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CHEMICAL ANALYSIS OF WALL PAINTING FRAGMENTS EXCAVATED IN ÁCS-VASPUZSTA

More than 40 samples taken from 25 wall painting fragments were investigated using an optical microscope, chemical analysis, X-ray diffraction, as well as, in some cases, energy dispersive X-ray analysis.¹

The aim of the investigation was the identification and characterization of the pigments and the level-

ling plasters (the intonaco or the upper layer of the intonaco if it has more than one), as well as the study of the plaster structure and the tool marks if any. The data obtained by the scientific investigations could contribute to the archaeological study of the fragments.

Steps of the investigation

The first step was the identification of the pigments or pigment mixtures. In most cases, we used X-ray diffraction for the qualitative analysis. In this way, we could identify the minerals and crystalline compounds present in the samples. The results are summarized in Table 1. The terms used in the table are:

Calcite: calcium carbonate – minerals like limestone and marmor consist of calcium carbonate. The slaked lime in combination with carbon dioxide in the air transforms into calcium carbonate. Sand can also contain some calcium carbonate.

Dolomite: calcium magnesium carbonate – is a mineral (found naturally). The limestone may also contain some dolomite.

Quartz: silicium dioxide – is the main component of the sand.

Hematite: iron oxide – a mineral found in the nature (its well crystalized form is identifiable by X-ray diffraction).

Gypsum: hydrated calcium sulphate – is a mineral found naturally.

Calcium copper silicate: is an artificially produced compound.

For the identification of non crystalline compounds we used either chemical or energy dispersive X-ray analysis, but in these cases we could determine only the elements from which the compounds are composed. Iron was found to be a main component in both red and green samples. In the case of red paint the use of a red clay (containing iron compound as colouring agent), may be supposed. In case of the green colour the so-called green earth (which contains ferrous silicate as the colouring agent) must have used.

The second step of the investigation was the determination of the composition of the levelling plaster. Its analysis can provide important data for the study of the method of execution of the wall painting and for a possible comparison of the fragments on the basis of these results (JÁRÓ 1985, 113–120; JÁRÓ 1987, 285–288). A qualitative X-ray diffraction analysis was conducted, but in every case the amounts of the main components were hinted as well. The results are found in Table 1. The notations used in the table are:

+? – a possible presence of the mineral in the sample,

+ – a small amount of the mineral,

++, +++ – rising quantity of the mineral,

++++ – the mineral is present as the main component in the sample.

For each fragment, the plaster layer/s under the levelling plaster, their number, thickness, colour, roughness, etc., and the tool marks, if any, on the backside or on the surface of the fragments were studied. The results are summarized in Table 1.

*Discussion of the results**The pigments used in Ács-Vaspuszta*

The pigments and pigment mixtures identified on the wall painting fragments of Ács-Vaspuszta are similar to those found on the excavated Pannonian fragments³ or on pieces coming from other Roman provinces (TABASSO 1969, 47–55; GIOVANOLI 1969, 53–60; KOTTULINSKY 1981, 91–92; SCHLEIER-MACHER 1983, 104–110, among others).

White pigments and additives

Slaked lime (transformed by now into calcium carbonate), limestone or marble dust and dolomite flour were used as white pigments. The gypsum identified in some pigments could have been a white additive.

Red pigments

Red clay found naturally, red ochre (well crystallized iron oxide found in nature or made by roasting yellow ochre), cinnabar found naturally – probably coming from Spain, or a mixture of these pigments with each other or with white pigments were used for obtaining red or rose colour on the wall.

Green pigments

Green earth, a natural, green coloured mineral served as green pigment (pure or mixed with white pigment).

Blue pigment

Artificially made calcium copper silicate, the so called Egyptian blue, was identified on the fragments. The quality of the pigments was different: a finely ground, light blue and a roughly ground, deep blue version were used. For obtaining a turquoise colour, green earth was mixed with Egyptian blue.

The levelling plasters

On the basis of the investigation data, three main types of levelling plaster could be differentiated:

A-type: levelling plaster containing a considerable amount of calcite (++++) and a small amount of quartz (+, ++) and in some cases a small amount of dolomite (+?, +, ++) as well. Limestone or marmor dust (sometimes containing a small amount of dolomite) and a small amount of sand were mixed with slaked lime. Limestone or marmor dust can be differentiated from the secondarily formed calcium carbonate (from slaked lime) using a light microscope.

B-type: levelling plaster containing large amounts of calcite (++++), a big amount of quartz (++++, +++) and a smaller amount of dolomite (+, ++). It was made by mixing limestone dust containing dolomite with a larger amount of sand and slaked lime.

