HERITAGE SCIENCE DAYS
Venues

22.11.2017 (Bassano-Saal)
Kunsthistorisches Museum Wien
Burgring 5
A-1010 Vienna
Austria

Host:
Dr. Sabine Haag
General Director of the Kunsthistorisches Museum with its associated institutions, the Weltmuseum Wien and the Theatre Museum

23.11.2017 (Festsaal)
Vienna University of Technology
Karlsplatz 13
A-1010 Vienna
Austria

Host:
Prof. Dr. Johannes Fröhlich
Vice Rector for Research

24.11.2017 (Festsaal)
Österreichische Akademie der Wissenschaften
Dr. Ignaz Seipel-Platz 2
A-1010 Vienna
Austria

Host:
HR Univ.-Doz. Dr. phil. Michael Alram
Vice President of the Austrian Academy of Sciences
Financial Support
Travel Information

TU Wien, Karlsplatz 13, 1040 Wien (23.11.2017)
Main Building TU Wien, Karlsplatz 13, 1040 Wien
Travel Information: http://www.tuwien.ac.at/en/contactsearch/visit_us_travelling_information/

Scientific talks, Festsaal

Entrance main building, Underground 4 - Exit Resselpark

Entrance Festsaal, Talks

Poster Session

Staircase 1st floor

Hof 3
Public talk, Hörsaal 8
Route to Venues

Vienna:
http://www.tuwien.ac.at/en/contactsearch/visit_us_travelling_information

Main Locations of TU Vienna (location maps)

Plane
The Vienna International Airport (VIE) in Schwechat is about 20 km away in the south-east of Vienna. On the airport’s website you find flight information as well as transportations into the city center:

Train S7 to Landstraße/Wien Mitte

Bus Service Vienna Airport Lines:

- VIA to Wien Schwedenplatz: Travel time 20 minutes
- VIA to UNO-City: Travel time 20 minutes
- VIA to Wien Südtiroler Platz: Travel time 20 minutes
- VIA to Wien Südbahnhof: Travel time 25 minutes
- VIA to Wien Westbahnhof: Travel time 35 minutes

City Airport Train (CAT)

A Taxi stand is right in front of the Arrival Hall.

Train/bus
If you prefer travelling by train you will find necessary information at http://www.oebb.at (Austrian Federal Railways) or via phone +43 05-1717.

Public transport in Vienna:

Kunsthistorisches Museum Wien, Burgring 5, 1010 Wien; Main Entrance, 2nd Floor – Bassanosaal

GPS coordinates: (48.2033847,16.3602533)

The main building of Kunsthistorisches Museum Wien is reachable with the underground lines U1, U2, U4 and the "Badner Bahn" (station = Karlsplatz) and also with the trams D, 1, 2 and 71 (station: Burgring).

TU Wien, Karlsplatz 13, 1040 Wien; Main Building, 1st Floor – Festsaal

GPS coordinates: (48.198931, 16.369805)

The main building of Vienna University of Technology is reachable with the underground lines U1, U2, U4 and the "Badner Bahn" (station = Karlsplatz) and also with the trams D, 1, 2, 62 and 71 (station: Opernring).
Österreichische Akademie der Wissenschaften, Doktor-Ignaz-Seipel-Platz 2, 1010 Wien – Festsaal

GPS coordinates (48.2083706, 16.3750973)

The building of the Österreichische Akademie der Wissenschaften is reachable with the underground lines U1, U4 (station: Schwedenplatz, 12 minutes walk), U3 (station: Stubentor, 8 minutes walk) and with the tram 2 (station: Stubentor).

Tickets are available at the airport, at the subway stations and in tobacco shops (so-called Traffik’s).

city map: www.wienerlinien.at
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Einleitung

Das Europäische Kulturerbejahr 2018 ist Anlass für alle teilnehmenden Institutionen, auf die besondere Bedeutung von Heritage Science in Österreich aufmerksam zu machen.


Wichtige Eckpunkte zur Vorbereitung dieser Beteiligung sind:

Heritage Science muss in den bestehenden Wissenschafts-Disziplinen sichtbar werden:

Der grundlegende interdisziplinäre Charakter dieses Forschungsfeldes zeigt die immer wieder geforderte Zusammenarbeit von nationalen und internationalen (Forschungs-)Institutionen in besonderer Weise. WissenschaftlerInnen verschiedenster Forschungsfelder, wie z.B. Physik, Chemie und Materialwissenschaften oder Medizin, eng verknüpft mit den geisteswissenschaftlichen Fächern sowie den digitalen Agenden der modernen Kommunikationstechnologie und Computerwissenschaften arbeiten in unterschiedlichsten Projekten zusammen.

Heritage Science verbindet Grundlagenforschung und Angewandte Forschung:

Über das enge Feld der industriebezogenen Forschung hinaus gelingt es, beide Forschungsarten für die Erhaltung des Kultur- und Naturerbes nutzbar zu machen.

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4 https://www.youtube.com/watch?v=ScLi6NC39OM
5 www.e-rihs.eu
Heritage Science benötigt etablierte, durch ausreichende Vorversuche abgesicherte Forschungsmethoden zur Anwendung an einzigartigen Kulturschätzen:

Da einmalige Kulturgüter nicht für „experimentelle Forschung“ verwendet werden können, heißt Angewandte Forschung hier u.a. auch umfangreiche Methodenentwicklung an Modellsystemen, um die zerstörungsfreie Anwendung an Originalen zuzulassen.

Heritage Science braucht langfristig erarbeitete Forschungskompetenz und Perspektiven:


Heritage Science in Österreich braucht nationale Förderprogramme:


Heritage Science in Österreich braucht eine nationale Roadmap:


Heritage Science braucht die Beteiligung Österreichs an internationalen Programmen zur Erhaltung/Dokumentation/Erforschung von Kunst-, Kultur- und Naturgut:

Um den Anschluss an die internationalen Entwicklungen nicht zu verlieren und im europäischen Forschungsraum konkurrenzfähig zu bleiben, ist die aktive Beteiligung Österreichs am Aufbau bzw. der Umsetzung von Programmen wie E-RIHS6 und der Joint Programming Initiative on Cultural Heritage (JPICH)7 unumgänglich.

Heritage Science braucht die Anbindung an Digitalisierungsprojekte und -initiativen national/ international:


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6 www.e-rihs.eu
7 www.jpi-culturalheritage.eu
Preface

On the occasion of the upcoming *European Year of Cultural Heritage 2018* the participating institutions want to point out the particular importance of Heritage Science in Austria.

For the first time the symposium *Heritage Science Days* provides a general overview of the scientific research carried out in the field of Heritage Science in Austria at universities, museums and other non-university related research institutes as well as organisations responsible for the safeguard of the cultural and natural heritage. Heritage Science\(^8\) means cross-disciplinary scientific research of cultural heritage. It encompasses research enabling access to cultural heritage, its conservation, interpretation and management. The term replaces the more traditional ones, Conservation Science or Preservation Science, which are only inadequately reflecting the breadth of research into Cultural Heritage. The research topics and projects presented at the *Heritage Science Days*, therefore, mostly show an inter- or transdisciplinary character and can often only be performed in close co-operation with internationally well-established researchers.

