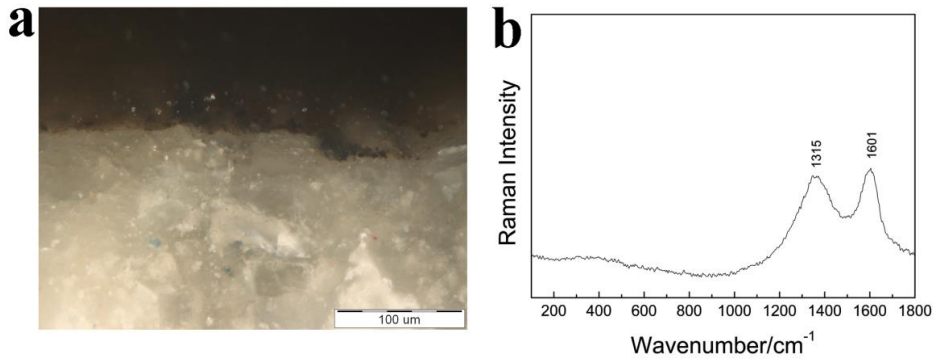

Figure 8. (a) Mošnje wall paintings: Photomicrograph of black paint layer (reflected light, parallel polars) – sample ANM210. (b) Raman spectrum of carbon black.

Table 1. Summary of investigated paint layer samples, their related locations and identified pigments.

Site	Sample	Location	Paint layer stratigraphy	Painting technique	Identified pigments
Školarice					
	ASO1	Secondary context (wall paintings from the thermal area)	yellow	fresco	yellow and red ochre (goethite, hematite)
	ASO2	Secondary context	black	fresco	carbon black
	ASO3	Secondary context	red	fresco	red ochre (hematite), yellow ochre (goethite)
	ASO4	Storehouse	red	fresco	red ochre (hematite)
	ASO5	Secondary context (wall paintings from the thermal area)	green	secco	green earth (celadonite)
			yellow	fresco	yellow and red ochre (goethite, hematite)
	ASO6	Secondary context (perhaps wall paintings from the previous building recognized under the thermal area)	white	fresco	lime white (calcite)
	ASO7	Secondary context (wall paintings from the thermal area)	red	secco	red and yellow ochre (hematite, goethite)
			yellow	fresco	yellow and red ochre (goethite, hematite)
Mošnje					
	ANM207	building 2, caldarium	red	fresco	red ochre (hematite)
	ANM209	building 2, caldarium	black	secco	carbon black (graphite)
	ANM210	building 2, tepidarium	black	fresco	carbon black (graphite)
	ANM211	building 2, caldarium	black	fresco	carbon black (graphite)
	ANM212	building 2, caldarium	red	secco	red ochre (hematite), magnetite
	ANM213	building 2, caldarium	white	fresco	lime white (calcite)
	ANM215	building 2, caldarium	red	secco	red ochre (hematite)
	ANM216	building 3	red	fresco	red ochre (hematite)
	ANM218	building 2, tepidarium	red	secco	red ochre (hematite)

4.2. VILLA RUSTICA IN MOŠNJE

In contrast to that recorded at Školarice, the colour palette of wall paintings at the villa rustica in Mošnje included only red, black and white (Tab. 1). Here a single layer of paint was applied, with both secco and fresco techniques identified. Compared to the Školarice wall paintings in which a secco layer was applied on top of a yellow fresco underpaint, the secco paint layer in the Mošnje wall paintings was applied directly to the mortar layer.

The sampled red paint layers consisted of red ochre (hematite), as identified based on Raman bands at 226, 292, 407, 610 cm^{-1}, with the paint applied either in secco (Fig. 7a) or in fresco (Fig. 7b). It is interesting to note that no goethite was identified in this layer, which could indicate the use of natural hematite. Raman bands at 222, 291, 667 cm^{-1} indicate the presence of magnetite in sample ANM212, although the magnetite grains are rare and most probably associated with hematite grains. SEM/EDS analyses revealed the presence of iron and small amounts of silicon and aluminium, as well as occasional magnesium. Pigment grains are typically very small (up to 10 μm), although larger grains (up to 20 μm) are observed in secco layers. A high phosphorus concentration in the wall paintings could be interpreted as a contamination effect.

As can be seen from Fig. 8, Raman bands at 1315 and 1601 cm^{-1} indicate the use of carbon black for the black paint layer (ANM209, ANM210, ANM211), which was applied either in fresco or in secco. Raman bands at 156, 282, 712, 1087 cm^{-1} for the white paint layers suggest that the white colour was obtained by using lime white (ANM213).

