Exploring High-Baroque Stucco: Microscopy of Materials and Techniques at Kroměříž Chateau

ITAM ARCCHIP
INSTITUTE OF THEORETICAL AND APPLIED MECHANICS
Czech Academy of Sciences

in collaboration with:
UNIVERSITAS JAGELLONICA CRACOVIENSIS
Palacký University Olomouc
Scuola universitaria professionale della Svizzera italiana SUPSI
UNIVERSITÀ DI TORINO

Sylwia Svorová Pawełkowicz [a*], Jan Válek [a], Petr Kozlovcev [a], Kristýna Kotková [a], Dita Frankeová [a]

a. Institute of Theoretical and Applied Mechanics, Czech Academy of Sciences, (Prague), Czech Republic

*Contact email: svorova_pawelkowicz@itam.cas.cz

Abstract

This study examines the materials and techniques employed in the high-baroque stucco decorations of *sale terrene* at Kroměříž Chateau, Czech Republic, executed by renowned Baldassare Fontana (1661–1733) and his workshop. During the early modern period, artists and craftsmen from the Lake Lugano region and the surrounding areas along the present-day Italian-Swiss border—encompassing Canton of Ticino and Lombardy—developed a remarkable expertise in stucco decoration. These skilled artisans travelled across Central and Eastern Europe, completing prestigious commissions to adorn noblemen's palaces.

Kroměříž in Moravia was the seat of the bishops and archbishops of Olomouc at that time. Bishop Karel von Lichtentein-Castelcorno, a notable supporter of high artistic quality, was responsible for the construction of the monumental Archbishop's Château (UNESCO Heritage Site) in its present form after the end of the Thirty Years' War. The Château was built in 1688 according to the plans of the architect Giovanni Pietro Tencalla (1629-1702).

The first documented stay of B. Fontana and his workshop in Moravia dates back to 1688[2]. The stucco decoration of *sale terrene* in the château in Kroměříž was executed most probably in 1688-1693.

Employing advanced methods such as a combination of thin section microscopy, scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS), thermal analysis (TA), and X-ray diffraction (XRD), the study provides insights into the stratigraphy and composition of the stucco layers. It also sheds light on how artisans adapted their techniques to local materials while maintaining high artistic standards.


Sala terrena. Château in Kroměříž. ®PM.

General information about stucco technique

Supporting structures/armature

Different kinds of supports were used, such as brick, stone, wooden structures and metal. Iron bars called „*virgelle*" were covered with textile.


Cavallasca, Oratorio Imbonati. ® JV. Cavallasca, Oratorio Imbonati. ® JV. Cavallasca, Oratorio Imbonati. ® SP. Cavallasca, Oratorio Imbonati. ® SP.

Mortars/plasters

I - core mortar, a modelling layer composed of gypsum or gypsum-lime binder and coarse sand;
II - fine plaster executed with high calcium lime and fine sand.

Cavallasca, Oratorio Imbonati. ® SP. Cavallasca, Oratorio Imbonati. ® SP. Bissone, Chiesa San Carpoforo. ®JV. Bissone, Chiesa San Carpoforo. ®JV.

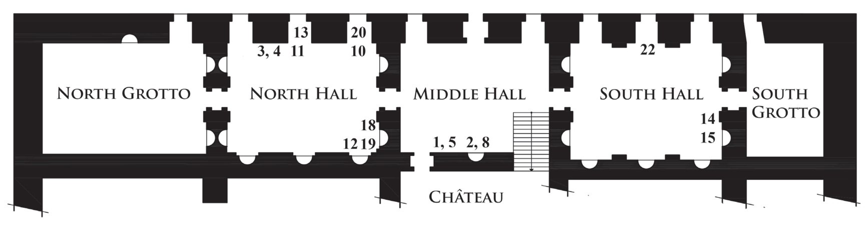
Final appearance/ finishing touches

III - finishing layers may vary substantially. They usually consisted of a whitewash, and sometimes a paint layer but this does not have to be the rule.


Cabbio Casa Cantoni. ®JV. Cavallasca, Oratorio Imbonati. ® SP. Cavallasca, Oratorio Imbonati. ® SP. Carona, Santa Maria d´Ongero. ®JV.