The *Heritage Science Days* are organised in the context of the ongoing preparation of a new research infrastructure called E-RIHS (European Research Infrastructure for Heritage Science)\(^9\). E-RIHS is part of the EU roadmap, building up Europe-wide networks of research facilities focused on pre-defined key topics. Although Austria is one of the European countries most famous for their Cultural Heritage, it is not directly involved in setting-up the E-RIHS program. To sustain the competitiveness of Austria and its excellent scientific research performed at a wide range of institutions on the topics of documentation and preservation of the cultural and natural heritage, it is mandatory to participate in international initiatives, like e.g. E-RIHS, in the future.

**Important tasks for the preparation of Austria’s active participation are:**

**Heritage Science needs to be incorporated into the well-known scientific disciplines:**

The strongly interdisciplinary character of Heritage Science especially relies on a close co-operation of national and international research institutes. Researches from different disciplines, e.g. physics, chemistry, material sciences, but even medicine, in close collaboration with the humanities as well as with the digital agenda of state-of-the-art communication technologies and computer sciences need to work together in a broad variety of scientific projects.

**Heritage Science combines fundamental science and applied science:**

Far beyond the field of industry related research, the study and preservation of our cultural and natural heritage involves both, fundamental and applied science, respectively.

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\(^8\) [https://www.youtube.com/watch?v=5cLl6NC39OM](https://www.youtube.com/watch?v=5cLl6NC39OM)

\(^9\) [www.e-rihs.eu](http://www.e-rihs.eu)
Heritage Science needs well established research methods that have been evaluated by comprehensive tests before studying valuable artworks:

Unique works of art cannot be used for "experimental research". Extensive development of analytical methods – sometimes also well-established ones – using model systems is a prerequisite to enable the non-destructive study of original objects.

Heritage Science needs profound research competence and long-term perspectives:

Extensive preliminary studies and the build-up of reference databases are often needed together with a profound research competence. Only this prerequisite yields to meaningful results when investigating highly valuable, often outstanding objects or collections. In many cases singular projects lead to a discontinuation in knowledge, as highly specialised research competence just laboriously gained gets lost after the project ends, e.g. if personnel cannot be further employed. A more sustainable institutionalization of this work is needed to avoid the necessity to build-up this competence repeatedly.

Heritage Science in Austria needs national funding schemes:

The monolithic funding schemes available today favour highlight and excellence research in particular scientific fields. At the same time, seldom possibilities for funding are offered for transdisciplinary projects, especially at the interface between humanities and natural or material sciences. New transdisciplinary funding schemes can be based on earlier experiences, e.g. the Translational Research or ForMuse schemes, no longer available.

Heritage Science in Austria needs a national roadmap:

Starting from the existing community working in the field of studying and preserving the cultural and natural heritage a focused development of the scientific field can only succeed, if appropriate general requirements, i.e. long-term perspectives, visions and strategies, are provided.

Heritage Science needs the Austrian participation in international programs dealing with the preservation/documentation/scientific study of cultural and natural heritage:

To stay competitive in research at an international level and within the European scientific community, the active participation of Austria in setting-up and implementing EU-wide programs like E-RIHS\textsuperscript{10} and the Joint Programming Initiative on Cultural Heritage (JPICH)\textsuperscript{11} is mandatory.

Heritage Science needs the connection to national as well as international digitisation projects and initiatives:

OpenScience, especially the free access to knowledge generated within research initiatives, is a prerequisite also for Heritage Science. Nonetheless, from the point of view of funding projects mainly focusing on the digitization of objects or collections need to be clearly separated from studies concerning the documentation, preservation and scientific investigation of our cultural and natural heritage. It is also relevant to avoid the blending of the uncontested important aspect of dissemination of results to a wider public with the object related scientific studies within future funding programs.

\textsuperscript{10} www.e-rihs.eu
\textsuperscript{11} www.jpi-culturalheritage.eu
(Vortragssprache Deutsch/Talks in German)

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<td>Fakten schaffen. Einblicke in die Herstellungstechnik des Urkundenkomplexes „Privilegium maius“</td>
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<td>Römerzeitliche Wandmalereien aus dem „Haus der Medusa“: Ein interdisziplinäres Forschungsprojekt</td>
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Chair: Bernhard Pichler

16.00 – 17:30 UHR

Die Period Rooms am Universalmuseum Joanneum in Graz –
aktueller Forschungsstand und Ausblicke
Valentin Delic (Joanneum)

Ein Blick unter die Oberfläche: Enthüllung verdeckter Geheimnisse
an Gemälden der Salzburger Residenzgalerie
Gabriele Groschner (RGS), Martina Griesser (KHM-NatLab)

Erkenntnisgewinn durch Kooperation. Chancen in der Zusammen-
arbeit zwischen den Landessammlungen Niederösterreich und
der Donau-Universität Krems
Armin Laussegger, Sandra Sam (Sammlungen NÖ)
(Vortragssprache: Englisch/Talks in English)

Chair: Manfred Schreiner

9:00 – 9:45 UHR  
Begrüßung/Welcome & Keynote  
Johannes Fröhlich (TU-Wien)  
Heritage Science: Need for Continuous Engagement  
Matija Strlic (Deputy Director of UCL Institute for Sustainable Heritage, London, UK)

9:45 – 10:45 UHR:  
The Centre of Image and Material Analysis in Cultural Heritage (CIMA)  
Heinz Miklas (Uni-Wien/TU-Wien/Akademie d. bild. Künste Wien)  
Isotopic tools for the investigation of cultural heritage objects  
Thomas Prohaska (BOKU)

10:45 – 11:15 UHR  
Kaffeepause/Coffee break

Chair: Tatjana Bayerová

11:15 – 12:45 UHR  
Textile dyeing from prehistory until the Industrial Revolution – interdisciplinary approaches  
Regina Hofmann-de Keijzer (Univ. f. angew. Kunst)  
Heritage science aspects of early Austrian electrotype artefacts  
Valentina Ljubić Tobisch (Uni-Wien)  
Viennese Minnow – the blast from the past  
Anja Palandačic, Ernst Mikschi (NHM)

12:45 – 14:00 UHR  
Mittagspause/Lunch break

Chair: Klaudia Hradil

14:00 – 15:30 UHR  
Fungi and insect pests in museum – climate change as challenge for scientists, restorers and politics  
Katja Sterflinger, Pascal Querner (BOKU)  
Long term stability of materials in art  
Rita Wiesinger (Akad. d. bild. Künste Wien)  
X-Ray into the past. Architectural research and infrared thermography in Schloss Eggenberg  
Martin Mudri, Paul Schuster (Schloss Eggenberg)

15:30 – 16:00 UHR  
Kaffeepause/Coffee break

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Chair: Martina Griesser

16.00 – 17:30 UHR

Lasers in Cultural Heritage Science: Cleaning and Stratigraphy
Wolfgang Kautek (Uni-Wien)

Materials of Contemporary Art – A Challenge for Analytical Chemistry
Valentina Pintus (Akademie d. bild. Künste Wien)