5. DISCUSSION

The pigment palette from the coastal villa at Školarice is slightly larger than that recorded at Mošnje, with yellow ochre and green earth observed in addition to red ochre, lime white and carbon black. These pigments together correspond to the palette described by ancient sources (Vitruvius,

Pliny the Elder), with those from both villas (red and yellow ochres, green earths) belonging to the common earth pigments that, according to Pliny the Elder, were known as "austere" or "sombre". The same pigments were also identified at Emona (Ljubljana, Slovenia), where additional pigment Egyptian blue which was mixed with green earth or red ochre, was also found (Gutman et al., 2015a). However, the expensive pigments, such as cinnabar was found in Roman municipium Celeia wall painting (Ropret et al., 2010).

At Školarice the wall paintings were applied in fresco, with details applied in secco on a yellow fresco underpaint. This technique was also identified in wall paintings at Emona (Gutman et al., 2015a) and Celje (Ropret et al., 2010), while a green layer on yellow underpaint has been recorded in Gallo-Roman wall paintings from Switzerland (Béarat, 1996). In contrast, the wall paintings at Mošnje were applied using the secco technique, which until now has been observed only in brown and grey paint layers at Emona (Gutman et al., 2015a).

Pigment analysis of the wall paintings from the villa in Školarice, which on first view exhibit only mostly modest decorative features, revealed the presence of rare components as well as quite refined technical solutions. The use of a mixture of red and yellow ochre in the red paint layer of sample ASO3 could be explained as an expedient and cheap method of reproducing the effect of cinnabar red, which the obtained tone resembles. Furthermore, the superposition of paint layers of different colours in samples ASO5 and ASO7 represents a sapient solution employed in order to achieve stronger nuances.

It is important to take into consideration the fact that the samples from Školarice refer to different parts of the Roman villa and probably also to different phases. Sample ASO6 was found in the thermal area and is related to a group of wall decoration fragments that are potentially earlier than the villa itself, associated with an older structure the remains of which were recorded under the thermal area and which were later obliterated by villa construction.

Samples ASO1, ASO5 and ASO7 refer to a large group of wall paintings of uniform preparation (with up to five conserved plaster layers), characterised by the presence of crushed ceramics (cocciopesto) in the lower layers. This group is related to the first phase of the thermal area dated towards the middle of the 1st century AD.

Sample ASO4 comes from the storehouse on the upper terrace of the villa, where other similar fragments were also found within rubble layers. These wall paintings potentially relate to later phases, up to the 3rd century AD. As the storehouse is part of the utilitarian area of the villa, the identification of expensive caput mortuum pigment in this sample on the basis SEM/EDS analysis is somewhat surprising.

As samples ASO2 and ASO3 were found within mixed, disturbed layers, it is difficult to define either their original position within the villa or their exact chronology.

From a decorative point of view, the wall paintings at the Roman villa in Školarice were quite modest, especially when compared, for example, with those from the nearby villa of Simonov zaliv on the Slovenian coast (cf. Zanier, 2012). However, it should be taken into consideration that the lower terrace at Školarice was partially destroyed, along with its associated wall paintings. Indeed, the pigments and technical solutions (mixtures of pigments, superposed paint layers, combination of fresco and secco techniques) employed at Školarice nevertheless attest to high standards of execution.

For the owners of the villa, identified as the Tullii Crispini family who were members of the aristocracy of the colony of Tergeste (Sakara Sučević et al., 2015), it was in this early "Romanised" area easy to obtain supplies of both rare components and specialist workers with considerable technical experience in the execution of wall paintings, as the villa was situated in an area where Roman supremacy was established in the 2nd century BC being then part of the province of Illyricum. The area then became part of Roman Italy from 42 BC (the villa is located in close proximity to the anticus auctae Italiae terminus, cf. Plin. HN 3.18.127) and part of Augustean Regio X from 7 BC, with the villa itself belonging to the territory (ager) of the colony of Tergeste. Other sites in the region include those from the late Republican period, as well as several maritime and littoral villas from the very beginning of the Imperial period, which all attest to a very early typically Roman architecture and lifestyle (Stokin, Zanier, 2011).

The pigment palette of wall paintings from the villa in Mošnje included red, lime white and carbon black. The majority of samples (ANM207–209, 211–215) originated from a caldarium and two samples (ANM210, ANM218) from a tepidarium, with both rooms part of a balneum (composed of caldarium, tepidarium and frigidarium) on the west side of the residential building on the east side of the villa. The presence of the caldarium illustrates the high quality of life available in Roman times to residents of what is now the modern-day Gorenjska region, with the floor covered with a black-white mosaic decorated with dolphins and a number of triangular geometric motifs. Besides these two rooms, only the building

near the entrance to the villa was decorated with wall paintings, red on a white surface, from where sample ANM216 was obtained. Although the villa itself was likely built in the 1st century AD, it is possible that the building near the entrance was added some time later. The artist(s) generally used secco as well as fresco techniques, with the paint layer in the first case applied directly to the mortar layer.