Sampling

Samples were selected from positions where an earlier damage occurred making it possible to assess the stratigraphy of layers. The sampling positions were carefully documented. Three types of stucco decorations are represented by the sampled set; **stucco relief sculptures, high relief garlands, and low relief decorative panels on the walls**,



Layout of the ground floor halls and the position of samples.

Three subgroups based on aggregate

Very pure, highly calcitic lime binder was determined in all samples and its source is linked to the Devonian limestone deposits near Přerov[3]. The binder is composed of 90 wt. % $CaCO_3$; magnesium, silica, alumina, and iron impurities were minimal.

The samples from the stucco layer do not differ in the type of binder, but can be divided into subgroups based on their different aggregates.

In the first subgroup (I) a typical siliciclastic aggregate composed of quartz grains, feldspars (albite), dark micas (biotite) and accessory opaque minerals was identified. The shape of the grains is irregular, sharp-angled, and often cracked.

In the second subgroup (II), in addition to the main siliciclastic component of the aggregate, significant amounts of marble clasts are present in samples STK 8, 10, 11, 15 and 20. These are sharp-angled, irregular fragments of coarsely crystalline marble with frequent twinning of grains. The marble fragments differ in grain size from the siliciclastic ones present, which may indicate separate production and sieving of these two aggregates.

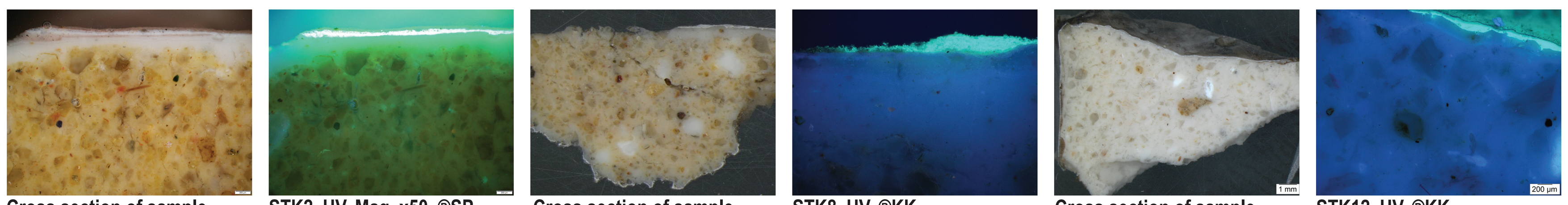
In the third subgroup (III), crushed marble has replaced siliceous sand. These are samples of the leaves decorating the niches in the North Hall.

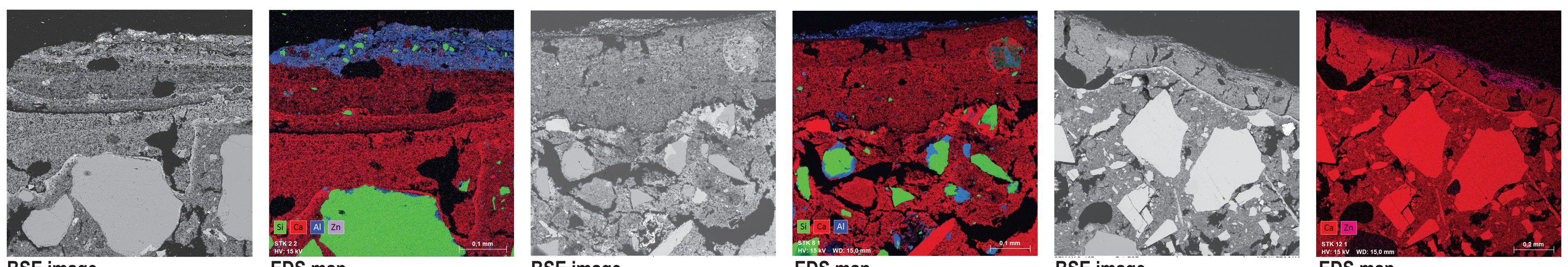
The marble in the stucco finishing layers was produced by crushing a metamorphic limestone that differs from the fine-grained Devonian limestone used to produce lime and even more from the Jurassic limestone of Kurovice[3] . The exact origin of this limestone has not been identified. However, similar marble was quarried in Nedvědice in Southern Moravia–a location that was well known to the estate, as marble for architectural elements and sculptures was obtained there.