Table 1: Result of investigation

Cat. No.	Levelling plaster					Pigment	Layer/s under the levelling plaster	Tool marks
	Composition			Thickness (mm)	Type			
	Calcite	Dolomite	Quartz					
V/1*	++++	+++	++	cca. 1	C	hematite, gypsum, dolomite	one layer with coarse, yellowish sand, the backside is plain	
V/3	++++	+	++	cca. 5	A	hematite?	two layers with rather coarse, yellowish sand (there is practically no difference between the colours of the two layers), rose over-painting on the surface	
V/4 (fig. 1.1) ² upper	++++	+++	+	cca. 2	C	cinnabar, hematite, dolomite	one layer with coarse, yellowish sand, earlier painting under it	
lower	++++		+	cca. 2	A		one layer with fine, greyish sand, the backside is plain	
V/5 green over-painting	+++	++++	++	cca. 0,5	C	iron compound	overpainting, no plaster under the levelling plaster, earlier painting under it	
lower	++++	+?	+++	cca. 1	B		one layer with coarse, greyish sand and bigger particles of slaked lime (or lime), on the backside grey clay and tool marks	concentric prints on the backside
V/8	++++	+	++++	cca. 1	B	iron compound	one layer with coarse, greyish sand and bigger particles of slaked lime (or lime), on the backside grey clay and tool marks	concentric prints on the backside
V/11 red	++++	+++	+	cca. 2	C	hematite, dolomite, gypsum?	one layer with coarse, yellowish sand, the backside is plain	
V/11 rose upper	++++	+++	+	cca. 2	C		one layer with coarse, yellowish sand, earlier painting under it	
lower	++++		++	cca. 2	A		one layer with fine, greyish sand, backside is plain with swelling (tool mark?)	mark from a pointed, triangular tool? (swelling)
V/13 "a" upper	++++		+	cca. 3	A		one layer with fine, greyish sand, earlier painting under it	marks from a pointed, triangular tool on the surface (niches) (fig. 1.2)
lower	++++		+	cca. 1	A		one layer with coarse yellowish sand and bigger particles of slaked lime (or lime), the backside is plain	marks from a pointed, triangular tool (swellings)

* Fragments with catalogue No. beginning with V come from the house No. 1 of the vicus

Table 1 (forthcoming)

Cat. No.	Levelling plaster					Pigment	Layer/s under the levelling plaster	Tool marks
	Composition			Thickness (mm)	Type			
	Calcite	Dolomite	Quartz					
V/14	++++	+	+++	cca. 1	B		one layer with coarse, greyish sand and bigger particles of slaked lime (or lime), on the backside grey clay and tool mark	concentric prints on the backside (fig. 1.4)
V/17 upper	++++	++++	+	cca. 2	C		one layer with coarse, yellowish sand, earlier painting under it	
lower	++++	+	+	cca. 5	A		missing	
V/19	++++	+	+++	cca. 1	B		one layer with coarse, greyish sand and bigger particles of slaked lime (or lime?) on the backside grey clay	
4a/1**	++++	+	++++	cca. 1	B	clay minerals, iron compound	one layer with coarse, greyish sand and bigger particles of slaked lime (or lime?), on the backside grey clay	
4a/2	++++	+	+++	cca. 0.5	B	calcium copper silicate, iron compound, the blue pigment is finely ground	one layer with coarse, yellowish sand	
4a/4	++++	+	+	cca. 5	A		two layers with rather coarse greyish (upper layer) and greyish-yellowish? (lower layer), sand, rose over-painting on the surface	
4a/5	++++	++	++	cca. 2	A		one layer with coarse, greyish sand and bigger particles of slaked lime (or lime?) on the backside grey clay and tool marks	concentric prints on the backside
9/1**	++++	+?	+	cca. 5	A		two layers with rather coarse greyish (upper layer) and greyish-yellowish? (lower layer) sand, rose over-painting on the surface	
9/3 upper	++++		+	cca. 3	A		one layer with fine, greyish sand, earlier painting under it	mark from a pointed triangular tool on the surface (niches) (fig. 1.5)
lower	++++	+	+	cca. 1	A		one layer with coarse, yellowish sand and bigger particles of slaked lime (or lime?), the backside is plain with toolmarks	marks from a pointed, triangular tool (swellings) (fig. 1.6)

** Fragments with catalogue Nos. 4/a..., 9/... and 39... come from the camp

Table 1 (forthcoming)

