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Results of the scientific characterization of stucco decoration

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Results of analyses of stucco decoration by B. Fontana compared to other artisits from Ticino



medium

coarse very coarse

40.00

fine

very fine

Research question

How the stucco decorations by B. Fontana were made?

Which materials have been used?

Did Fontana always use the same techniques and materials in the different case studies in Ticino and abroad? Is it possible to provide new elements to attribute some undocumented decorations to Fontana?

Did Fontana use the same technique as the other plasterers from Ticino or did he develop his own?



Stucco has a very heterogeneous composition and is therefore a complex material to study





Mortar is a very interesting material for study because it is a source of so much different information

the European Union



Mechanism of deterioration

Mortar mix design for restoration

Absolute dating of structures

Lime technologies





Carbonation of lime forms different minerals depending on the composition of the former rock and the reaction conditions



Portlandite Ca(OH)2



Hydromagnesite Mg5[OH)2/(CO3)4] • 4H2O



Calcite CaCO3



Nesquehonit Mg(CO3) • 3H2O



Magnesite MgCO3



Landsfordite Mg(CO3) • 5H2O



Brucite Mg(OH)2



Artinit Mg2[(OH)2/CO3] • 3H2O



Gypsum stone





Treatment for gypsum stone to prepare gypsum binder





T> 150°C



Temperature treatment

Range T	Mineral	Chemical formula	Use in architecture
105-135°C Atm >1 bar Wet	Bassanite	CaSO ₄ *1/2 H ₂ O	Fast setting binder
120-180°C Dry	Bassanite	CaSO ₄ *1/2 H ₂ O	Slow setting binder
140-200°C	Soluble Anhydrite	CaSO ₄	Metastable
>360°C	Unsoluble Anhydrite	β -CaSO ₄	
1180°C	High temperature anhydrite	α -CaSO ₄	



Hemi-hydrate + water form gypsum

Hemi-hydrate CaSO₄ *1/2 H₂O

 $+ H_2O$

Solution

 Ca^{++} $SO_4^{=}$

Precipitation

gypsum $CaSO_4 * 2 H_2O$

Solubility in water = 10 g/l



Solubility on water = 2 g/l



Aggregate is a river sand



Fotografie di Roberto Bugini

Aggregates form the skeleton of the mix. They are generally natural sands, theoretically inert, with a maximum size of less than 4-8 mm.



Properties of aggregate



Grain shape and texture, grain size distribution, percentage of fine elements and voids characterize aggregates



Introduction to material analyses for stucco characterization



The internal support structure - rX Radiography





PLM and SEM to characterize the fibres













PLM Petrographic characterization of mortars





Artistic techniques



Fresco su fresco



BRP of lime and gypsum





FT-IR can identify the presence of gypsum and lime



Mg-phases not always distinguished Binder and aggregate are mixed



SEM-EDS higher magnification and chemical analyses of the binder







Crystal morphology





SEM-EDS mapping





TG/DTA can quantify the lime/gypsum ratio



Binder and aggregate are mixed



Results of Fontana's stucco artworks



Baldassarre Fontana (Chiasso, 1661-1733)





Bas reliefs



Architectural decoration

Baldassarre Fontana was one of the most important plasterers from the Lombardy-Ticino lake region

Tridimensional elements



Case studies in Ticino



Chiesa San Giovanni, Morbio Superiore, 1701, attributed to Fontana by M. Karpowicz

Casa Cantoni, Cabbio attributed by stylistic considerations. Beginning of 18th C.



Case studies in Czech Rep



Holy Hill, Olomouc, 1722-1731



Sala terrenas Archbishop Castle, Kroměříž (CZ)





Church of San Giovanni Evangelista, Morbio Superiore



Casa Cantoni, Cabbio (CH)



Internal structure: wood

Ground layer: Binder is Mg-lime and low gypsum content. B/A=1:1. Aggregate: river sand selciferous limestone.

Finishing layer: lime with frequent BRP, sporadic fragments of calcite and quartz. Casein in one sample.



Uherčice Castle, 1692-1696 (CZ)



(Medea Uccelli et al, 2022)



Uherčice Castle, 1692-1696 (CZ)



Ground layer: clear beige colour. Binder: mix of lime and gypsum. Heterogeneous aggregate, river sand, Impure lime > Mg%. B/A= 1,5:1.

Finishing layer: white colour, lime and fine homgeneous aggregate. Collagen in 2 samples.



Mix of binder



Lime:gypsum=1:1
Ground layer

	100–180 °C	180–600 °C	600–850 °C	CaCO ₃	CaSO₄.2H₂O
SUHE 1b	0.41	4.62	37.42	85.0	0.0
SUHE 2b	0.90	4.40	32.40	73.6	4.3
SUHE 3b	0.49	3.72	26.94	61.2	0.0
JUHE 1b	4.10	3.20	24.30	55.2	19.5
JUHE 2b	6.93	2.92	17.21	39.1	33.0



The Holy Hill Church Olomouc, 1722-1731



Ground layer: Binder with lime and low gypsum content. B/A=2:1. Aggregate: river sand (heterogeneous composition) and brick fragments.

Finishing layer: lime and fine, well sorted homgeneous aggregate.



Archbishop Castle, Kroměříž

Bas reliefs



Ground + finishing: deteriorated area
 Finishing: sound area



Tridimenstional elements



Frames of the niche



5. Ground + finishing: deteriorated area

4. Core mortar deteriorated areaV1-V2. Ground + finishingV3. Core mortar

Bas relief – inner layers



Finishing layer Kr_sta_SF_02

Binder: homogeneous, clear beige. Porous lime lumps of small and large surface. No underburned nor over burned. **Mineralogical composition:** lime and rare trace of gypsum (one residue).

Pores: High porosity. Most of porosity are elongated shrinkage cracks
B/A= >>1

Aggregate

Grain size: fine and very fine, medium sand subordinated Dimension (MGS): 0,3 mm Sorting: well sorted Roundness: sub-angular, sharp edge Mineralogical composition: quartz in single crystal, plagioclase, feldspar, polycrystalline quartz, siliceous rock fragments, iron oxides, cherts.



Bas relief – surface finishing









Bas relief – surface finishing





Kr_sta_SF_01



Tridimensional elements – core mortar and iron bars



BRP of gypsum, no anhydrite

Tridimensional elements – core mortar and iron bars



Co-funded by the European Union

Tridimensional elements – Layers





Tridimensional elements – surface finishing







Bas relief stucco of the frame



kr_sta_SF_05



Conclusion

- Fontana adapted his modus operandi during trips across the Alps.
- All high relief stuccos consist of several layers.
- The core mortar is used only for the tridimensional elements. It is in contact with the iron bar and it is made of gypsum and not sorted silicate sand.
- The ground layer is always present and applied in several wet layers. It is a mix of lime and gypsum mortars. The sand has medium-low sorting, mainly of silicate composition with frequent iron oxide, rock fragments.
- Substantial differences emerge in the realization of the finishing layer. In the Czech Republic
 it is a thick layer of lime with significant quantities of well-selected fine sand, in Ticino
 stuccoes the finishing layer is composed almost exclusively of lime. This difference in
 composition is not attributable to differences in raw materials availability.
- In one sample the finishing layer is different and with the use of marble powder, never found before in the stuccoes made by B. Fontana.
- An important limitation are the few cases of stucco decorations by Fontana in Ticino, which
 prevent a more in-depth study of his work at home.



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Thank you for your attention

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