Extraction site of sample STK 2 and 8. ®JV.

I *Subgroup – siliciclastic aggregate*	II *Subgroup – mainly siliceous sand, and crushed marble is a minor component*	III *Subgroup – mainly crushed marble, and siliceous sand is a minor component*
STK 1, 2, 3C, 4 and 5	STK 8, 10, 11, 15 and 20	STK 12, 18, and 19


Extraction site of sample STK2. ®PM. Extraction site of sample STK8. ®JV. Extraction site of sample STK12. ®JV.


Cross section of sample STK2.®SP. STK2. UV. Mag. x50. ®SP. Cross section of sample STK8.®KK. STK8. UV. ®KK. Cross section of sample STK12.®KK. STK12. UV. ®KK.


BSE image. EDS map. BSE image. EDS map. BSE image. EDS map.

Relief sculptures

STK 3 - Section of the putto's forearm

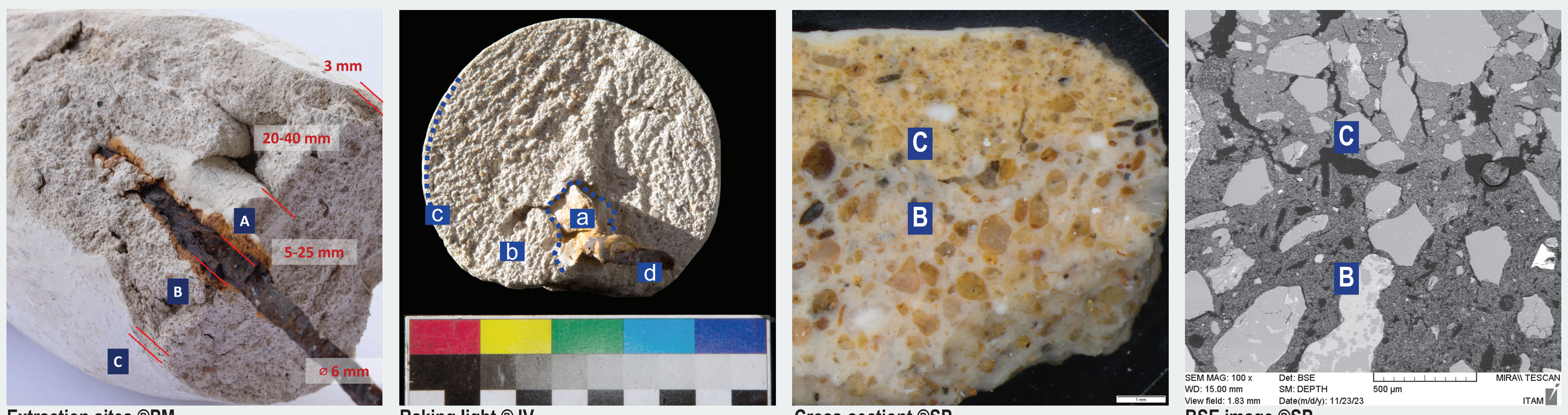
As the result of extreme damage, where part of the forearm of a putto was separated from the remaining torso due to corrosion of the internal supporting element, it was possible to study the construction of relief sculptures.

By studying the stratigraphy of the putto's broken forearm, it was possible to infer the construction sequence of this relief sculpture. The detached stucco fragment was about 8 cm in diameter and had an iron skeleton element (forged roughly to 4 x 6 mm) encased in a gypsum layer of variable thickness of 4 to 15 mm. A sample of this material was labelled STK 3A. This layer was clearly distinguishable from the subsequent layer, as there was a 'cold joint' between them—in some areas the two layers were not fully bonded. This indicated that the next layer was applied after the first had set. The second layer was between 10 and 40 mm thick. It consisted of several sub-layers that were very well bonded and not easily distinguishable, thus it was considered one material for the analysis. The sample of this layer was denoted STK 3B. A third layer was the final stucco layer. It was approximately 4 to 6 mm thick and was distinguishable by a finer structure (aggregate). The sample of this layer was labelled STK 3C.