Cat. No.	Levelling plaster				Pigment	Layer/s under the levelling plaster	Tool marks	
	Composition			Thickness (mm)				Type
	Calcite	Dolomite	Quartz					
39/1**	++++		+	cca. 5	A	two layers with rather coarse, yellowish sand (there is practically no difference between the colour of the two layers), rose over-painting on the surface		
39/2	++++	+	+++	cca. 1	B	one layer with coarse, greyish sand, grey clay on the backside		
39/3	++++	++	+	cca. 3	A	one layer with coarse, yellowish sand		
39/4	++++	+++	++	cca. 4	C	roughly ground blue pigment	one layer with coarse yellowish sand, the backside is plain, tool mark on it	mark from a pointed triangular tool (swelling) (fig. 1.3)
39/5	++++	++	++	cca. 2	A	finely ground blue pigment	one layer with coarse, greyish sand, backside is plain, tool mark on it	mark from a pointed triangular tool (swelling)
39/10 over-painting	++++	+?	+		A			
lower	++++	+	+	cca. 6	A		two layers with rather coarse, yellowish sand (there is practically no difference between the colours of the two layers), rose over-painting (the layers represent two periods??)	
39/11	++++	+?	++	cca. 6	A		two layers with rather coarse, yellowish sand (there is practically no difference between the colours of the two layers, rose over-painting (the layers represent two periods??)	
39/12	++++	+?	+	cca. 6	A		one layer with coarse, yellowish sand, the backside is plain, red-rose overpainting	

** Fragments with catalogue Nos. 4/a..., 9/... and 39/... come from the camp

C-type: levelling plaster containing a big amount of calcite (++++), a considerable amount of dolomite (+++, +++) and a small amount of quartz (+, ++). Dolomite flour (or limestone and dolomite flour) and a small amount of sand were mixed to make this type of plaster.

The groups described above do not insure that differentiation is sure (from the points of view of dating,

workshop, master, etc.), because, for instance, the painter could mix various amounts of sand with the limestone dust and slaked lime during the decoration of the same room or house. But, of course, it could have been the special technique of the painter as well. The use of dolomite flour instead of (or besides) the limestone or marmor dust could mark a difference because it means that the painting material came from

a different source. In spite of that, we can not exclude that both of the materials (limestone dust and dolomite flour) were used at the same time for the painting of the same building because the difference in composition was not known to the Romans. In Pannonia, dolomite was in widespread use not only for making levelling plasters (JÁRÓ 1985, 113–120), but probably also as a white painting material. Among the raw pigments found at Baláca (B. THOMAS 1964; JÁRÓ-KRISTON 1987, 763–764) there were also two fragments (ballshaped) made of dolomite.

Observations completing the material investigations

Layers under the levelling plaster

The thickness, colour and quality of the plaster layer/s supporting the levelling plasters vary in a great deal.

In some cases, fine, sieved, greyish coloured sand was mixed with the other components of the plaster. In other cases, the same sand was probably used but without sieving (or a rougher sieve was used). This plaster is also greyish, but it contains bigger pieces of gravel and in some cases white particles or lime or not transformed slaked lime. For making other plasters, yellowish sand was used, sieved or without sieving. In most of the plasters we can find imprints of vegetable fibres.

Tool marks

On the backside of some fragments concentric prints can be observed with the remains of a greyish clay. These are probably the marks of a handheld tool which served in stamping the surface of the still wet mud wall and so preparing it for painting. The uneven surface obtained in this way assured a better adhesion of the plaster to the wall. The marks of a same type tool were observed on the backside of a Roman wall painting discovered in Tăc (Gorsium).⁴

On the surface (as niches) and on the backside (as swellings) of some fragments, the marks of a pointed, triangular tool can be seen. This tool was probably used for making the plain surface of the old painting or plaster ready for holding the new plaster layers (such a tool is still in use today for the same purpose).

Some remarks concerning the relative chronology of the fragments on the basis of the investigation

In the following part some possible examples for the use of the investigation data are given.

Two, very similar fragments are registered, one from the camp (9/3) and one from the house No.1 of the vicus (V/13"a"). Both of them represent probably 4 periods of painting on the same wall. The first painting no longer exists. Its place is marked only by the tool marks on the backside of the fragments. The swellings mean that the previous (the first?) plaster

layer was prepared for the new one using the already mentioned triangular tool (fig. 1.5). The new, wet plaster filled the niches made by the tool. This plaster layer was covered with a mixture of white limestone dust, slaked lime and a small amount of sand (A-type levelling plaster). On one of the fragments (9/3) it was painted black. During the re-painting of the wall (3rd period) a thin plaster layer was applied first, made with greyish, fine, probably sieved sand (in the 2nd period yellowish sand was mixed to the slaked lime). The levelling plaster covering it is of a thin A-type. In both cases the surface of the fragment is white, and we can see the marks of the triangular tool (fig. 1.6). It means that the wall was repainted again – or prepared for the re-painting.