Clothing remains between 2000 BC and 1000 AD. Interdisciplinary research and dissemination concepts
Karina Grömer (NHM)

17:30 – 19:00 UHR

Posterpräsentation/Poster session

19:00 – 20:00 UHR

Öffentlicher Abendvortrag/Public evening lecture
TU Wien, Hauptgebäude, Karlsplatz 13, 1040 Wien, Hörsaal 8, 2. Stock (Heinz Parkus Hörsaal)

Old master paintings and innovative X-ray imaging – the road to new insights on past and future
Koen Janssens (Faculty of Sciences, University of Antwerp, Belgium)
(Veranstaltungssprache: Englisch/Language: English)

Chair: Martina Griesser

9:00 – 9:15 UHR  Begrüßung/Welcome
Michael Alram (ÖAW)

9:15 – 10:45 UHR:  European Research Infrastructure for Heritage Science
Luca Pezzati (E-RIHS coordinator; INO-CNR, Istituto Nazionale di Ottica, Florence, Italy)

CLARIAH.AT: Doing it the Austrian Way
Karlheinz Mörth (ÖAW – Austrian Centre for Digital Humanities)

Development of E-RIHS France, the French national infrastructure for Heritage Science
Loïc Bertrand (Director IPANEMA European ancient materials photonic research platform, SOLEIL, CNRS, Paris, France)

10:45 – 11:15 UHR  Kaffeepause/Coffee break

Chair: Manfred Schreiner

11:15 – 13:00 UHR  The various expectations from Cultural Heritage
Sabine Ladstätter (ÖAI)

New Need for Old Sciences: Diplomatic and Epigraphy and their Contribution to an Interdisciplinary Reassessment of European Cultural Heritage
Andreas Zajic (ÖAW – Institut für Mittelalterforschung)

Challenges and Opportunities in Digital Archaeology
Edeltraud Aspöck, Barbara Horejs (ÖAW – Institut für Orientalische und Europäische Archäologie OREA)

IAEA support to study of tangible cultural heritage
Iain G. Darby, Roman Padilla-Alvarez (IAEA, Nuclear Science and Instrumentation Laboratory)

13:00 – 14:30 UHR  Mittagspause/Lunch break

14:30 – 16:00 UHR  Podiumsdiskussion/Panel discussion
Heritage Science in Austria within the European context
Moderation: Johannes Fröhlich (TU-Wien)
Mit/With: Eva Blimlinger (Akademie d. bild. Künste)
Sabine Haag (KHM)
Bernhard Palme (Universität Wien, ÖAW, ÖNB)
Luca Pezzati (E-RIHS coordinator; INO-CNR, Italy)
Klement Tockner (FWF)

16:00 – 16:30 UHR  Abschluss/Closing session
In 1543, Benvenuto Cellini handed over a golden work of art to Francis I., King of France. The iconographic content of this piece was dominated by the opposite poles of salt and pepper. Made of precious material and guided by complex and ambiguous content components, this work of art served as a distinction instrument for its commissioner: the owner not only underlines his wealth and prosperity, but also knowledge and wisdom. The knowledge of the complexity of the artwork could easily serve to demonstrate the own intellectual and knowledgeable superiority. Thus, the original main function of this work of art lay in the representation of the claim to royal interpretative authority and to royal power. With the death of the commissioner, this original function was extinguished and the work of art should be fused. Only by chance, the golden artwork, the *Saliera*, escaped the melting pot. It became a diplomatic gift, which sealed the marriage between Charles IX of France and Archduchess Elisabeth of Austria. In the course of two centuries, it scraped a hidden and almost forgotten living at Ambras Castle near Innsbruck. It was only in the late 18th century that the emerging historical and art-historical interest led again to the insight, that the *Saliera* was “the original work of the famous sculptor Benvenuto Cellini,” as we read in the inventory of 1788. At the time of the Vienna Congress, this “original work” was made accessible to the public in the k.k. Ambras collection in the lower Belvedere. Its “rediscovery” was propagated through newspaper announcements and lectures and brought to the attention of Goethe, the translator of Cellini’s *Vita*. Later, the golden work of art was transferred to the Imperial Coin and Antique Cabinet, even later to the Imperial Treasury. With the opening of the *k.k. Kunsthistorisches Hofmuseum* (now Kunsthistorisches Museum), it finally came to be a part of the “Sammlung kunstindustrieller Gegenstände” (now Kunstkammer). Here, it continued to experience a changing history, in order ultimately to be highly stylized as an icon, as an identification object for the entire museum, and at the same time to be demoted as a marketing instrument.

This briefly sketched “life” of the work of art is intended to show that the comprehension of the history of meaning of an artwork can sometimes make more sense than its consideration as a historical fact in seclusion. As we learn from the aesthetics of reception, the changing characteristics of a work of art reflect the specifics of the time. In this respect, we gain from such an observation both, insights in specifics of past times as well as into our own time.

For such a survey, we can hardly find any other work of art, which would be more suitable than the *Saliera*. Its origin is documented from the first conceptual phase in Rome to the execution in Paris. At the same time, it is the artist himself, who describes this process and the genesis of his work. In his autobiography, the *Vita*, he describes in colorful pictures the circumstances in which the work was thoughtfully born and ultimately materially implemented. In the *Trattati*, a meticulous treatise of artistic techniques, he finally presents in detail the nature of his technical achievements. In so doing, he elucidates the fact that he had done the golden work for Francis I. in freehand hammering technique. He would have applied this most elaborate, most challenging and most demanding of all goldsmithing techniques – an undertaking that sounds almost unbelievable, if we consider the compositional clarity of the artwork and its virtuoso appearance. At the same time, however, this is the technique by which the goldsmith can put his art into competition with the rival art forms of painting and sculpture. Only
this technique allows composing during the artistic process, thus approaching Michelangelo's technique of liberating figures free-hand from the marble block, literally designing them as he carved the stone.

Apart from this approach, which belongs to the field of the *paragone*-debate, we find in Cellini's *Trattati* detailed recipes and descriptions of manufacturing techniques. Considering the exaggerated and novel-like explanations in his autobiography these descriptions should not be trusted with blind faith. They rather should be tested either experimentally or on the analysis of existing originals. In the field of goldsmithing, only the *Saliera* can be considered for such a review since it is the only reliable work in this field.

In the course of broad scientific studies, the materiality and the manufacturing techniques of this goldsmith work were examined and the results compared with the data in the *Trattati*. The results of these studies can not only be used as references in the field of technical issues of comparable works, but also provide information about the credibility of the data given in Cellini's *Trattati*. In fact, we can now say that the information given in the *Trattati* coincides with the results gained from our examinations – which in turn implies that we should consider Cellini's *Trattati* as a credible source and as a practical textbook on Renaissance goldsmithing and sculpture.

