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The Treatment of Wall Paintings affected by Salts: An Interdisciplinary Task as seen from a Conservator's Perspective

H. Leitner
Hochschule für Bildende Künste Dresden, Germany

Abstract

The interdisciplinary collaboration and implications between scientist, scientist in conservation and conservator is focused from the point of view of the conservator, facing conservation problems in the field of salt damaged wall paintings. Two case studies, the outdoor paintings of the castle of Parz of the late 16th century and the Romanesque wall painting cycle of St. Georgen, are discussed in the context of conservation history of the last two decades. The façade paintings of Parz, covering more than 600 m², were threatened by severe degradation due to sulfatation and weathering. The application of the Florentine method using ammoniumcarbonate and bariumhydroxide gave reasonable good results in cleaning and consolidation. This treatment was the first step to introduce this method to wall paintings conservation, outside of Italy. The indoor paintings of St. Georgen of Judenburg represents one of the main important discovery of wall paintings of the 13th century in Austria in the last two decades. The paintings were threatened crystallization of various salts, due to rising damp, water infiltration and salt containing building materials, resulting in a solution of soluble salts that could be defined as a real "explosive cocktail". The impact of the application of several conservation treatments, like the introduction of a drainage system, elimination of cement plasters, extraction of soluble salts by paper pulp compresses, and the use of ion-exchange systems by ion exchange resins, ammoniumcarbonate and barium hydroxide is discussed. First steps done in 1988 based on empirical experiences were followed by a period of scientific research, resulting finally in the application of a stabilization treatment. After eight years the situation is still stable and can be seen as a basis for a continuous maintenance program.

Keywords: Romanesque Paintings, Wall Paintings, Salts, Sulfates, Magnesiumsulfat, Conservation history, Interdisciplinary collaboration

Behandlung von salzbelasteter Wandmalerei: eine interdisziplinäre Aufgabe aus Sicht eines Restaurators

Zusammenfassung:

Die interdisziplinäre Zusammenarbeit und Verquickung zwischen Naturwissenschaftler, Naturwissenschaftler in der Konservierung und Restaurator wird aus der Sicht des Restaurators, der sich mit Problemstellungen der Erhaltung bzw. Konservierung von salzbelasteter Wandmalerei befasst, dargestellt. Zwei Fallstudien, die Außenwandmalereien von Schloß Parz in Oberösterreich aus dem späten 16. Jahrhundert und der romanische Wandmalereizyklus von St. Georgen ob Judenburg (um 1240) in der Steiermark werden im Kontext ihrer Restauriergeschichte der letzten zwei Dekaden besprochen. Die Fassadenmalereien von Parz, welche eine Fläche von über 600 m² bedecken, waren durch schwerwiegende Zerstörungsmechanismen, in Zusammenhang mit Bewitterung und Vergipsung gefährdet. Die Anwendung der in Florenz entwickelten Techniken – Methoden, mit Ammoniumcarbonat und Bariumhydroxid führten zu ermutigenden Ergebnissen in Fragen der Reinigung und Festigung, die erste großflächige Anwendung dieser Technik außerhalb Italiens. Der Wandmalereizyklus im Chorturm der romanischen Pfarrkirche von St. Georgen ob Judenburg zählt zu den bedeutendsten mittelalterlichen Wandmalereifunden der letzten Jahrzehnte in Österreich. Die Malereien waren durch Salzkristallisation, in Zusammenhang mit aufsteigender Feuchte, Wasser Infiltration und salzbelasteten Baustoffen, die ein gleichsam explosives Gemisch ergaben, extrem gefährdet. Die Auswirkungen unterschiedlicher Maßnahmen, wie die Einbringung eines Drainagesystems, die Entfernung von zementhaltigen Beschichtungen, bzw. Ausbesserungen, die Extraktion löslicher Salze, sowie die Verwendung von Ionenaustauschsystemen, wie Ionenaustauschharzen, Ammoniumcarbonat und Bariumhydroxid wird dabei diskutiert. Erste Maßnahmen im Jahre 1988 fußten noch auf empirischen Versuchen, welche durch eine wissenschaftliche Erforschung abgelöst wurden, die schließlich in eine effiziente Sicherungsmaßnahme mündete (Verklebung und Festigung). Nach nun über acht Jahren ist die aktuelle Situation weiterhin als stabil einzustufen und kann als Grundlage für ein kontinuierliches Pflegeprogramm angesehen werden.

Stichwörter: *Romanische Malerei, Wandmalerei, Salze, Vergipsung, Magnesiumsulfat, Restauriergeschichte*

1 Introduction

The conservation of wall paintings threatened by salt damage is not feasible without the help of science, both pure and applied science. Although in general, the field of pure science undervalues that of applied research, the latter is of fundamental importance for conservation. Thus, the difference between a pure scientist and one involved in conservation must be understood and accepted, as well as the difference between the scientist in conservation and the conservator himself.

In the context of cultural heritage preservation, reality cannot be reduced to mathematical models or scientific graphs. Reality is the work of art itself in all its aspects, and science can play an essential, but restricted, role in its conservation. If science could answer all the questions to guarantee the survival of our heritage, its preservation would be easy. Unfortunately, this is far from reality and we must face a situation in which decisions must be made with insufficient knowledge and often in the face of conflicting opinions. The various professional disciplines involved in conservation are all of essential importance. However, it is the conservator-restorer who has the responsibility to intervene on the object. This responsibility, and its implications, must be recognized.