The skeleton of the relief sculpture is made of forged iron. The first layer composed of gypsum mortar with a very low amount of lime, was applied directly onto the iron. This layer served as a bonding bridge between the iron and the core modelling mortar, which significantly stiffened the entire skeleton. While this hypothesis cannot be verified through material analysis, the mass of the successive layers suggests that a solid base was absolutely necessary. The main body mass was modelled in layers until he desired shape and proportions were reached. The layers were not regular but were very well bonded; their interfaces were visible only in some sections. This indicates wet-on-wet application until the body part was completed in a single stage.

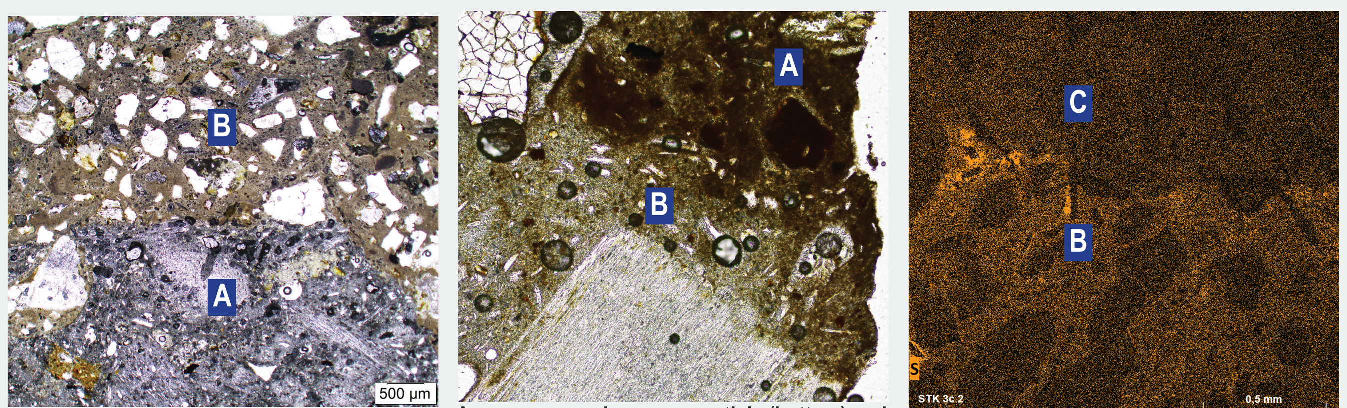
Results obtained by thermal analysis (TA) and X-ray diffraction (XRD) are in agreement (see Table 1 and 2). The gypsum content is greater in the core layer than at the surface of the stucco decoration. Additionally, TA indicated the presence of an organic compound. Traces of collagen (animal glue) and ovalbumin (egg) were identified by nano-LC-TimsTOF in the core mortar layer.

The stucco was finished with a white limewash coating applied in several (1-3) thin layers.



Extraction sites ®PM. Raking light ®JV. Cross-sectiont ®SP. BSE image ®SP.

Legend:
a – gypsum layer,
b – core mortar,
c – finishing stucco,
d – forged iron bar.



Transition between a lime-gypsum core mortar with a quantity of silica aggregate (upper layer) and a greyish coloured gypsum layer containing gypsum particles of varying degrees of processing (lower layer). Sample STK 3 A/B, PPL. An unprocessed gypsum particle (bottom) and cracked quartz grains of the aggregate (top). In the upper right corner, brownish to rusty discolouration of the matrix due to contact with the iron reinforcement. Sample STK 3 B, PPL. Sulphur EDS map.

Coatings:

The first coat of paint on the stucco was a limewash which typically consisted of two to three application layers. The transitions between these application layers were barely perceptible with both the optical and electron microscopes, indicating that the craftsman applied multiple layers of limewash wet-on-wet. Clear difference in luminescence in UV light was noted between the first limewash and the subsequent coatings composed of limewashes and paint layers. There are distinct morphological differences between the first and successive limewashes, the latter exhibiting more pronounced vertical cracks and weaker adhesion.