The results and interpretations of these analyses as well as the historico-cultural-, historical- and art-historical researches, will be published in a comprehensive publication. This book is supported by the Samuel H. Kress Foundation, New York, and the Friends of the Kunsthistorisches Museum. Both in terms of content as well as in its composition, this book is based on the idea of capturing the life of a work of art, but also on the idea of reflecting Cellini's two writings: the *Vita* and the *Trattati*. According to the technical textbook, the second part of the publication, with its scientific and technical investigations, resembles the description of the anatomy of the work. The first part is its biography, its *Vita*: it starts with the social and historical environment, leads to the genesis of the work and draws its character – its iconography. Furthermore, the different steps in the life of the *Saliera* are traced, from the intellectual birth in the age of Mannerism up to our time. An epilogue is devoted to the coins and medals of Cellini, which are kept in the Kunsthistorisches Museum, thus rounding out the view on the artist, his work and its history as a collectible.

In order to implement this study, which tried to look at an unprecedented work of art from as many different angles as possible, the scientists of the Kunsthistorisches Museum were supported by experts from the international university and museum sector. In addition to Martina Griesser, Helene Hanzer, Gabriele Helke, Paulus Rainer, Konrad Schlegel, Katja Schmitz-von Ledebur, Václav Pitthard, Katharina Uhlir, Heinz Winter and Karin Zeleny from the Kunsthistorisches Museum, Denise Allen from the Metropolitan Museum of Art New York, Michèle Bimenet-Privat from the Musée du Louvre Paris, Andreas Prater from the University of Freiburg, Martin Warnke from the University of Hamburg and Sascha Winter from the Academy of Sciences at Göttingen were involved in this project.

The technological studies were supported by the Vienna University of Technology (scanning electron microscopy – SEM/EDX), the Seibersdorf Laboratories of the International Atomic Energy Agency (IAEA; X-ray fluorescence analysis – XRF) and the FH Oberösterreich Forschungs- und Entwicklungs-GmbH, Wels (computer tomography – CT). Hence, this project put out results creating new foundations and at the same time fulfilling the expectations that a work of great European dimensions demands on us. This may also apply to the general approach, which could well be a guide for further projects.
Antique Portraits in Vienna – A forMuse-Research Project of the Collection of Greek and Roman Antiquities [1]

Preparation of a catalogue raisonné of the portrait sculptures in the Collection of Greek and Roman Antiquities of the Kunsthistorisches Museum

Manuela Laubenberger and Ulrike Müller-Kaspar

Collection of Greek and Roman Antiquities, Kunsthistorisches Museum Vienna, Burgring 5, 1010 Vienna

The sculpture holdings of the Kunsthistorisches Museum’s Collection of Greek and Roman Antiquities [2] include a large number of portraits – primarily Roman marble busts – that were repeatedly altered between late antiquity and the modern era. These additions and reworkings are closely connected to both the history of the collection in Vienna and that of their original collections, which evolved over at least five centuries and reflect contemporary fashions and taste.

Our research project therefore focused on the criteria that can or should be applied when evaluating a sculpture in a historic collection that – unlike archaeological finds – has not been preserved in its original condition but has undergone several alterations since its discovery.

In addition to compiling a comprehensive documentation for each portrait (location, previous owner(s), acquisition, history within the collection), the main focus of our work is on identifying and listing all later additions and alterations, and on provenance research.

In conjunction with information on the artefact’s history, the stylistic and technical analyses of these alterations and additions offer a new and more comprehensive survey of historical changes to classical sculptures.

In the course of the project, it was also necessary as a first step to deal with the history of the collection. Secondly, it became apparent that many questions required us to look also at male busts, e.g. formerly in the large Obizzi Collection (“Este Collection”). And, thirdly, restorations became visible that were carried out in the 18th and 19th century, which in effect means we are dealing with sculptures repeatedly reworked and altered in classical antiquity and again since the 16th century.

Our cooperation partners were an internationally renowned research institution (Vienna, Österreichisches Archäologisches Institut, Dr. Maria Aurenhammer) and two major European Museums (Madrid, Museo Nacional del Prado and Dr. Stephan Schröder; Munich, Staatliche Antikensammlungen und Glyptothek and Prof. Dr. Raimund Wünsche).

With these two museums we share similar origins and thus a similar collection history – former royal collections begun in the 16th century – and functions (e.g. artefacts used as decorative objects). Our discussions produced valuable methodical suggestions and a lively exchange of experiences. Additionally, we got in touch with other institutions that are researching similar topics. Thus we participated in two international symposia and a scientific collaboration on the afterlife of classical portraits at the Autonomous University of Barcelona [3].
The aim of our three-year research project was to compile the first part of a catalogue raisonné of our collection, which comprises a total of 63 female portrait sculptures of identified or unidentified empresses, women, girls and poetesses. Preparatory work for our project had already been carried out in connection with the new installation of the collection in 2003 and 2005: the fifteen female portraits that have been on display since September 2005 were newly restored, installed, photographed and documented. Conservation interventions, analyses of binders and supplementary materials as well as photographing were then extended to include all female portraits in the collection. High definition photographs and a detailed mapping of their condition form the basis of the projected new catalogue raisonné. The results of this research will also be included in the Kunsthistorisches Museum’s image database.

[1] forMuse - Research in Museums – A support programme of the Federal Ministry of Science and Research. The generous support of the Federal Ministry of Science and Research helped pay for additional staff and safeguarded work on the extensive research project for three years 2009-2012. The continuation of this project was partially financed by the Kunsthistorisches Museum and the Friends of the Kunsthistorisches Museum.

[2] Only about twenty per cent of the c. 250 portraits in the collection (excl. finds from Ephesus) are on display; the remaining objects are in the depot and most have not yet been published.


Two examples of Roman Portraits with modern bust and base, restored in the 16th - 17th c.:

**Julia, daughter of Titus** (63 - 89 n. Chr.), Collection of Greek and Roman Antiquities, inv.-no. I 1296 and

**C. Julius Caesar** (100 - 44 v. Chr.), Collection of Greek and Roman Antiquities, inv.-no. I 1486. (© KHM)
Small but powerful.
Medals as part of visual representation under
Empress Maria Theresa (1717–1740)

Anna Fabiankowitsch

Coin Collection, Kunsthistorisches Museum Vienna, Burgring 5, 1010 Vienna

During the 18th century, medals were a popular means of distributing a monarch’s image into the world. They offered place for political statements, dynastic propaganda, or the staging of power. Hence, during Maria Theresa’s reign (1740–1780), medals were playing a central role in visual representation. [1] Being among the period’s foremost artistic mass media, they were regarded as a historical record that would last forever.

The Kunsthistorisches Museum Vienna (KHM) holds both the largest and by far the most significant collection of medals minted under Maria Theresa. For the preparation of publishing this stock, it proved of huge importance to research the historical conditions of medal production, distribution and function. Furthermore, by cooperating with the Art History Department of the Institute for History of Art and Musicology of the Austrian Academy of Sciences (ÖAW), numismatic research results could flow into a broader (art) historical context. The research project “The representation of rulers and the historical culture under Maria Theresa (1740-1780)” directed by Univ.-Doz. Dr Werner Telesko (FWF project P27512) built the framework of the interdisciplinary scientific exchange. First achievements of this collaboration were incorporated in the exhibition “Zuhanden Ihrer Majestät. Medaillen Maria Theresias” (28.03.2017–18.02.2018, KHM) and its catalogue [2] as well as in the conference „Kaiserin Maria Theresia (1717–1780). Repräsentation und visuelle Kommunikation“ (29.–31.3.2017, ÖAW/KHM).