2 Professional Profiles

The professional profile of the conservator-restorer has changed fundamentally in recent decades. This development can broadly be characterized as having started from an artistic craft-based profession which has evolved into a discipline centered on a scientific approach (*scientific* here is intended in the German sense of *Wissenschaftlich*; that is, not restricted to the natural sciences but rather with a generic sense and connoting a rigorous methodology). This approach allows us to speak today about conservation science, not to be confused with science in conservation. Of course this definition of the profession as scientific should be treated with caution, since the interdisciplinary character of conservation means that the scientific approach cannot replace but should complement the practical skills and aesthetic sensibility of the conservator.

Although the definition of the conservator's discipline has been widely discussed in the last 25 years and elaborated in various official documents, the definition remains a matter of discussion. It is significant that the definition of the conservator's profession is not yet covered by legal protection, with the exceptions of Greece and the German Land of Mecklenburg-Vorpommern.

Historically, the conservation of wall paintings has been mainly considered an aesthetic task, and the conservator was by and large employed to reintegrate or retouch the visual image. Over time, however, it was recognized that wall paintings are an integral part of architecture itself. Consequently, attention could not be focused exclusively on the surface, but had to be related to the support of the wall painting as well as its surrounding context.

Following this shift in focus, the primary characteristic of the conservator's approach can be broadly characterized as involving an intensive dialogue with the object itself, in its many related dimensions, leading to a holistic understanding of the object. The conservation of wall paintings represents a significant example of this approach, especially regarding the question of salt damage.

This fundamental change in approach—from a visual repair, that is, a cosmetic intervention, to an understanding of the underlying causes of deterioration—must be seen as an essential improvement in conservation. Nevertheless, it is important to note that even though this approach is now widely accepted, the expectations of the conservator's work remains biased towards visible results and the presentation of the painting, but with the added demands of effectively intervening on the causes of damage for a long-term stabilization.

This requires a better understanding of the parameters—both individually and in their complex interrelationships—that affect wall paintings, and a variety of investigations of the highly damaging effects of salt contamination in wall paintings. To achieve this, interdisciplinary cooperation among specialists, especially between the conservator and the scientists, has proved crucial in defining the best strategy for the conservation of the object. This requires from the conservator a specific transdisciplinary understanding and a specific role within this interdisciplinary collaboration.

The process from investigation to intervention characterizes the conservator's responsibilities and aims. This requires a combined understanding of the artistic and physical nature of the object and an intensive dialogue with the object on various levels, involving observation (*Schule des Sehens*) and knowledge combined with an intuitive experience at one's finger tips (*Fingerspitzengefühl*), as important qualities in a conservator.

To achieve this means an increasing need for cooperation among specialists. In this collaboration, the conservator has to be seen in his direct relation to the object as managing coordinator and the natural sciences as a complementary partner.

3 Case Studies

An important characteristic of wall paintings—which correspond to the architectural surface—is that they are only some micrometers thick on a structure that is itself likely to be close to a meter thick. This thin paint layer defines the surface as the physical and optical interface between the architectural structure and its environment. Therefore, the conservation of these few micrometers is of fundamental importance and must be seen as a specific challenge in the quality of conservation.

The following two case studies—the façade paintings of Parz which were threatened by sulfation, and the discovery of the medieval wall painting cycle of St. Georgen—may demonstrate some of the tasks the conservator has to master.

3.1 The Façade Paintings of Landschloß Parz bei Grieskirchen, Upper Austria

The extensive painted façade (over 600 m²) represents a rare case of painting from the time of the Reformation movement. Due to its political subject, it was covered during the Counter-Reformation, shortly after its execution around 1580. These covering layers, applied continuously during subsequent centuries, have saved the painting from extensive damage. (Figure 1).

Figure 1: Facade paintings of Parz, Mosè guides his people through the Red Sea, detail representing the pope as "Antichrist".

However, lack of maintenance during the 20th century resulted in the weathering of the covering layers and the partial exposure of the painting. Due to its location, climatic conditions and air pollution, the painting was at extreme risk of sulfation (Figure 2-4).

Following an international colloquium to consider possible treatments (Parz 1988, participation of several international experts without publication)—such as covering, consolidation with acrylics, etc.—the Florentine method of treating sulfated wall paintings with barium hydroxide was considered to be the most promising intervention. This treatment, first used on wall paintings at the beginning of the 20th century with negative results (London, Westminster Abbey, chapter house), was redeveloped in the 1960s by the Florentine scientist Enzo Ferroni. This new treatment concept introduced the application of ammonium carbonate solution as the first step, followed then by the Bariumhydroxid treatment. The practical application of this theoretical concept—converting the calcium sulfate to barium sulfate, while at the same time producing barium carbonate and calcium carbonate—was only possible with the development of a specific application technique by conservator Dino Dini. He introduced the reactive materials by means of cellulose pulp poultice. The positive results by this technique over the last 35 years are the consequence of a fruitful collaboration between scientist and conservator.