The Mošnje villa rustica is one of the earliest known examples in the Gorenjska region, with the majority of Roman villas discovered thus far generally dating from the 2nd to 4th centuries AD. The nearest Roman site, the town of Carnium (modern-day Kranj), was established at the end of the 1st century BC and was contemporary with the Roman town of Emona (modern-day Ljubljana). We presume that the Mošnje villa was built near the road that led to the centre of regnum Noricum, modern-day Magdalensberg in Austria, and belonged to the ager of the colony of Emona, part of Regio X (Šašel Kos, 2002).

The villas in Školarice and Mošnje were probably comparable in size. Although at Školarice a total area of 6136 m^2 has been excavated, structures continue in all directions outside the excavation area; similarly, the villa at Mošnje probably extended to at least 12000 m^2, of which only the northern 6000 m^2 has been excavated. Furthermore, the two villas were both located near to an important road: the villa at Školarice on the Tergeste-Parentium-Pula road (Via Flavia) and the villa at Mošnje on the road to Noricum. Both villas were located within the eastern part of Regio X and were therefore in Roman Italy, with the villa at Školarice within the territory of the colony of Tergeste and the villa at Mošnje within that of the colony of Emona (Šašel Kos, 2002; Šašel Kos, 2010).

Although the wall paintings at both villas are from a decorative point of view quite modest, very clear differences can be seen in the use of pigments and techniques, even if we compare only coeval samples from Školarice and Mošnje. The samples obtained at Mošnje are all from the same period, that is from the first half of the 1st century AD, with theoretically only that from building 3 (entrance) potentially younger. Samples from Školarice that are definitively coeval with those from Mošnje (i.e. dated towards the middle of the 1st century AD) are ASO1, ASO5 and ASO7; any proper comparison should thus take into account only these samples.

In the samples from Mošnje, only red, black and white colours were used, while those from Školarice include red, white, yellow and green. In the Mošnje samples obtained from the thermal area, where wall painting preparation was characterised by intonaco layers containing crushed ceramics, the secco technique was employed, with fragments without cocciopesto made using a combination of fresco and secco techniques (the latter being used only for details). In the coeval Školarice samples, which are also from this villa's thermal area and are likewise characterised by crushed ceramics in their preparation (albeit only in lower mortar layers), a combination of fresco and secco techniques was employed (ASO5 and ASO7, where secco was used for the superposed paint layer). Samples from the villa at Školarice are especially distinctive in terms of the superposition of two different paint layers (red on yellow in ASO7, green on yellow in ASO5) and the mixtures of pigments (for the yellow tone in ASO1 and for the red tone in ASO7).

In-depth analysis of the samples from the two villas has thus enabled the identification of important differences in the execution of wall paintings that might at first seem similarly modest or poor, taking into consideration only their decorative features, with analysis of the Školarice wall paintings revealing a higher level of sophistication. These differences are likely the result of variation in the supply of both materials and specialist workers, reflecting the very different levels of Romanisation of the two areas.

6. CONCLUSIONS

Results showed that the wall paintings from the two selected villae rusticae in Slovenia were executed using the fresco and secco techniques. However, whereas the Školarice paintings were typically painted in fresco, with some areas painted in secco applied on a yellow underpaint layer, the Mošnje wall paintings were largely painted in secco directly onto the mortar layer, with some areas painted in fresco. Red ochre, lime white and carbon black pigments were identified at both villas, although the paintings at Školarice were also characterised by the use of yellow ochre and green earth. Whereas red ochre was the sole pigment used in the red paint layers at Mošnje, red ochre was usually mixed with yellow ochre for both the red and yellow paint layers at Školarice.

The selected analytical techniques enabled the detection of important differences in the execution of wall paintings which are similarly modest from a decorative point of view and which are related to Roman villa complexes that are comparable in chronology, size and topographic location (in the vicinity of important roads), with both complexes also administratively belonging to the eastern part of Roman Italy's Regio X. Analysis of the Školarice wall paintings revealed the presence of rare components

as well as quite refined techniques, while the Mošnje wall paintings are characterised by very basic components and technical features. This variation can be explained by the influence of the specific location on the supply of materials and specialist workers: Whereas on the coast, where the villa of Školarice is situated, the presence of several earlier villa complexes attests to the complete diffusion of Roman architectural standards, in the region interior, higher quality Roman architecture appears first in the towns and then in the countryside.

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