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# EVALUATION OF POULTICE DESALINATION PROCESS AT MADAME JOHNS' LEGACY, NEW ORLEANS

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## Abstract

Within the framework of the EU project "Desalination", Madame John's Legacy in the French Quarter of New Orleans was selected as a field site to evaluate the effectiveness of four desalination poultices under warm and humid environmental conditions. The poultices were applied to salt-laden brick walls in a sheltered exterior environment and in an air-conditioned ground floor. Effectiveness was defined to take into account the percentage of salts removed as well as the depth of desalination. Preliminary results from the investigation demonstrate the importance of environmental conditions, shrinkage, adhesion and drying rates in poultice effectiveness. Desalinating masonry in a humid environment led to leaving the poultice on for months instead of weeks, resulting in a significant reduction in salt content of well over 90% for two poultices.

Keywords: poultice desalination, salt reduction, rising damp, masonry conservation.

## 1. Introduction

Optimizing the removal of soluble salts from contaminated building materials is an important topic in the treatment of history masonry and wall paintings (Leitner, 2006; Vergès-Belmin and Siedel, 2005). There have been a number of meetings dedicated to the problem of salts and desalination (Petzet, 1996; SFIIC, 1996; Simon and Drdacky, 2006) which have helped to illustrate some of the problems associated with large scale desalination efforts. These problems include unexpected mobilization of salts by excess water, poor extraction of salts from some materials, and rapid re-appearance of salts after some treatments.

One method of salt reduction commonly used by stone conservators is simply to apply a poultice, analogous to blotting a stain on a piece of clothing. One of the advantages of poultice treatments is that the material remains 'retreatable' after the intervention, as no new material is permanently introduced to the substrate other than water.

The poultice is typically a porous, hydrophilic mixture of materials that is wetted to a consistency where it can be applied and adhere to vertical surfaces such as sculpture and walls. When applied to a porous, salt-contaminated substrate, some of the moisture is transferred from the poultice to the substrate and then--in theory--back to the poultice along with some of the dissolved salts (Terheiden and Kaps, 2003). Poultices often shrink as they dry and may detach from the wall, at which point they cease to extract moisture and salts (Verges-Belmin, 2006).

There are several ways to improve removal of salts with poultices such as: 1) Optimize the pore characteristics and structure of the poultice relative to the substrate--finer pores for suction, coarser pores for water and later salt storage, with a structure that minimizes shrinkage. 2) Optimize the amount and rate of moisture introduced. Standard poultices are a byproduct of cleaning methods and recent work shows that their application in some cases results in the rearrangement of salts rather than in their reduction (Lombardo and Simon, 2006). 3) Improve the interface and application/removal process. The detachment of the poultice layer due to drying and cycling is clearly important, however it is not well understood. 4) Better understand the effect of environment and relative humidity on drying rates and poultice effectiveness (for example, transport of salts by advection vs. diffusion). Field tests are needed to begin to evaluate these processes, examining both the efficiency and effectiveness of poulticing in reducing rates of salt weathering as well as the recurrence of salts. If conservators can more efficiently remove salts, poulticing may receive greater use as an element of routine maintenance.

To test some of these processes, and as part of a larger EU project on guidelines for desalination (DESALINATION, 2008), the site of Madame John's Legacy was selected as a case study of poultice desalination. One of the oldest buildings in Louisiana, dating to 1789, it is an important example of Creole architecture (Riegel et al., 2005)(Fig. 1). The brick masonry at the site contains significant soluble salts after a 1998 restoration effort to help deal with termite issues and enable the ground floor to be used as museum display space (Fig. 2). The high humidity of Louisiana was expected to result in drying of poultices slower than in some other sites where comparative studies are taking place.

Figure 1. Madame John's Legacy, a 1789 brick and wood building in the French Quarter of New Orleans which is affected by soluble salts.