The application of this method on the paintings of Parz was carried out in close collaboration with the staff of the Opificio delle Pietre Dure, comprising both scientists (Mauro Matteini and Arcangelo Moles) and a conservator (Sabino Giovannoni). Local knowledge about the object itself, combined with the experience of the Florentine specialists

Figure 2: Facade paintings of Parz, the covering of the paintings by limewash, during the counterreformation (around 1600) was meant as destruction, but acted as protection layer. Because of lack of maintenance the covering limewash layers have been partly fallen off by the weathering activity exposing the paint layer. The dark areas indicate a heavy sulfatation.

Figure 3: Facade paintings of Parz, detail of sulfatated area with progressive corrosion

Figure 4: Facade paintings of Parz, detail with complete loss of the painted surface corroded into the plaster-layer

Figure 5: Facade paintings of Parz, during the application of the Florentine treatment

Figure 6: Facade paintings of Parz, general view after the treatment of the remaining painted areas

provided the possibility to develop a specific application technique for the object with all its individual characteristics (painting technique, specific local climate, condition of the painting, etc.). In particular, the variables in the methods of application (devised on the basis of specific experiences of the conservator) were essential for a positive result in consolidating the surface to the extent that now, after more than ten years after the intervention, it can still be characterized as unchanged.[1] (Figures 5-6).

1. "Fassadenrestaurierung am Beispiel zweier gemalter Fassaden des späten 16. Jahrhunderts", Restauratorenblätter 16, *Fassadenmalerei -painted facades* , Österr. Sektion IIC, Wien 1995, page 161-170

3.2 The Romanesque Wall Painting Cycle in the Parish Church of St. Georgen bei Judenburg, Styria

The tower area of the Romanesque church (Chorturmkirche) of St. Georgen bei Judenburg in Styria is decorated with a vast wall painting plan contemporary to its construction. Part of the plan includes the earliest known representation of the legend of St. Georg in Austria. The paintings are dated around 1240 and considered to be one of the first examples of *Zackenstil* in the eastern Alps. (Fig. 7) The paintings were discovered during a systematic investigation program, carried out by conservators as a preliminary step towards a projected renovation of the interior.

The construction is coarse ashlar, covered by a single plaster layer varying significantly in the thickness between 2 mm and 10 cm. After setting, this plaster was covered by a layer of limewash mixed with fine sand applied roughly with a brush (brush strokes are clearly visible). The painting was executed on this limewash while still fresh, using, on the one hand, the fresco effect of the fresh lime, combined with the binding effect of the slaked lime mixed with the pigments, but also with the addition of calcium caseinate as an organic binding medium (Fig. 8).

The paint layer itself was built up in several layers. A coloured base layer was applied over large areas without any distinguishing details, mainly using red and yellow earth and charcoal as pigments. Finishing (Modeling) by differencing details and modeling of draperies and flesh areas, was built up on top by use of light and shadow effects, partly by mixing the pigments with lime white but also by introducing more precious pigments such as red lead and copper chloride green. The final finish was done with the use of white highlights and outlining with black, creating an effect similar to medieval glass painting.

When soluble salts are present, the uncovering of wall paintings must be considered very critically. The justifiable interest in exposing the painting must balance the protecting qualities that the covering layers may provide. At St Georgen, areas with rising damp showed severe and active salt damage to the paintings. Since this dynamic salt activity was destroying the paint layer even with a covering layer of thick plaster, it was decided to uncover the paintings to be able to intervene by conservation treatments. (Fig. 9)

After uncovering, the paintings were in surprisingly good condition, even considering the sensitive painting technique, which can be classified as *Kalkmalerei* and represents one of its best preserved examples in Austria. The principal losses were linked to architectural changes—such as the addition of the gothic choir in the middle of the 15^{th} century—and to damage from rising damp.