To give one example of the comprehensive research results, the production and function of the medals on the coronation in Preßburg in 1741 is representative. Maria Theresa’s Hungarian coronation took place during the Austrian war of succession. Due to this uncertain period, the coronation ceremony was of enormous significance for the consolidation of her power. [3] Numerous votive medals were produced on this occasion. Their distribution to honoured guests and to the public was part of the traditional coronation rituals. Besides these “official” medals, also commemorative medals made by the medallists Matthäus Donner, Anton Wideman and Andreas Vestner exist. [4] They all pick out the traditional coronation ride as central theme, showing Maria Theresa on horseback, the coronation sword in her right hand, in front of the skyline of Preßburg. The small format demanded compressed, symbolic representations. Designing of these messages was an important task – the pictures were after all to be preserved for eternity and contribute to shaping the myth of the Empress.
Medal commemorating the Hungarian coronation of Maria Theresa.
Matthäus Donner, Vienna,
KHM, Coin Collection, inv.no. 1885bB


Vienna Genesis: Research on Late Antique Silver Inks

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Vienna Genesis is a fragmentary Greek manuscript of the book of Genesis written in silver ink on purple dyed parchment. On each folio miniatures illustrate the text on recto and verso. Text and images were carefully edited and form a unit. The manuscript with its 48 miniatures is dated to the first half of the 6th century. Vienna Genesis was integrated in the Royal Court Library in 1664. Prefect Peter Lambeck clearly described deterioration caused by the ink at this occasion. The components of the ink and unfavourable storage conditions have caused severe degradation of the parchment carrier.

It is the aim of an international research project supported by the Austrian Science Fund FWF to investigate the materials of the manuscript and to find the best methods for conservation and storage. Vienna Genesis is one of few illuminated manuscripts that have been preserved from late antiquity. Material analysis is needed to study the art technology that painters and scribes used before the development of scriptoria in the Middle Ages. In order to better understand the manufacture and the deterioration process, the composition of the ink was analysed with SEM (scanning electron microscopy), XRD (x-ray diffraction) and XRF (x-ray fluorescence) analysis. Based on the results of the ink’s analysis two sets of silver inks were prepared according to historical recipes and applied on purple dyed parchment. In addition to the main component of powdery silver, the historical recipes contained a wide range of different non-metallic and metallic components, like saltpetre or verdigris. Samples of silver ink on parchment were then submitted to accelerated aging. Suitable ageing conditions (95 °C, 30/70 %RH for 13 days) were chosen based on the detection of the parchment’s shrinkage temperature, which corresponds with the material’s grade of deterioration, by MHT method (Micro Hot Table).

Also the artificially aged samples were analysed with XRF, XRD and MHT method. Depending on the reference inks’ composition, the samples showed different degrees of damage as a result of the accelerated ageing. Copper content in inks can result in degradation of the parchment carrier. XRF analysis of the original silver ink showed considerable amounts of copper and an almost constant ratio between silver and copper throughout the entire codex. However, the exact amount of copper in the used silver ink is hard to evaluate based on the reference inks. In order to verify external/environmental influences on the degradation of the silver ink, chosen reference inks will be chemically altered with hydrogen sulphide, nitrous gases and sodium chloride containing aqueous vapours in a second series of artificially ageing and will be analysed with in-situ XRD.

The results of the ongoing project will be applied in the conservation of the fragile silver ink. Areas with loose particles of ink and parchment have to be stabilised. The methods and materials used in conservation and storage must preserve the current condition. The re-creation of the artistic process helps to understand the former impression of the text: a bright polished silver ink on deep purple parchment.
Damage caused by a copper containing reference ink (ST12) after accelerated ageing.

Damage caused by the silver ink on Vienna Genesis.
© Austrian National Library
From the basement via the attic to the mezzanine.
The restoration of the daimyō yashiki hinagata, a Japanese architectural model from 1873.

Henriette Wiltschek (1) and Florian Rainer (2)

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Through the basement, attic, and mezzanine, the story of the daimyō yashiki hinagata unfolds. This Japanese architectural model from 1873 was made by the workshop of Musashiya, exclusively for the Vienna World Fair. The creators aimed to use the same materials as would be used in the real building. Where this was not possible, similar materials or imitations were substituted. The model is built of wood, stone, paper, ceramics, metal, and plant fibres, with every detail executed with precision. The entire model consists of three parts, measuring approximately 454 cm in length and 303 cm at its widest point.

For too long, this model was stored in the Weltmuseum Wien before Bettina Zorn, the curator, identified it in 1995 as one of the Japanese models from the 1873 Vienna World Fair. After raising funds, extensive restoration began in 2013, led by Florian Rainer and Henriette Wiltschek. The project involved conservators and students of conservation, as well as assistance from several other experts. Miniature tiles were produced by the Vienna University of Technology, wooden spare parts were crafted by Werner Ramharter, and architectural research was conducted by Gergely Barna and Shigeatsu Shimizu.

The Conservation Science Department of the KHM and Yosei Kozuma did the analysis of pigments and binding media, and also analysed the tiles for further research and documentation. Research around the model and related topics was conducted, including an international conference held at the Weltmuseum Wien in 2014. The contents of this conference were published in the Archiv 65, Archiv Weltmuseum Wien, 2015.

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1 A Japanese regional lord.
4 Florian Rist, senior scientist at the Institute of Art and Design, Vienna University of Technology and Jenny Grabenhofer, student at the Vienna University of Technology
5 At that time PhD candidate at Kyoto Institute of Technology
6 Professor at the Kyoto Institute of Technology
7 Nara National Research Institute for Cultural Properties
The daimyō project bore numerous challenges, like coordinating work on the model, understanding the materials used as well as the difficult transportation of the individual bulky parts: from the cellar to the first workspace set-up in the mezzanine, then to the second workspace in the attic and afterwards again to the mezzanine, this time into its final showcase. At that time the museum housing the daimyō residence was partly under construction itself, so it was difficult to find sufficient space to work.

In the end, everything turned out well. In September 2017 the daimyō yashiki hinagata was installed into its showcase at the newly reopened Weltmuseum Wien, as part of its permanent exhibition.

Working together and coordinating various different groups of experts are crucial for any large-scale project. Such projects take a great deal of time and money. Time pressure, setbacks concerning small details and a general lack of funds necessitate an enormous degree of flexibility as well as creative problem-solving.

However, they are always worth the trouble, for without them, important cultural heritage will be lost forever.
The marbles of the Roman emperors –
The provenance of ancient marbles

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The significance of colored marbles as prestigious materials and trading goods is uncontested in the field of research into cultural-historical antiquity, and numerous studies have been devoted to this theme. The problem for comparable studies for white and for white-grey marbles is that the possibilities to characterize white marbles by the naked eye are rather limited. The vast number of investigations in this field during the last years have revealed a large number of locations of marble quarrying in antiquity. Only moderate progress in the methods and techniques to discriminate between these marbles, however, has been made and often the analytical methods applied are restricted to stable isotope analysis. This entails that the corresponding data-fields of the different marbles often overlap and consequently the possibilities of a sound identification are often very much restricted. During recent years we have achieved some progress by extending the techniques of marble provenance analysis. To safely define the origin of ancient white marbles of artefacts one single method as for instance the analysis of the stable isotopes is usually not sufficient for a safe discrimination. A multimethod approach, including additional chemical analysis and the analysis of microinclusions in the marbles, substantially improves the discrimination of macroscopically similar marbles.