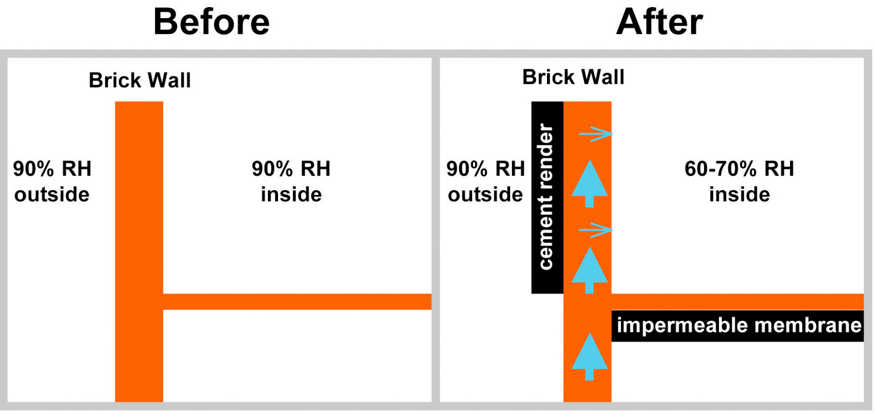

Figure 2. Cross section diagram of brick wall at Madame John's Legacy showing the situation before and after a 1998 renovation added a cement render to the exterior, an impermeable membrane to the floor and air conditioning to the ground floor (not to scale). Salt weathering of the interior brick was a notable problem starting in 2002 with the likely path of moisture transport outlined with blue arrows.

## 2. Materials and Methods

The condition of the walls was documented photographically on three occasions before poulticing, which aided in the selection of areas where both active damage was taking place and concentrations of salts were noted. The salts in the walls were characterized using ESEM-EDS, XRD and ion chromatography before and after poulticing in three areas: two interior spaces and one sheltered exterior space. Four poultices using commonly available materials and recipes were tested, namely a commercial poultice, one paper pulp poultice, one paper pulp/clay poultice and one clay/sand poultice (Tab. 1). The sand fraction used was from 0.5 to 1.0 mm. Details can be found in Bourges and Verges-Belmin (2008). The poultices tested have a 16-fold range in water content and it was found that the base of the poultice was wet while the upper section was significantly dryer due to differences in moisture uptake. Two drying conditions were tested: a sheltered exterior site and an air-conditioned ground floor.

Table 1. Desalination poultices tested at Madame Johns Legacy.

| | | |
|---|---|---|
| Panel A: Arbocell BW40/BC1000 mixture, Outdoor | Panel B: Commercial Poultice 1, Indoor | Panel C: Arbocell BW40/BC1000 mixture, Indoor |
| Panel X: Commercial Poultice 1, Outdoor | Panel Y: Cellulose/Sepiolite mixture, Outdoor | Panel Z: Bentonite/sand mixture, Outdoor |

### 2.1 Sampling Procedure

Small samples of powdered brick were acquired at four depths (0-1, 1-2, 2-4, 4-6 cm) and four heights from the floor (0.1, 0.5, 1, 1.5 and 2 meters) to characterize the salt distribution in the wall before and after the poulticing. A 3 mm ceramic drill bit was used with a variable-speed, battery-powered drill operated at low speed to reduce the effects of heating on the powders. The powders were dried in a 40 C oven until their weight was stable and ~0.06 g was dissolved in 10 ml of ultra-pure water (18.2 megaOhms) for three days (agitated) and then filtered before ion chromatography analysis. The longer dissolution time was undertaken in an effort to dissolve more of the gypsum present in the samples. The poultice samples were extracted from the surface with a scalpel as 5 x 5 cm pieces, which were subsequently homogenized and aliquots prepared for ion chromatography. The poultices were applied October 10-11th, 2007 and removed April 2nd, 2008.

## 3. Results and Discussion

Salts identified by XRD and ESEM include mirabilite, thenardite, sodium chloride, gypsum and sodium nitrate, with the first three salts predominating. The distribution of the salts follows a pattern influenced by the use of hydrophobic agents at the base of the wall. Also, salts of somewhat lower solubility, such as sulfates, occur lower on the wall and more soluble nitrates and chlorides occur higher up on the wall. This separation of salts based on solubility is a common phenomenon. Photographs of the drying patterns show that in two cases, the poultice dried from the top and bottom, leaving the middle of the poultice area (with the highest salt concentrations) to dry last. Before poulticing, salts were observed deliquescing in the middle of the wall.

### 3.1 Ion Chromatography results from wall before and after poulticing

Representative anion and cation concentrations profiles from the bricks before and after poulticing are reviewed for poultice panel A in figures 3 and 4 (Arbocell BW40-BC1000 50/50 mix). The results for panel A show high concentrations of sodium chloride and sodium sulfate before poulticing and low concentrations after poulticing. An increase in gypsum concentration (calcium and sulfate) could be a sampling issue or a result of the removal of the more soluble fraction. The solubility of gypsum may be influenced by the presence of other salts (He et al., 1994). Initial sulfate levels are significantly higher at the 50 cm height (Fig. 4) than at the 100 cm height (Fig. 3), while chloride levels are lower at the 50 cm level than the 100 cm level.