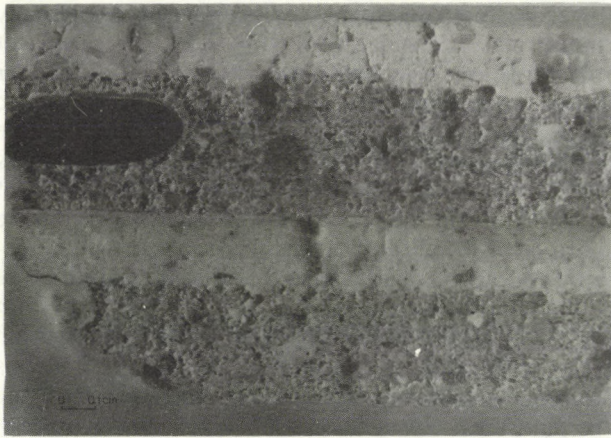
Two fragments coming from the vicus (V/4 and V/11 rose) represent 3 periods of painting of the wall they come from. The preparation of the still existing lower painting is very similar to that of the upper ones (3rd period) from the above-mentioned fragments (greyish, fine sand mixed with slaked lime for the plaster itself and a thin A-type levelling plaster). The backside of the fragments is flat showing that they covered an already existing plaster (fig. 1.1). On the backside of the fragment V/11, a swelling was probably caused by the plaster penetrating into the niche made by the already mentioned triangular tool. This earlier painting could have been a similarly prepared one as in the case of V/13"a" or 9/3 the 2nd period painting. When the wall was re-decorated, a plaster layer made with yellowish, coarse sand was applied first. It was covered with a C-type levelling plaster made with dolomite flour.

The dolomite appears on three other fragments coming from the house No.1 of the vicus (V/1, V/5 and V/17) and from the camp (39/4) as well. Three of these fragments (V/5, V/17 and 39/4) surely represent two periods: on V/5 a thin white and green layer covers part of the surface, the swellings on the backside of the fragment 39/4 are of an earlier painting. On the backside of the fragment V/17, we can still see the levelling plaster of the earlier painting.

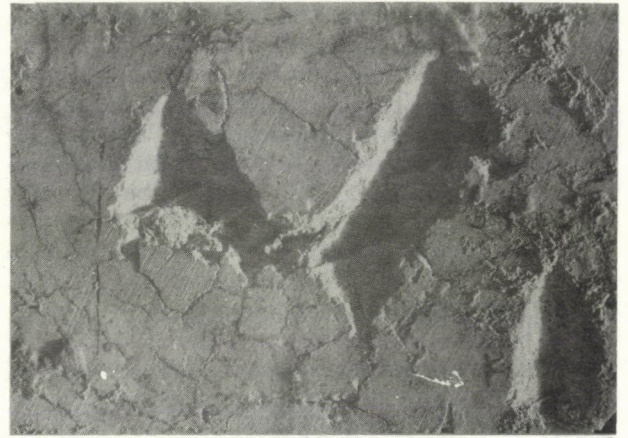
The backside of the fragment V/1 is plain which means that it covered a wall or more probably an earlier painting. The dolomite flour was used in all these cases during the re-decoration of the wall.

In the case of the above mentioned V/5 fragment, the C-type levelling plaster (made with dolomite flour) directly covers that of the earlier painting (B-type made with a considerable amount of sand). On the backside of the fragment concentric prints and greyish clay can be observed. Therefore, the building with mud wall was constructed earlier than the time when the dolomite flour came into use.

More investigation data, for instance the determination of the plaster composition (quantitative analysis), trace element analysis of the pigments, etc. could yield other information for dating and provenance study as well.



1



2



3



4



5



6

Fig. 1 1: Cross section of the fragment V/4; 2: Niches made by a triangular, pointed tool on the surface of the fragment V/13'a"; 3: Swelling on the backside of the fragment 39/4. The wet plaster filled the niche made by the pointed, triangular tool on the surface of the earlier painting; 4: Concentric prints on the backside of the fragment V/14. Tool marks of a stamping tool (?) probably used for the preparation of the mud wall for painting; 5: Niche on the surface of the fragment 9/3; 6: Swellings on the backside of the fragment 9/3

Notes

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- 2 József Rosta is thanked for the photos
- 3 Not published data on wall painting fragments coming from Tăc, Baláca, Aquincum, Pécs and Sopron
- 4 I am grateful to Mrs Judit Bakay-Perjés for the information

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