Long term mineral poultices with clay mineral content for the application in microbial and heavily salt contaminated monuments

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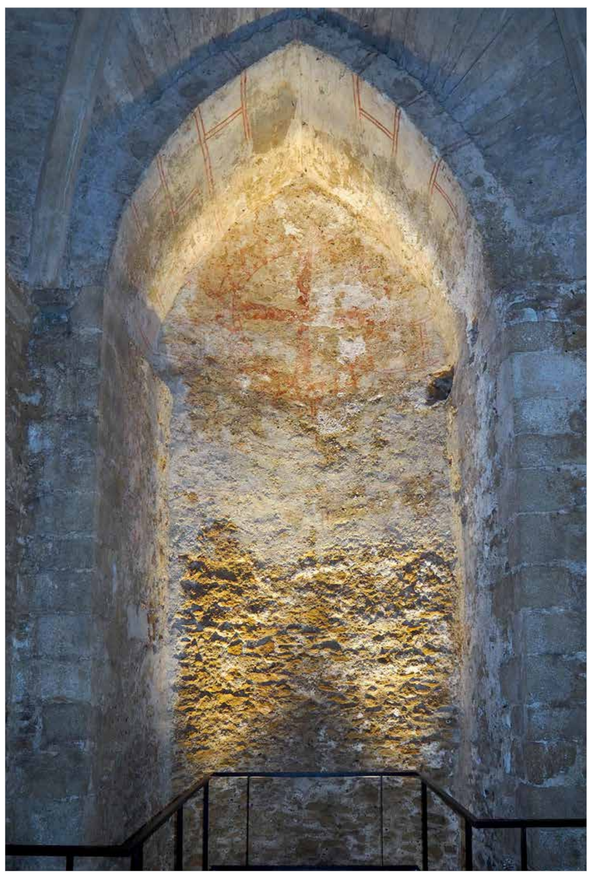


Eastern niche on the south side: The plaster is almost completely lost till the middle height of the niche due to the progressive salt damage. The painted consecration cross is barely recognisable.

Characteristic salt damages in the Virgil Chapel: (left side) salt crusts on the surface, (right side) pressed-off salt crust.

The research project “Pretty in pink”, funded by the Heritage Science Austria Programme of the Austrian Academy of Sciences (ÖAW) deals with new restoration treatments to mitigate salt crystallisations and pink discolouration in historic buildings and monitoring of their effectiveness through “omic” analysis. Part of this project is the development of mineral poultices with clay mineral content, which show a high storage capacity of salts and protect the surface from progressive degradation.
In order to be able to test the developed poultices under real conditions, surface areas were selected in the Virgil Chapel in Vienna, which is subject to ongoing salt accumulation and weathering due to its location underground and is colonised by halophilic microorganisms.

In 1973, the Virgil Chapel was discovered and excavated during the construction of the nearby subway. Due to its location below the Stephansplatz, it is exposed to a massive accumulation of building damaging salts from the surrounding soil and surface. Their repeated crystallisation due to climatic fluctuation is responsible for the considerable damage to the wall surface of the 13th century. Recurrent water inputs due to increased heavy rainfall events lead to an acceleration of the crystallisation cycles and following damage to the monument. A high rate of sanding and visual impairment due to salt efflorescence on the wall surface are the consequences.

Attempts in the past to minimise climatic fluctuations and to keep the climate within a certain range, that lies around the deliquescence moisture of the salt mixture (mainly sodium chloride), are now counteracted by the noticeable effects of climate change.

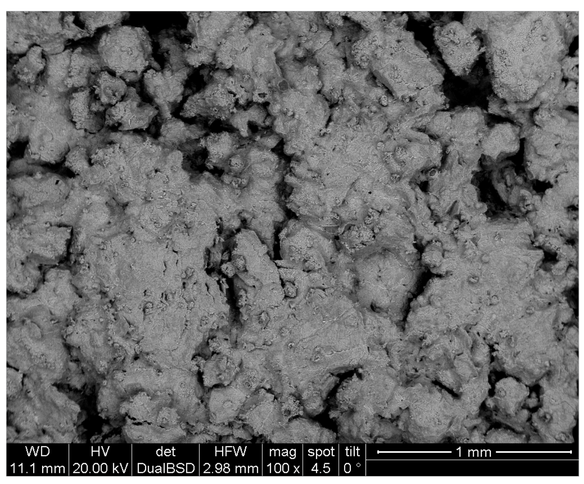
The idea of applying mineral poultices with a clay mineral content, that can remain on the microbial and salt contaminated surfaces for a long time in order to prevent the surface from degradation, imposes special requirements on the poultice mixtures like good applicability on fragile substrate, suitable workability and lasting adhesion to the substrate, low residual stress, an adapted pore radius distribution for the best possible capillary water and salt transport from the substrate via the poultice to the surface and a residue free removal, just to name but a few properties. Especially in the case of the Virgil Chapel, the application of mineral poultices over a longer period of time could prevent the continuous loss of surface material and thus represent a sustainable protection of the historical substance.

