MOSAIC MORTARS – WHY AND HOW WE STUDY THEM?

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Pavla Bauerová vystudovala geologii na Přírodovědecké fakultě v Praze. K materiálovému průzkumu mozaik se dostala díky mozaikovým kurzům restaurátorky Magdaleny Kracík Štorkánové. V současné době pracuje ve Fyzikálním ústavu AV ČR a dálkově studuje doktorský program na Stavební fakultě ČVUT v Praze. V rámci studia se zabývá výzkumem podložních malt a spárovacích hmot historických mozaik. Je členkou Art a craft Mozaika z.s.

In the course of time the status of modern mosaics (e.g. late 19th and 20th century) is shifting from contemporary artworks to historic monuments. Since they have not been considered "enough historic" so far, quite low attention has been drawn to them and their conservation. Thus little is known about their materials composition and degradation processes. The lack of information concerns not only the materials of tesserae but also fixing mortars and mortar beds. To our knowledge a systematic comparative research into materials characterization of mosaic mortars and their interactions with the tesserae and environment (salts, moisture) has not been carried out. This paper presents the first steps of an attempt to characterize and compare mortars of mosaics ascribed to an Innsbruck mosaic workshop Neuhauser found in 1877 [1]. The goal of the study is to find out whether there could be any common features in the mosaic mortars studied which could alternatively be used as "fingerprints" characteristic for Neuhauser´s mortars. At the same time the paper points out fulfilling this goal will be a long-term process requiring an international and interdisciplinary cooperation.

The five mosaics studied at at the first stage of the research come from the turn of 19th and 20th century, are situated in different places and are mostly parts of sepulcher decoration. Their overview is given in Table 1. The mosaic Resurrected Christ from Peluněk sepulcher in Malvazinky Cemetery in Prague is mentioned in archival documents of the Tiroler Glasmalerei/ Neuhauser Company and its Innsbruck origin is therefore certain. The rest of investigated mosaics situated in Prague have been ascribed to the same workshop based on art historic research and stylistic similarities [2]. The Pfeiffer-Kral mosaic was originally also considered to have been made by Austrian mosaicists from Neuhauser [3] but now it seems its origin is different (unknown). Yet its mortar bed was included into our study. These mosaics are discussed in Mag-

sample identification	monument	location	date of origin
PB1702	Sladkovský sepulcher	Olšany Cemetery, Prague, Czech Republic	around 1884
PB1706	Beneš sepulcher	Olšany Cemetery, Prague, Czech Republic	before 1900 (1886?)
PB1707	Peluněk sepulcher	Malvazinky Cemetery, Prague, Czech Republic	around 1900
PB1708a	Pfeiffer-Kral sepulcher	cemetery, Jablonec nad Nisou, Czech Republic	early 20th century
PB1709	Madonna, now a cemetery wall, originally in an interior and then on the façade of a parish office	Reith bei Seefeld, Austria	around 1906

Table 1. Overview of samples studied.

dalena Kracík Štorkánová´s paper. The Madonna from Reith bei Seefeld (Fig. 1) was made by Josef Pfefferle (1862-1939) around 1906 [4]. He had been working for Neuhauser since the company´s foundation but in 1900 he established his own mosaic workshop [1].

The mortars were studied by common analytical methods - optical microscopy to see the microstructure, scanning electron microscopy (SEM-EDX) to determine the microstructure and chemical composition, thermal analysis (DTG) to characterize a type of mortar binder. For some samples Fourier transformed infrared spectroscopy (FTIR) was employed to identify and extracted organic compound. Apart from instrumental analyses we performed classical HCl dissolution tests to calculate the aggregate/binder ratio. Mineralogical composition of the aggregates was studied by x-ray powder diffraction (xrd). All the employed methods are invasive and some of them destructive, e.g. a small sample has to be taken out and processed further, in case of HCl tests it is eventually destroyed.

The results confirmed a close similarity of the three mosaic mortars from Prague (Fig. 2). According to thermal analysis (Fig. 3), their binders contain hydraulic compounds and surprisingly also a large amount of unreacted portlandite Ca(OH)2. This implies an incomplete carbonation unexpected in mortars of this age. In two of three samples (PB1706, PB1707), the presence of portlandite was confirmed by xrd. Moreover, all of these mortars contained an organic compound identified by FTIR as stand oil or aged linseed oil. The compound was extracted from the mortars with chloroform. Its amount was quite high – 3 – 6 wt%.The FTIR spectra fit very well with the reference spectrum of stand oil. The identification seems to be very probable but still needs confirmation and a more accurate quantification by some other methods. The presence of an oily substance (linseed oil) explains the high portlandite content as linseed oil has been proved to inhibit the carbonation process [5].

According to DTG the Pfeiffer-Kral mosaic mortar (PB1708a) as well as the mortar of Madonna from Reith (PB1709) seem to be lime mortars as there are no significant peaks indicating the presence of hydrated calcium silicates or calcium aluminates in the range 0 – 200°C. However, in the PB1708a sample ceramic shreds can be clearly identified in a light microscope. The presence of element such as Al, Si, Mg, Ca, Ti, Fe, K and O revealed by SEM-EDX corresponds with the xrd results (identification of feldspars apart from quartz and hematite) as well as previous results reporting the presence of clay minerals [3]. But it must be noted no clay minerals were detected by xrd in our study. Anyway, due to the presence of ceramic shreds this mortar differs from the rest of samples where no such particles were observed.

The last mortar bed from Reith made by Josef Pfefferle is also different from the three Prague samples. It is a lime mortar with only 5 wt% of aggregates. Xrd analysis confirmed only quartz as an aggregate compound but microscopic observations suggest there might be also other minerals.