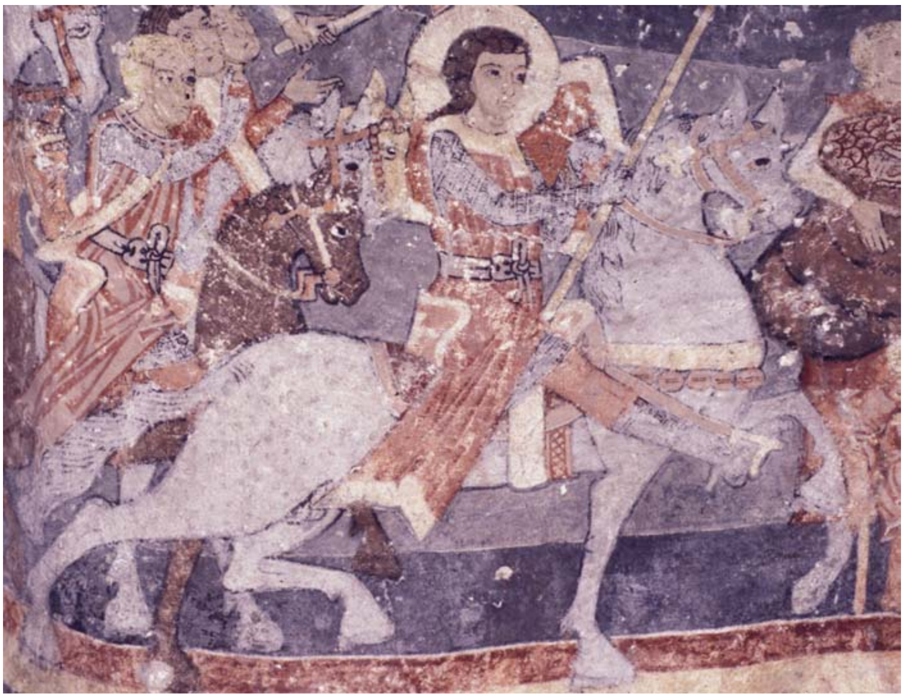


Figure 7: St .Georgen, detail of the legend of St. George

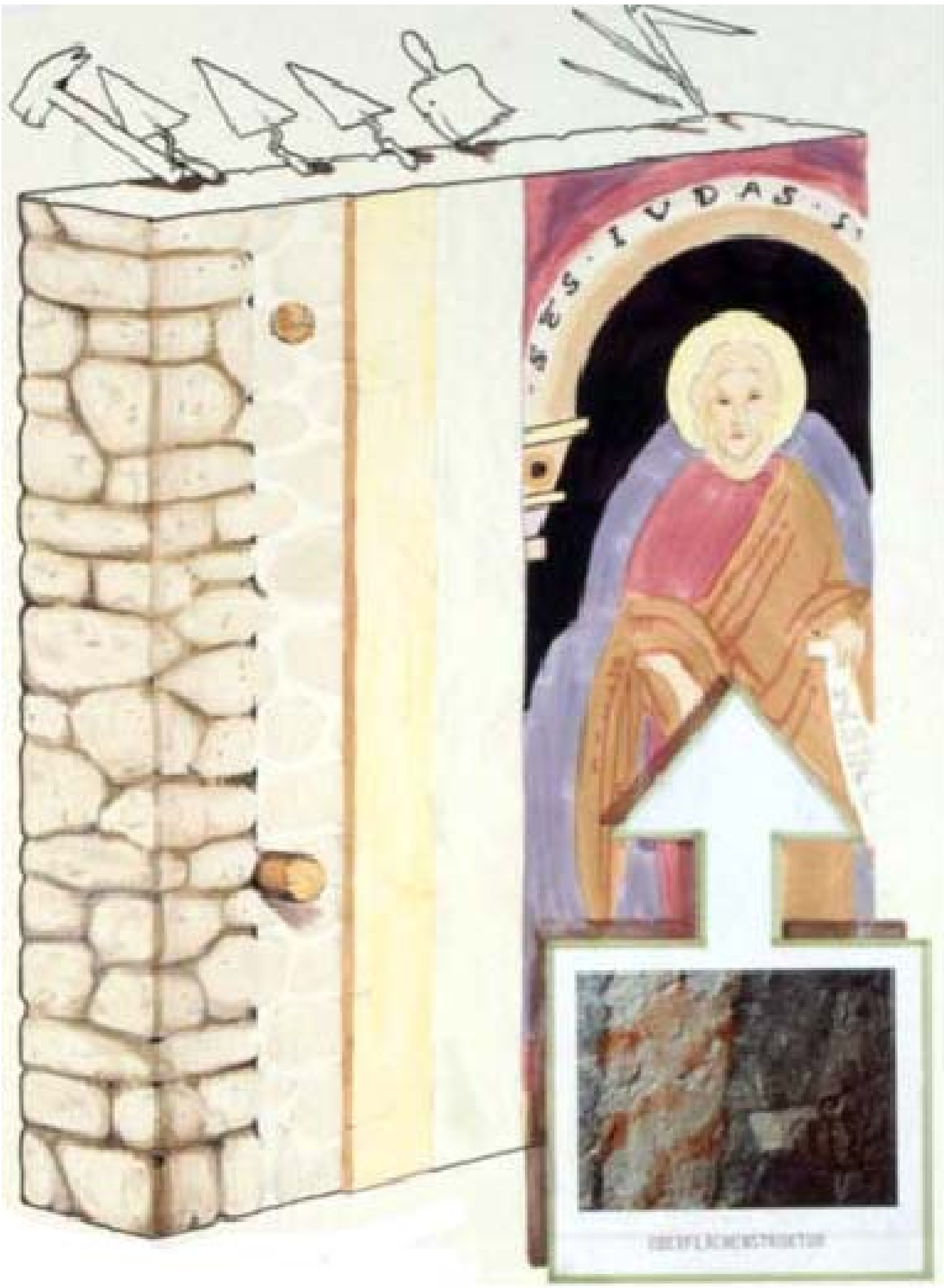
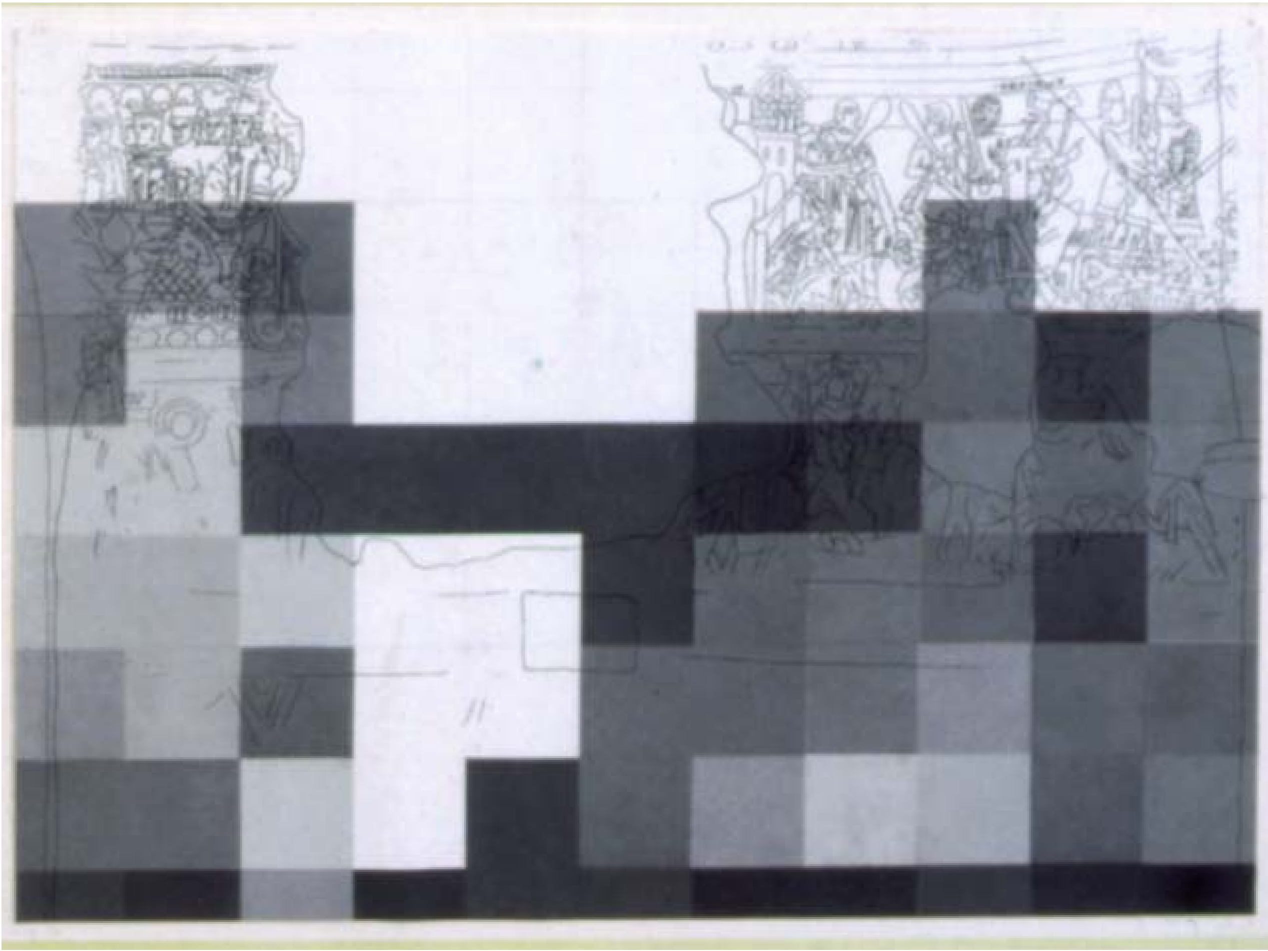