The discovery of the abandoned ancient quarries of Göktepe in Asia Minor a few years ago turned out to be a landmark in the investigation of Roman portrait marbles. By then thousands of artefacts of Göktepe marble displayed in the museums were considered to be Carrara. This discovery unveiled the existence of a so far unknown marble of utmost importance and contributed essentially to the knowledge of the marbles used in Roman times throughout the whole empire. The production of fine-grained white marble of highest quality used almost exclusively for portraits is attested from the mid of the first century AD until advanced late antiquity. The petrographic and chemical features of the Göktepe and Carrara marbles presented here allow an unambiguous discrimination of these two types of marble. On this basis, it can be demonstrated that the marbles from Göktepe were in fact the most important portrait marbles in Roman Antiquity.

More than 200 Roman Imperial portraits were investigated using isotopic, trace elements, EPR and grain size analyses with the aim of obtaining quantitative data on the use of sculptural marble. Imperial portraits, mostly coming from Rome, were selected for being top quality sculptural productions of known chronology that may provide important diachronic information. The selection spans approximately 500 years from the mid 1st century AD (portraits of Caesar were analyzed) to the end of the 4th or beginning of the 5th century AD, because a portrait identified as Valens or perhaps Honorius was tested. Additional archaeometric work, presented elsewhere, was carried out to improve discrimination and especially, to obtain unequivocal separation between Carrara and Göktepe. Twelve different marbles were identified, but most of the portraits were made using only four different varieties that are, in order of frequency, Göktepe, Parian lychnites, Carrara, and Docimium (see Fig.1). Approximately half of the portraits (48 %) were found to be Göktepe with Parian lychnites following at great distance.
(21 %). The distribution frequency is strongly time dependent. Till the end of the 1st century AD the marble of choice was lycnites, used for 78 % of the Julio-Claudian portraits analyzed. A sudden change, however, happened in Hadrian times when the use of lycnites sharply reduced to 10-15 % and was replaced by Gökstepe (60 %) that became the statuary marble par excellence, a trend that continued and grew further in later times. The portraits of Caracalla provide a particularly striking example of this tendency. Ten portraits of this emperor were tested: nine of them turned out to be Gökstepe, whereas the last one is marble of the Aphrodisias city quarries. Within this picture the marble of Carrara plays a rather minor role. This is the first large scale quantitative study on the use of sculptural marbles and leads to the clear conclusion that, during Imperial times, Gökstepe became the most important and widespread marble used for top quality sculpture. Apparently, its use, introduced by Aphrodisian sculptors, rapidly extended to most metropolitan ateliers. The significance of this phenomenon in determining the stylistic and technical peculiarities of urban production will be briefly considered.

Fig.1: The change of the marbles used for the imperial portraits throughout time (JC-Julio/Claudian, Fla-Flavian, Traj-Trajanic, Hadr-Hadrianic, EA-Early Antonine, LA-Late Antonine, Sev- Severan, LE-Late empire).
The Privilegium maius is one of the most famous and most spectacular forgeries in medieval Europe. In 1156 Austria became a duchy. For this solemn act emperor Friedrich I Barbarossa issued a charter with a golden bull for the ruling family in Austria, the Babenbergs. Two centuries later duke Rudolf IV, a member of the Habsburg family, commissioned a forgery of this charter and of four others. He wanted to elevate the rank and the prestige of his family and to show that they at least equalled the electors of the Holy Roman emperor. Today, these five charters are kept in the Haus-, Hof- und Staatsarchiv Department of the Österreichisches Staatsarchiv in Vienna. Since almost 200 years, it is known that the documents are false: due to their inner and outer characteristics, historians have been able to see through the albeit excellent forgeries.

In 2017, a scientific conference regarding the forgeries took place in Vienna, with the scope to bring the experts on the topic together and to catch up on the latest developments in the investigation of these famous documents and the environment in which they came into existence.

For a better understanding of the materials and techniques used to produce the set of falsified documents, non-destructive investigations combining different photographic and analytical techniques were performed at the Kunsthistorisches Museum Vienna (KHM). Diagnostic techniques leading to information concerning the condition of the documents, i.e. VIS- and UV-photography, were combined with X-Ray radiography, Infrared reflectography (IRR), and X-ray fluorescence (XRF) studies to answer technological questions concerning the writing materials as well as the ones used in the wax-based and golden plated seals.

Jiri Vnoucek, University of York, UK, who investigated the parchment, supported these investigations. For further studies, concerning the composition of the wax in the seals, gas chromatography-mass spectrometry (GC-MS) was applied by the Conservation Science Department of the KHM to a limited number of wax samples. To identify the colorants used in the cords of the seals further studies were performed by Maurizio Aceto, Dipartimento di Scienze e Innovazione Tecnologica, Università degli Studi del Piemonte Orientale, Italy.

The partly unexpected results allowed new insights into the production as well as the preservation history of the documents, which will be shown to the public within an upcoming exhibition at the KHM in autumn 2018.
UV and IRR image of the document dated to 24th August 1228.
"The House of Medusa" in Enns, Austria: An interdisciplinary restoration project of Roman wall paintings

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In 2000/01, during archaeological emergency excavations, Roman wall paintings were found near the town of Enns in Upper Austria. Enns, the antique Lauriacum, was a very important city during the Roman Imperial Period. The paintings were part of a vaulted ceiling with corresponding wall decorations in a private residence from the 3rd century A.D. The archaeological find substantially extends our knowledge about Roman wall paintings in Austria; so far, there has not been found such a large complex, which stems from several rooms of the same site. In addition, the fragments show up to four painting layers with different decorations. The wall paintings are of surprisingly good quality regarding their painting technique as well as their conservation status. One room of the house was completely repainted three times with entirely different decoration programs.

In 2012 the Department for Conservation and Restoration in the Federal Office for the Protection of Monuments started an interdisciplinary project in collaboration with the Department of Archaeology. At that time nobody expected that the five big blocks and 60 wooden boxes full of fragments would result in over 2000 fragments. The first project phase pursued the aim to detach the blocks from the finding situation and develop a long-term conservation strategy. Further key topics included the excavation as such, documentation, cleaning, consolidation and stabilization of the fragments and storage conditions. In view of the enormous number of single fragments from different decoration systems and various rooms, the main challenge was to keep the overview and to reassemble the fragments into bigger pieces. The complexity of the tasks required an interdisciplinary scientific discourse. Hence, the restoration process was supported by archaeological research and scientific investigations.