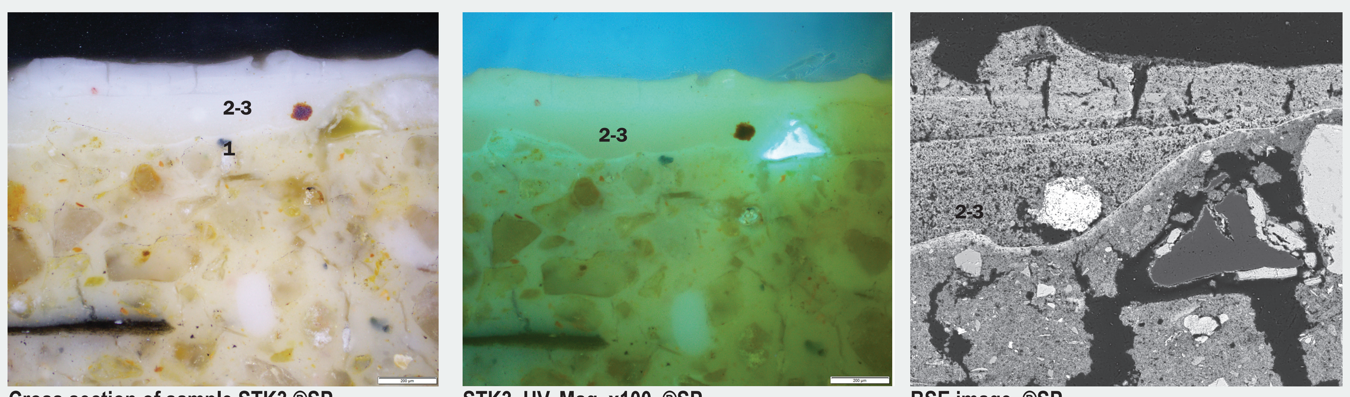
Table 1. Composition of the mortar in wt %. Based on XRD results.

Sample	Quartz	Calcite	Muscovite	Gypsum	Albite	Amorphous
STK 3C (top layer)	8.9	80.9	-	8.0	2.2	*
STK 3B (midlayer)	4.0	51.8	-	44.2	-	*
STK 3A (bottom layer)	2.1	8.6	0.1	76.9	-	12.4

* it was not determined due to the small amount of material

Table 2. Composition of the mortar in wt %. Based on TA results.

Sample	weight loss (%wt)					
	50-200°C	200-600°C	600-950°C	$Ca(SO_4)_2 \cdot H_2O$ (%)	$CaCO_3$ (%)	Remarks
SPH1	0.84	4.22	34.88	4.0	79.3	organic cp.
STK 3A	17.35	1.22	3.64	81.8	8.3	organic cp.
STK 3B	7.61	2.95	23.33	33.3	53.0	organic cp.
STK 3C	2.39	3.36	29.65	7.9	67.4	organic cp.



Cross section of sample STK3.®SP. STK3. UV. Mag. x100. ®SP. BSE image. ®SP.

Table 3. Cross section description.

No	Description
1	plaster
2	original whitewash
3	original whitewash
4	secondary whitewash
5	secondary whitewash
6	secondary whitewash
7	paint layer or dirt deposit

Conclusion

The stucco decoration of the Ground Halls at the Kroměříž Château was described by means of material analysis of a number of samples obtained to represent the major plasterwork features. The study confirms that the stuccowork was carried out according to the generally accepted technique of the time, including the use of gypsum, forged iron reinforcement, and multilayer application and provides details about the composition of the materials used.

The presence of crushed marble in certain decorations suggests recipe changes and indicates a multi-phase construction process possibly extending beyond Fontana's supervision.

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Photocredits
JV - Jan Válek, SP - Sylwia Svorová Pawełkowicz, PM - Peter Majoroš, KK - Kristýna Kotková.

Co-funded by the European Union

Acknowledgements
This research was carried out within the project STUCCO DECORATION ACROSS EUROPE, ID 2022-1-CZ01-KA220-HED-000085652.