Figure 8: St. Georgen, technique of execution of the wall paintings (see Ref. [3])

After uncovering, the paintings showed varying states of preservation:

- In the dado area, the paint and plaster layers were mainly lost by the action of rising damp; only small areas of the plaster survived, probably reflecting damage that occurred hundreds of years ago.
- In the lower register of the St. George legend, the condition was characterized by the loss of the finishing layers, but still preserved the base paint layer.
- By contrast, the upper register was overall well preserved, with all the finishing layers, which very rarely survive on this type of painting. The damage in this area was primarily linked to mechanical damage from the past by keying the surface for the application of a new rendering.
- The main area of active deterioration—with decohesion of paint layer and partial loss of the plaster layer—was in the lower register.
- A high content of soluble salts was assumed in the two registers, due to the action of rising damp.

Before any activity inside the church was initiated, a number of measures were undertaken to address



Explanation of the content of this figure:
Measured values of the electrical conductivity indicate the presence of water and water soluble salts respectively. Different grey levels shown in this figure characterize the average moisture content of the corresponding area.

Figure 9: St. Georgen, liquid water survey (see Ref. [3])

the problem of rising damp. On the exterior a drainage system was installed and the cement plaster (applied in the 1970s) was removed.

The actual uncovering of the painting was uncomplicated, and several mechanical methods were used. In some areas, preconsolidation of flaking was necessary. For the ceiling area, a final presentation of the paintings terminated the interventions.

However, the lower part—presenting all the problems due to rising damp and salt activity—required further interventions. A first intervention of reducing the soluble salt content was executed by the application of a long-term cellulose pulp poultice applied with deionized water. The poultice, consisting of Arbocel BWW 40, was sprayed on the surface to a height of about 3.5 m, with a thickness of about 3 mm, in order to achieve some salt reduction (Fig.10, 11).