The outcome of this restoration project is presented in the current exhibition entitled "The House of Medusa" at the Kunsthistorisches Museum in Vienna. The concept of the exhibition traces the way of the fragments from the point of excavation to the finished ‘product’ after restoration.
The Period Rooms at the Universalmuseum Joanneum Graz: Current state of research and future prospects

Valentin Delic

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The Universalmuseum Joanneum in Graz, founded by Archduke Johann of Austria, houses one of the most important, yet little known early collections of Period Rooms. It is one of the earliest examples for Period Room displays in the world, starting soon after the first documented exhibitions of complete historic interiors by the Bayerisches Nationalmuseum in Munich and the Germanisches Nationalmuseum in Nuremberg. Karl Lacher (*1850 †1908) was an outstanding figure in the early development of this momentous concept of museum display. First professor at the School for Applied Arts in Graz, he became founding director of the Culturhistorisches & Kunstgewerbe=Museum, which is part of Universalmuseum Joanneum today.

When Karl Lacher came to Graz in the early 1870ies, he soon became interested in historic interiors. On his explorative journeys throughout Styria, he acquired seven complete ensembles dating from the Renaissance to the Empire. Two further interiors from the eighteenth century, the pharmacy of Bad Radkersburg and the so called Maria-Theresien-Zimmer from the castle in Murska Sobota/Slovenia, were acquired shortly before and after World War II. Based on Lacher’s very detailed documentations the circumstances of discovery such as the former owners and locations, conservatory issues, and acquisition are known. The most important Period Room of the collection, the Knights’ Parlour of Otto von Radmannsdorf from Castle Radmannsdorf near Weiz, is dated to the year 1563 with documented names of the two master craftsmen. Lacher’s concept of Period Room display was an absolute novelty at its time going beyond the examples from Munich and Nuremberg.

Lacher’s interest and innovation at this time was his focus on the complete room including its floor, wall panels, windows, doors and furniture. His concept of period rooms even included museum architecture. Decades after he began to collect ensembles, Lacher influenced planning and construction of the new museum building led by architect August Gunold in 1890 to 1894. The northern wing of the museum was perfectly adapted to the historic interiors with their specific requirements regarding dimension, light, and accessibility. This adaptation of architecture is most remarkable and contrary to most exhibitions, where Period Rooms are adapted to fit into the museum. Thus, Lacher succeeded in creating an extraordinarily authentic setting for his ensembles within a museum context.

Lacher’s concept of Period Room display became immensely influential and served as model for other museums such as in Zurich or Munich, which are much better known today. The Period Rooms themselves and Lacher’s publications about it had a large and demonstrable influence on the cultivation of and taste in home decor around 1900 in Graz, Styria, Austria and beyond that.
Today’s little attention of scholars towards the Period Rooms in Graz and their impact results from the museum’s policy in recent decades. Starting in 1964, the ensembles were gradually dismantled and eight of them were de-installed in favour of special exhibitions. The last remaining ensemble, the Renaissance parlour, was closed to the public for conservatory reasons. In 2011, the cultural history collection moved from its original site to the Palais Herberstein, itself a historic building from the eighteenth century. The only example of Period Rooms that was put on display there from 2011 to 2017 was the Leykam-Zimmer.

This situation requires prospective solutions: Do we have any possibilities to present all the important Styrian Period Rooms to the public in future? Should such presentation be physical, or can we replace it by virtual means? Is it possible to document and digitize the whole rooms or parts of it for such virtual presentations? What is the design and location of virtual presentations and how does it affect the experience of visitors? Should it be available only on the museum’s webpage or, for example, in addition to the documented, conserved, restored and, based on Lacher’s concept, re-appointed Renaissance parlour? All these questions will be discussed in my PhD.
A look below the surface:
Uncovering hidden secrets of paintings kept in
Salzburg’s Residenzgalerie collection

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The Residenzgalerie Salzburg (RGS) houses the Land’s Old Masters collection. Dutch paintings of the 17th century came into the property of the RGS by the purchase of the former Czernin collection in 1980. Today they occupy an important position within the collection.

The Old Masters collection includes an early genuine Rembrandt painting (Rembrandt Harmensz van Rijn, Old Woman Praying, oil/gilded copper plate, Residenzgalerie Salzburg, Inv. No. 549). A research project on this painting was started by the research office of Land Salzburg in 2014/15. In the summer of 2016 the project was expanded in cooperation with the Kunsthistorisches Museum Vienna (KHM) and the company XGLab, Milano, Italy. For the first time, comprehensive technical examinations were carried out using portable non-destructive investigation techniques. The project traces provenance, painting materials, texture, genre (tronie), specific features of Rembrandt’s character studies, methods and processes used in his workshop, contemporary critique, art-historical background and the artistic environment in Rembrandt’s native town of Leiden.

Rembrandt’s Old Woman Praying, 1629/30, belongs to a series of three small-scale tronies executed on a gilded copper plate. This unusual painting support is a special feature both in Rembrandt’s work and in the entire history of art. Today the two reference paintings are kept in the Mauritshuis, The Hague (The Laughing Man) and in the National Museum, Stockholm (Self Portrait).

For a deeper study of the painting technique of Old Woman Praying Infrared reflectography (IRR) and X-ray fluorescence analysis (XRF) were used. IRR is well-known in the field of Heritage Science for uncovering underdrawings underneath the paint layers, whereas XRF is used regularly for the detection of inorganic materials, i.e. pigments or metals. Recent developments of the XRF instruments made their in situ use increasingly possible, even in the field of macro X-ray fluorescence scanning (MA-XRF), e.g. the ELIO system by XGLab. Through comparison of the different distributions of elements detected, XRF mapping allows conclusions to be drawn about the sequence of layers.

For the evaluation of the distribution of lead different XRF signals can be used. It was detected that the Pb Mα distribution (originating from a lesser depth) only partly overlaps with the Pb Lα distribution (originating from a greater depth). The Mα line relates to areas of flesh tones, a few lighter shadings and the neckscarf and indicates the use of lead white in these areas. The Pb Lα signals are found additionally in the background, originating from a preparatory paintwork (underpainting) containing lead white. Comparing the Pb distribution from the underpainting with the gold distribution shows that the gold was applied directly on the copper plate, which is in contrast to the two other small-scale tronies.
New questions and investigative techniques into the working process and choice of materials afford new insights, allowing a different perspective – a look “under the skin” of Rembrandt’s painting. Documented here for the first time are the master’s initial ideas and the stages in the development of this painting with a special picture carrier.

The interplay of different sciences enables the acquired results of the technical investigations to be applied to the interpretation of art history. Therefore, the successfully completed pilot project is planned to be pursued in collaboration with the Kunsthistorisches Museum and the University of Natural Resources and Life Sciences. A further research question on the tonal painting of the Haarlemer and Leiden school will follow.

Reference

Scientific Knowledge through Cooperation.

Opportunities of the Cooperation of Lower Austrian State Collections and Danube University Krems

Armin Laussegger and Sandra Sam

Lower Austrian Regional Collections and Danube University Krems

The core missions of museums according to ICOM’s (International Council of Museums) and the Austrian Museums Association’s (Österreichischer Museumsbund) standards are "collecting, preserving, researching, exhibiting and educating" [1]. Research is fundamental for providing a basis for all other fields.