To conclude, materials research proved the similarity of three of five samples studied. However, these first results need to be confirmed or supported by additional experiments. It is a matter of future research to find out whether the similarity of the three Prague mosaic mortars and especially the presence of linseed oil is a coincidence or an intentional technological feature and whether the mortar beds were prepared in Innsbruck at all or later in Prague by a local engineering company. Josef Pfefferle´s lime mortar from Reithalso arises questions. Did he use lime mortar because the mosaic was originally supposed to be in an interior [6]? (Lime mortars have worse mechanical properties than hydraulic mortars.) Or has he always preferred this type? Was there any standardised procedure of mortar bedding in Neuhauser Company? Will it be possible to find some Neuhauser fingerprints at all? To answer these questions long-term investigation and more samples from other mosaic artworks both from the Czech Republic and Austria would be required. The materials research should be supported by historic and archival search. Besides possible solutions to these "academic" issues a good and detailed characterisation of mosaic mortars can help design an optimal conservation-restoration treatment of Neuhauser mosaic artworks. Many of them (both on Czech and Austrian side) are in a desperate condition.

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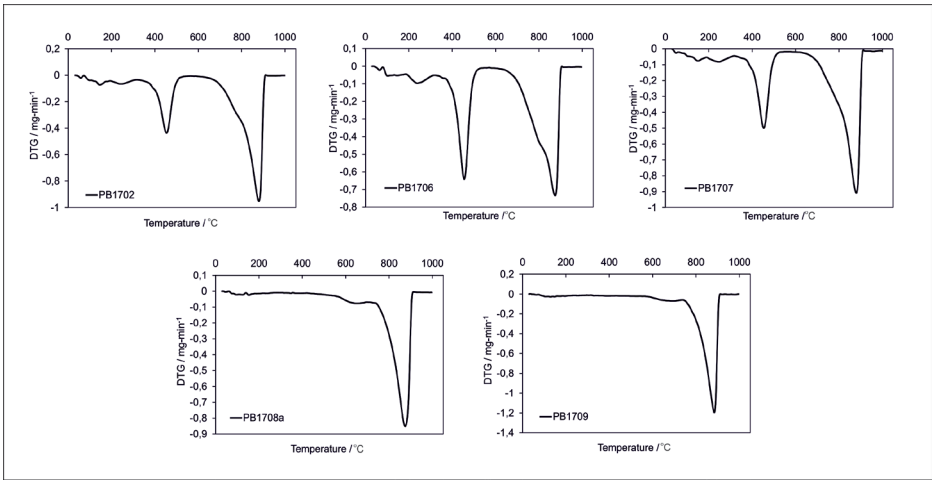
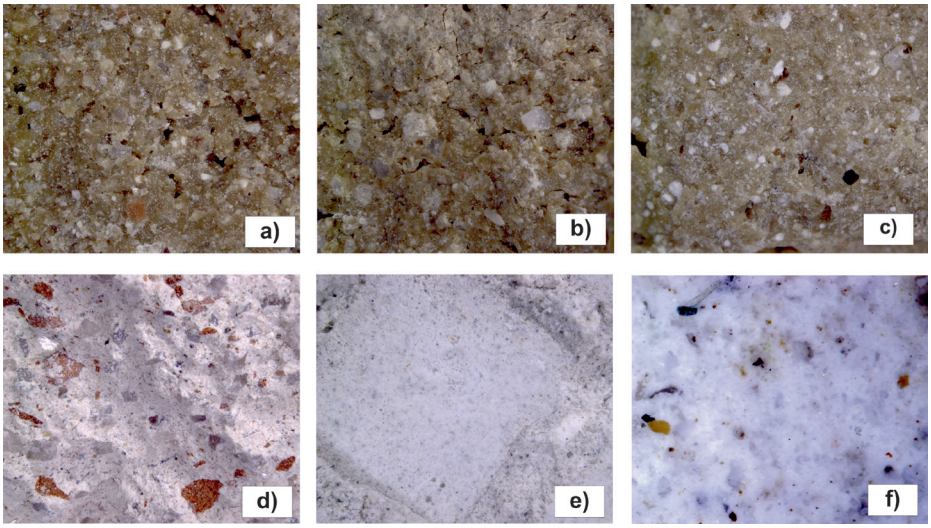
References:
[1] STORCH, Malu a Maireth Elisabeth. Mozaiky z Neuhauserovy dílny a Tyrolské sklomalířské a mozaikářské dílny v 19. a 20. století. Zprávy památkové péče. 2017, 77(3), 321-323. ISSN 1210-5538.
[2] KRACÍK ŠTORKÁNOVÁ, Magdalena. Mozaiková výzdoba hrobek na Malvazinském hřbitově. A : atlas funeral : hřbitov Malvazinky. Únětice, 2015. ISBN 978-80-7414-978-8.
[3] PERNÁ, Ivana, Tomáš HANZÍČEK a Magdalena KRACÍK ŠTORKÁNOVÁ. Characterization of Historic Mosaic at Pfeiffer-Kral Sepulcher, Jablonec nad Nisou: A Study of the Mortar and Tesserae Origin. Ceramics - Silikáty. 2014, 58(4), 308-313.
[4] Malu Storch, private communication, February 2018
[5]Cristiana Lara Nunes, private communication, February 2018
[6] Malu Storch, private communication, February 2018



DTG curves of studied mosaic mortars.



The appearance of studied mosaic mortars. 3D binocular microscope – a) PB1702, b) PB1706, c) PB1707, d) PB1708a, e, f) PB1709; a-e) magnification 10x, f) magnification 100x.

Mosaic Madonna from Reith bei Seefeld, Austria. Photo: courtesy of Storch family.