### 3.2 Ion Chromatography analysis of poultice

Salt concentrations in the poultice evaluated by ion chromatography (Fig. 5-6) show results consistent with the wall profiles with up to 2200 mEq of chloride per gram of poultice extracted. The results confirm that the majority of the salts removed were from the middle of the wall, and relatively little salt was removed from the base of the wall.

This was expected, since the bases of the walls were treated at in the early 1990s with a hydrophobic treatment (Eugene Cizek, personal communication).

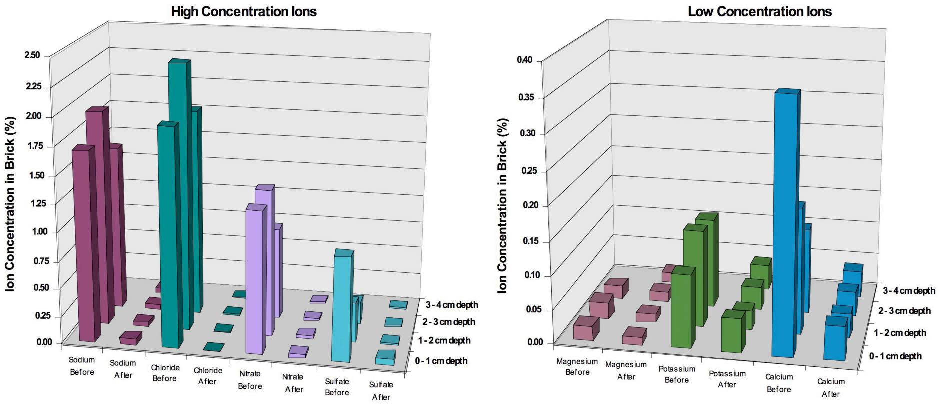

Figure 3. Depth profiles in brick showing changing ion concentrations in masonry wall at 100 cm wall height before and after poulticing with paper pulp mixture, panel A.

The results from the poultice generally mirror the brick profiles, with substantial chloride, nitrate and sulfate salts removed. The efficiency of desalination can be evaluated by considering the percentage of salts removed (Domaslowski and Kesy-Lewandowska, 1998). Several elements in the poultice A data show greater than 90% removal efficiency, which is high compared to that achieved by Domaslowski. This efficiency is likely tied to the extended length of the treatment (months vs. weeks) and the good adhesion of the poultice to the brick surface during drying.

## 4. Conclusions

The poulticing of salts under humid conditions was not expected to result in efficient removal due to the slow drying conditions and anticipated limited mobilization. Instead, efficiencies well over 90% were achieved due to the extended time the poultice was left on the walls. Also, the limited shrinkage of the poultice in the humid conditions apparently led to less poultice detachment than is often the case. Typical results for poultice efficiency are on the order of 50-70% (Domaslowski and Kesy-Lewandowska, 1998). The results acquired in this study support the common practice of many conservators in Mediterranean regions of sheltering poultices from drying too rapidly. Additional analyses are needed to evaluate the question if better desalination results can be obtained by designing poultices that have a lower shrinkage factor and if extending the time of poulticing may be a useful strategy for conservators.

## 5. Acknowledgements

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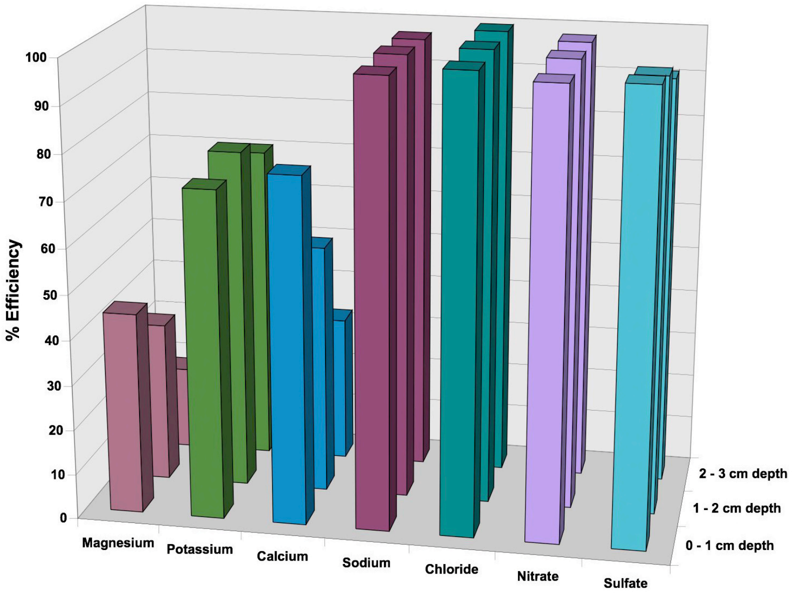