This poulticing technique was developed some years before and used quite often in Austria, even though the results and the actual functioning of this method were not yet clear. Because of this lack of assessment of this empirical treatment, it was decided to investigate it further with help from a scientific team. Therefore, after drying, a grid was drawn on the poultice, dividing it into squares of 50 cm. These squares were removed individually;

Figure 10: St. Georgen, salt reducing treatment

Figure 11: St. Georgen, during the removal of the salt reducing poultice

the intention was to be able to analyze the amount of relevant salt ions taken up by the poultice squares in relation to their positions on the wall. The methodology and results of these procedures were presented in a paper by the responsible scientist in 1993 [2].

Apart from evaluating the analytical results of the poultice, the effects on the object itself were carefully investigated and revealed new flaking phenomena in some areas of the northern wall connected with salt efflorescence (Fig. 12). The affected zones were at a level of approximately 2.5 m from the ground, and the salts proved to be mainly magnesium sulfate, in a whisker-like form, while on the reverse of the flakes this salt was accompanied by gypsum. The gypsum also crystal-

Figure 12: St. Georgen, scaling of the paint layer by the dynamic of salt crystallization

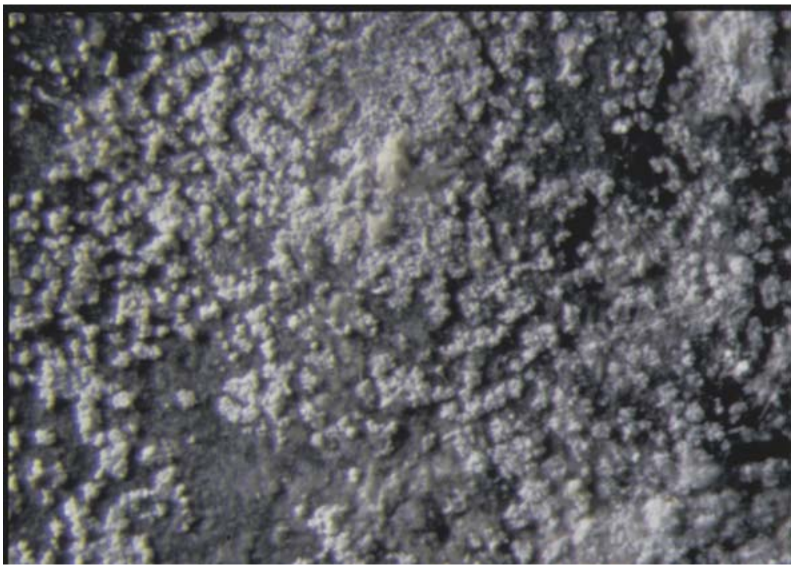


Figure 13: St. Georgen, gypsum growing in tiny pustules, cauliflowerlike agregates

lized in the form of a whitish veil and in pustules, most intensively developed at the height of about 2.5 to 3 m (Fig. 13).

The fact that damage by salts continued after the salt reduction treatment indicated that the poultice had exerted only a very limited and superficial effect and that further studies were necessary in order to find a long-term concept for controlling and stabilizing the situation. Thus a two-year research project was defined, at the end of which it should not only be possible to establish the most favorable climatic parameters for this indoor situation, but also to improve knowledge of moisture transfer and salt behavior in old walls.

The research project carried out in the following years revealed very surprising results, partly published in the paper by the research team [2]. The climatic situation proved to be very stable with regard to temperature (seasonal changes ~ 20 °C; daily changes about 2 °C), but was more sensitive to changes in relative humidity. The drainage system and the removal of the cement plaster on the exterior almost eliminated the presence of rising damp.

It had been intended that the anticipated crystallization phase of soluble salts—after the drying of the walls—would have been resolved by the reducing the salt content via poulticing. The results of the research showed that the water poultices had an extraction efficiency for chloride and nitrate ranging between 70 % to 90 %, while for sulfate it was only about 10 %. This implies a relative enrichment in sulfate in the pore solution. Hence, the extraction of salts with high solubility (nitrates and chlorides) favored an additional crystallization of gypsum causing serious problems.

The relative enrichment in of lower solubility salts caused by the preferential extraction of chlorides and nitrates is likely to have caused gypsum and epsomite to crystallize, both salts having formerly been dissolved in the pore solution. This was manifested by scaling of the paint and preparation layers, by the formation of a whitish veil or of pustules on the surface (depending on the technical qualities of the pigment areas).

Therefore, although aqueous extraction successfully reduced the nitrates and chlorides, in the presence of high concentrations of sulfates this treatment must be accompanied by further procedures to address the sulfates, such as the use of ammonium carbonate. In fact, by combining what up to now had been considered separate interventions—such as aqueous extraction and the Florentine ammonium carbonate–barium hydroxide treatment for sulfation—it was possible to develop an approach that appears to have been successful in stabilizing the damaged areas.

After various trials both in the laboratory and *in situ*, including a diploma work by Olaf Schwieger (Fachhochschule Hildesheim)[2] , the decision was made to intervene using the following techniques.