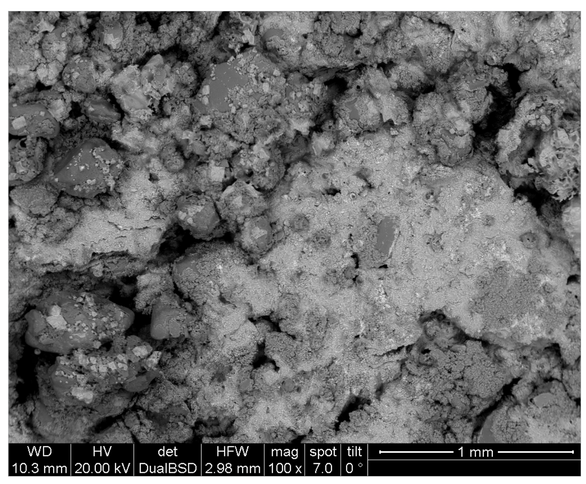
For the poultice mixtures, different layered silicates and aggregates in different mixing ratios were tested in a first phase under laboratory conditions.
The three most promising poultices in terms of the predefined properties were then applied in the Virgil Chapel on the selected surface areas with visible microbial contamination, each on an area of 20 by 20 cm and a layer thickness of about 1 cm. Sampling of partial areas for analysis was carried out after 7, 30, 90 and 365 days.
The poultices taken are examined for their properties and salt accumulation by means of mercury pressure porosimetry, X-ray diffraction (XRD), ion chromatography (IC), and in the scanning electron microscope (SEM).

First results indicate a great influence of the chosen clay mineral on the extraction of salts and the storage capacity of poultices. Likewise, after 3 months, a difference in the resistance of the three poultice mixtures to the salt load can already be seen, resulting from a combination of the salt load and the intrinsic properties of the poultices.

Test areas in the eastern niche of the south side: (from left to right) poultice with sepiolite, with kaolin and with vermiculite one week after application.

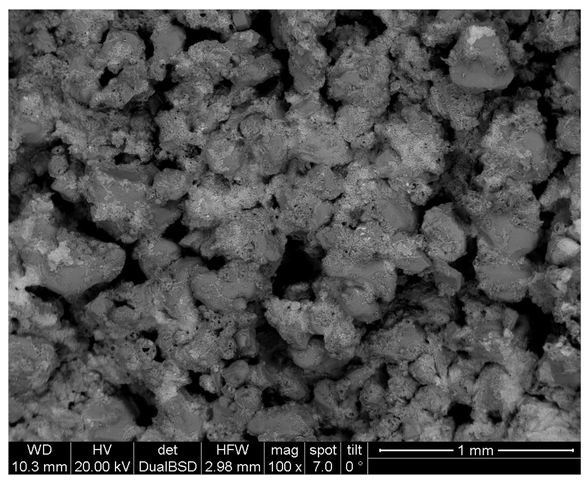
Test areas in the eastern niche of the south side: After three months, the poultices are differently damaged. The sepiolite containing poultice lost its surface. The kaolin and vermiculite containing poultices are still structurally intact.





SEM images of poultices with vermiculite content in comparison with a kaolin containing poultice:
(top left) The vermiculite containing poultice saturated with sodium chloride under laboratory conditions shows a surface almost completely covered with salt crystals.
(top right) In the poultice with vermiculite content from the Virgil Chapel, taken after three months, the salt crystals have accumulated on the components and in the spaces between them.
Despite the high salt load, the poultice in both cases can continue to absorb salts into the interstices.

(bottom right) In the kaolin containing poultice salt crystals (bright areas) are deposited sporadically, but without completely enveloping the components or filling their interstices. The poultice mixture only retains a small amount of salts compared to the poultice with vermiculite.



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