Figure 4. Efficiency profiles versus depth in panel A for soluble ions. Note abundant ions show no change in removal efficiency with depth while less common ions show a trend of decreasing efficiency of removal with depth (see fig 3).

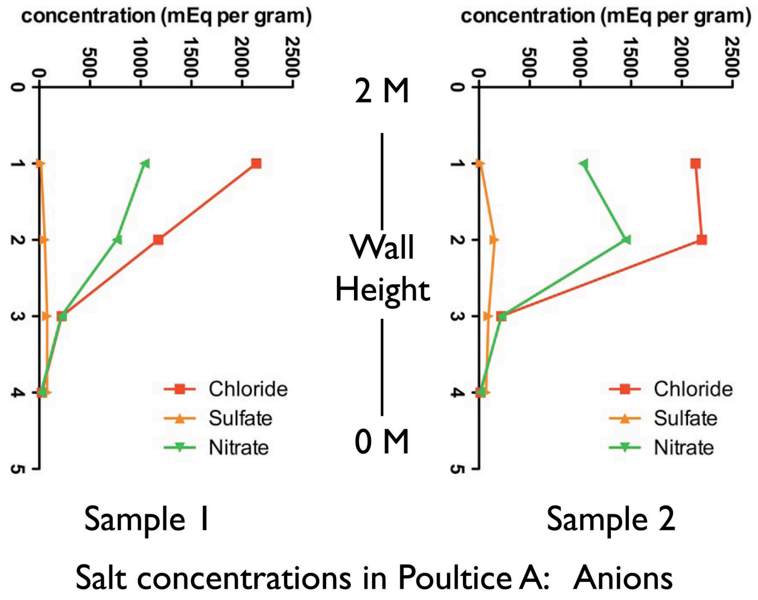

Figure 5. Height profiles showing ion concentrations in paper pulp poultice in two replicate samples. Note similar profiles and low concentrations at the base of the wall.

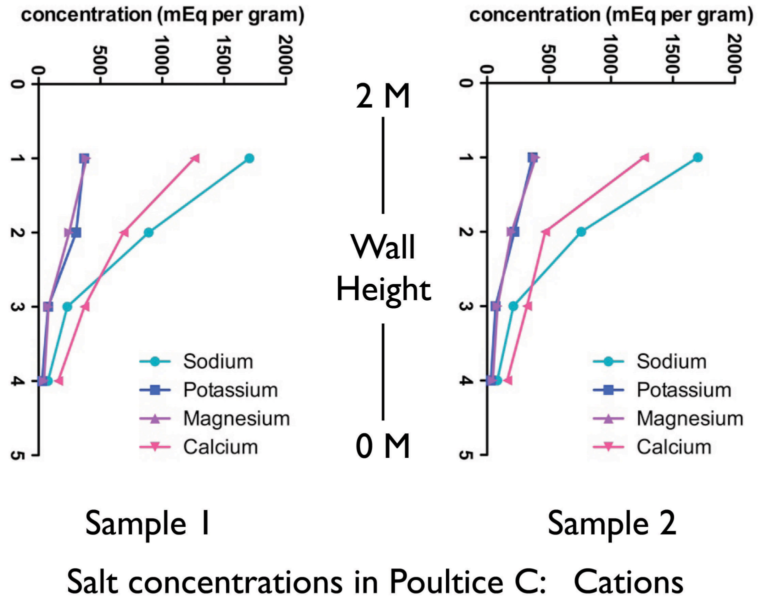

Figure 6. Height profiles showing ion concentrations in paper pulp poultice in two replicate samples. Note similar profiles and low concentrations at the base of the wall.

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