- Areas of flaking paint with preparation layer were re-adhered using silicate ester; a fast hydrolisation was obtained by the use of lithium waterglass.
- Surface incrustations and pustules of gypsum were reduced by the use of an anionic ion exchange resin, applied through Japanese tissue and cleaned off with deionized water. Up to this stage a minimum of water was introduced.
- The next step was to apply a poultice of cellulose pulp mixed with barium hydroxide as preconsolidation. The poultice with a 7 % solution of barium hydroxide was applied over Japanese tissue and removed after 8 hours. This step was first applied to a limited area of minor importance. Analyses and control of the reaction were verified using SEM.
- This poultice application using a low concentration of barium was successful as a preconsolidation and provided sufficient resistance to allow the application of a subsequent poultice with ammonium carbonate (20 %).
- Following analytical control of the effect (using SEM) and a waiting time of two weeks, the area was once more treated with a barium hydroxide poultice (15 %).

The situation after these consolidations—by transforming the gypsum into the insoluble barite and introducing additional barium carbonate—gave a satisfying result (Fig.14).

After eight years—including, importantly, winter periods in which the likelihood of salt damage is particularly high—the situation remains stable and can be seen as a basis for a continuous maintenance program.

During ten years of investigation, intervention, further investigations, research and final interventions, our understanding of the salt activity improved enormously. The object itself provides an interesting intervention history in conservation over the last hundred years:

- traditional covering and repairing with lime mortar up to the 1930
- replacement of the external plaster with a cement plaster, exacerbating the rising damp in the 1960s
- the installation of drainage and removal of significant parts of the cement plaster to address the problem of rising damp in 1988
- the conditioning of the interior to ensure a high relative humidity to prevent salt efflorescence with a drastic effect in exfoliation of paint layer by the dynamic activity magnesium sulfate in changing hydration phases (1988)
- the reduction of soluble salts by aqueous extraction, disturbing the equilibrium of the salt mixture and favoring the crystallization of gypsum (1989)
- additional intervention with ion-exchange resin, ammonium carbonate and barium hydroxide (1997)

2. Olaf Schwieger, Konservierungskonzept für die restaurierten romanischen Wandmalereien in der Pfarrkirche St. Georgen ob Judenburg - unter besonderer Berücksichtigung der Salzproblematik, unpublished Diploma work, Hildesheim 1997

Figure 14: St. Georgen, steps of treatment with ammoniumcarbonatsolution and barium hydroxide

A conclusion that must drawn is that empirical interventions must be considered critically, but are nonetheless worth discussing and investigating. A beneficial effect may well have negative side effects that are not always anticipated. Any intervention that interferes with the prevailing equilibrium—such as dehumidification, salt extraction etc—must be approached with extreme caution.

4 General Observations

These two case studies illustrate the need for collaboration in both diagnosis and treatment, and can be contrasted with the traditional approach. Traditionally, even in the case of salt contamination, the aim of conservation-restoration was to aesthetically improve paintings in a damaged condition. In the past, therefore, the purely empirical approach in the field of practical conservation for salt contaminated objects had mainly been one or more of the following:

- Removal of contamination and subsequent reconstruction of the image.
- Detachment of the painting from its original support.
- Consolidation and fixation.
- Covering the surface of the painting.

Too often this involved dealing with a non-visible problem which was consequently ignored and interventions have frequently been executed in damaging ways.

Over time, the direct relationship between salt damage and humidity has been recognized and consequently addressed by correcting adverse sources of humidity. However, this in turn has led to a new double-edged problem regarding the manipulation of ambient relative humidity when salts are already present. The salts, although introduced by rising damp and other water ingresses, will not disappear once this source of moisture has been removed. Therefore the problem may not necessarily be resolved by removing the source of moisture but can instead, lead to further problems. Sometimes this has resulted in renewed consideration of detaching the painting in order to remove the salt-contaminated plaster since stabilization of areas weakened by salt damage by means of consolidation has only rarely been successful, and more often aggravates the condition.

Thus, based on the experience that the removal of the moisture ingress did not succeed in solving the problem, the removal of the salts seemed to be essential next approach.

5 Conclusions and Recommendations

In the past, the invisible presence of the salts and their poorly understood behaviour made most of the attempts to treat them useless. The “removed” salts were mainly pushed back into the porous system, ready to recrystallize. Such situations turned out to be extremely difficult for a conservator who is expected to correct the situation.

Scientific consultation is therefore indispensable. On the one hand, it is necessary to understand the mechanisms of deterioration, and, on the other, to help design a strategy for conservation. Scientific knowledge about the behaviour of salts, as well as specific interventions were studied and proposed by scientists. But there remain many unanswered questions, and overall the conditions on site turn out regularly to be different from laboratory conditions. And it is these conditions on site that finally have to be addressed.

However, the scientific contribution to the problem has opened up a broad range of methods and techniques. Once applied by conservators they have brought not only promising results but new problems as well. Also, the development of different “schools” of treatment or methodology has risked limiting the exchange of information and ideas to the detriment of the object.

There are therefore various treatments that can be used such as salt extraction using different compress materials under various conditions (vacuum, electrical charges etc.); the conversion of soluble components to stable components; and, the extraction of dangerous ions by controlled ion exchange. Last but not least there is also the approach of attempting to affect the surrounding environmental conditions with the aim of achieving a stable environment, or at least some sort of equilibrium that minimizes further damage (passive intervention). However, the attempts to introduce new technologies, in some cases extremely successful, has led to several undesirable side effects, such as concealing the object, obscuring painted surfaces behind plastic tents, or drilling them full of holes intended to carry an electric current.

The desire for simple treatments is understandable but must be approached with care; often reality does not necessarily follow theory. Standardized approaches and interventions cannot be uniformly applied to diverse and individual objects, and unforeseen side effects can occur with disastrous results.

The tendency to generalize problems and to apply standardized techniques of treatment must be seen from the perspective of a gradual increase in knowledge. After the last few decades of intensive scientific research, further complex questions are being posed. It is now clear that a general system of treating salt contaminated structures is not feasible. Rather it should involve the application of specific selected treatments, based on the most precise knowledge of the condition of the object and integrating as far as possible current technological methods. Therefore an open, international and interdisciplinary exchange should guarantee further development. Even the acknowledgment that our knowledge is still inadequate must be considered an important step forward.

Based on the fundamental principle of minimum intervention, the preservation of a sensitive equilibrium must often be accepted. To achieve this it is necessary to be aware that long-term preservation requires long-term conservation, and continuous maintenance. The desire for a complete solution can never be entirely fulfilled. Although the concept of long-term maintenance may be difficult to achieve, it should be attempted.

Any intervention should be based on detailed study of the object. The object itself defines the demand for an intervention strategy, involving known methods or requiring the development of new ones. The question then arises as to what is the conservator’s part in that task. Is he exclusively the executor of the intervention, or only limited to attempting some aesthetic improvement using a brush and some colors?

In ideal cases the investigation, analysis, diagnosis and treatment is integrated into an interdisciplinary process between the conservator and other specialists. However, it is useful to define the principal tasks of the conservator in the current reality in the field. Certainly the duties of the conservator are varied, and typically include:

- A generic observation to define the necessity of investigation for intervention or maintenance. The investigation itself on the object must be done by the conservator, who involves the scientist as appropriate.
- Phenomenological examination, visual observation, the pattern recognition of certain phenomena and signs of dynamic processes, all of which are integrated into a holistic understanding of the object.

- Evaluation of the nature of the original appearance of the object (and its conservation history), which cannot be achieved exclusively by scientific analysis, but relies fundamentally on the experience and intuition of the conservator as well as on historic information and records.
- The conservator-restorer is the link between the object and research and must be in the position of defining and coordinating strategies, such as examination and sampling (execution of sampling and defining the questions to be answered by the scientist), as well as undertaking the interventions.
- The interpretation of the results of the examination and the diagnostic investigations is worked out by means of a dialog between the conservator and the scientists.
- The strategy for intervention is based on the interpretation of the results and is developed with regard to the necessary interdisciplinary involvement, but the responsibility for the intervention strategy lies with the conservator.
- The development of a treatment requires a combination of experience and innovation, involving sensitivity, knowledge, craft skills, and creativity in the approach to materials and application techniques, and last, but not least, a good dose of intuition. Treatments must be adapted specifically to each case and in close collaboration with the scientist.
- The conservator undertakes the necessary intervention tests with scientific support, as required.
- Dissemination of the results through publications. It should be stressed that publications can offer only a limited amount of information concerning practical interventions and the approaches required to resolve complex issues. Therefore, direct in reality. For this direct interaction with colleagues is an important further responsibility.
- The conservator undertakes the intervention.
- Maintenance must be based on a critical systematic observation of the object. To achieve this the presence of the conservator is essential, as well as periodic liaison with the scientist.
- Finally, the importance of conservator's proposals for basic research topics should be emphasized.

To summarize, we can say that scientific support is indispensable. However, problems cannot simply be delegated entirely to the scientist; they require interpretation by the conservator. On the other hand, full control of scientific tasks by the conservator cannot be done; thus knowledge transfer is vital.

The symbiosis between conservator and scientist is crucial in defining research into the preservation of our cultural property. The different perspectives of the two should not be seen as an obstacle but as contributing to a complementary relationship. Cooperation, understanding and respect for other disciplines form the basis of any successful interdisciplinary cooperation. In this respect, the most important quality is individual responsibility based on a specific professional identity. Finally, it is the conservator who has to intervene and has to be responsible for his actions.

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Professor Heinz Leitner is currently professor at the University of fine arts in Dresden. His first practical formation in Austria and Italy, starting 1972 was completed 1978 by the studies on the ICCRom Wall-paintings Conservation Course, followed by a long collaboration as assistant, lecturer and member in several international missions.
In Austria he initially collaborated in the conservation laboratory of the Bundesdenkmalamt in Vienna and finally established his own workshop "Arbeitsgemeinschaft für Restaurierung und Konservierung", being personally responable for a number of major conservation projects. Regulary lecturing and publishing activity was linked to a close collaboration with several European institutions in education of conservation of wall paintings, like Bern, Cologne, Hildesheim and the Courtauld Institute in London, where he completed 1997 his Master Degree.
Since 1999 he is head of the department for the conservation of wall painting and architectural polychromy at the HfBK Dresden, where he focuses additionally to Further professional education, organising conferences, seminars , workshops etc., like the international seminar and conference on "Mauersalze und Architekturoberfläche" 2001.
E-Mail: leitner@serv1.hfbk-dresden.de

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