Decisions on what to collect, on which objects may be a meaningful addition to the collection and on what may be considered as unnecessary can be made on the basis of research. Suitable procedures for the preservation of objects can be deduced from research. And, finally, research can find and process the content to be shown with and through objects in exhibitions.

In the year 2006 representatives of ICOM Switzerland, ICOM Germany and ICOM Austria met in Schaffhausen in a meeting called the Bodenseesymposion to warningly call attention to the situation of science and research in museums [2].

One of the speakers was Carl Aigner as the president of ICOM Austria and the director of the Landesmuseum Niederösterreich (Lower Austrian State Museum). His lecture "Museoentertainment" was a critical consideration of the topics science and research in Austrian museums. Relying on a survey of the ministry, he emphasized the shortcomings in the fields of storerooms and research.

This lecture suggests the year of 2006 as a starting point and highlights the initiatives taken since then by the state of Lower Austria to institutionalise and professionalize museum research. A historical review at the beginning shall outline the Museum Niederösterreich’s (Landesmuseum Niederösterreich until 2015) collections’ and the close associated Lower Austrian Regional Collections’ (Landessammlungen Niederösterreich) development.

A description of the Danube University Krems and its Center for Museum Collection Management follows. An outlook will draft possibilities for new approaches to scientific knowledge resulting from the cooperation of Lower Austrian Regional Collections and Danube University Krems.

With the focus on Lower Austria all this shared efforts shall lead to an accessible and eligible museum collection’s inventory, a well-performing cooperation of institutions collecting and dealing with collections, a networking of national and international research facilities, regular publications, innovative collection projects and to defined requirements for communicating and educating of the collections.

The intensification of the cooperation of Lower Austrian Regional Collections and the Center for Museum Collections Management with Lower Austrian regional and town museums as well as with Lower Austrian monasteries and convents is to be considered as an exceptional challenge for the next years. The emphasis will be placed on safeguarding and scientifically accessing outstanding collections.
Fig. 1: Lower Austrian Regional Collections: Art collection in the depot St. Pölten (Photo: Christoph Fuchs)

Fig. 2: Danube University Krems, view to the west from the Goldberg (Photo: Herta Hurnaus)

At first sight, arguing the case for Heritage Science should be straightforward: there is a need to understand and manage cultural heritage, and surely, this is what heritage scientist should be good at. However, cultural heritage is a culturally dependent social construct that requires that the engagement of science with cultural heritage is continuously negotiated. The skillset needed to do this goes beyond the traditional analytical scientific skills and requires not just cross-disciplinarity but also intensive transferrable skills.

To address this and to build capacity in the young field, University College London, University of Oxford and University of Brighton, established the Centre for Doctoral Training in Science and Engineering in Arts, Heritage and Archaeology (www.seaha-cdt.ac.uk). This £8M initiative aims to train 60 PhD students in 2014-2022, and has developed a network of 60+ global partners and 100+ supervisors from academia, heritage and industry. The projects are partly funded from public sources (UK Research Councils), partly from industry and other funding, and all of them require supervision by academic, heritage and industry partners, which ensure engagement across institutional stakeholders.

Additionally, public engagement is at the heart of SEAHA through cohort activities such as science festivals where the public can engage with science and art. The public are further engaged through participatory research and in citizen science projects, thus providing an open and seamless learning environment that extends well beyond the walls of traditional academia and that benefits not only the students but everyone involved in heritage science research.
The Centre of Image and Material Analysis in Cultural Heritage (CIMA)

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The Centre of Image and Material Analysis in Cultural Heritage (CIMA) is an interuniversity research institution which was established at the beginning of 2014 in the framework of the HRSM [1]-project “Analysis and Conservation of Cultural Heritage – Modern Imaging and Material Analysis Methods for the Visualization, Documentation and Classification of Historical Written Material (Manuscripts)” (http://hrsm.caa.tuwien.ac.at/). Specialized on research in the fields of imaging, image enhancement and analysis as well as the non-invasive chemical analysis of the materials used for the production of historical objects, CIMA represents a unique facility with an interdisciplinary approach to the investigation of cultural heritage.

The Centre brings together the expertise of three disciplines from three universities: Philology (University of Vienna), Computer Science (Vienna University of Technology) and Chemistry (Vienna Academy of Fine Arts). Since the partners involved can look back on several years of successful cooperation, the main idea behind the foundation of CIMA was to prolong and intensify this cooperation by establishing a central laboratory offering its services to universities, libraries, museums, exhibitions, etc. Aside from productive research, we have recently started conducting university courses, and, encouraged by the positive reception, we are planning to hold also international summer schools.

Presently the focus of CIMA is on mediaeval manuscripts, written in different languages and scripts. So far Old Slavonic, Greek, Latin, Old High German and some Caucasian parchment manuscripts and palimpsests from the Austrian National Library and various other monastic and public libraries dating from the 8th until the 14th century have been analyzed, but the selection is constantly increased. Apart from richly decorated codices, we are focusing primarily on poorly preserved objects and manuscripts containing overwritten text (palimpsests) that pose particular challenges to its decipherment and description.

Philology. The philologists propose the objects of investigation, supervise the subsequent work and execute the philological examination of the manuscripts. The primary aims of the philologists’ work with the manuscripts are their overall description and the edition of their text(s), leading from the codicological and palaeographical analysis over the reading process, language analysis to the textological work of identification, comparison, stemmatization (if several text-copies are preserved) etc. to the phototypical and critical text edition with apparatuses, indices and glossary. Further aims concern the description (and, if known from other objects: identification) of the producers of the manuscripts’ physical, textual and artistic outfit, the time and place of their origin as well as the time, place and environment in which the object was produced.

While technical aid is used for all outlined steps, the specific attribution of CIMA’s scientists is directed towards codicology including material analysis, palaeography, text decipherment and the preparation of the images for phototypical reproductions. As a result, a great number of important manuscripts
have been successfully examined and partly also edited both by CIMA members and colleagues of other Austrian and foreign institutions.

**Computer Vision.** The computer vision specialists work on the digital restoration and readability enhancement of degraded writings by means of Multispectral Imaging (MSI) and the subsequent enhancement of the images. For these purposes, a set of tools and techniques for post-processing have been established, from the fine registration of the multispectral layers up to dimensionality reduction and binarization.

![Fig. 1: MSI-setup and an example of a successful text restoration](image)

**Material Analysis.** The development of new instrumental devices and the advances in computer science have led to a miniaturization of the equipment for material analyses, which allows the on-site application of non-invasive techniques in libraries, museums etc. CIMA presently applies three complementary methods in order to analyze the materials found in manuscripts (parchment, inks, pigments, dyes): X-ray fluorescence analysis (XRF), Fourier Transform InfraRed spectroscopy in the reflection mode (rFTIR) and Raman spectroscopy.

![Fig. 2: Material-analysis of manuscripts in the Austrian National Library, Vienna, a) with ELIO-XRF analyzer and scanner, b) ALPHA rFTIR and c) Raman spectrometer.](image)

Questions of provenance and authenticity are of major concern with regard to cultural heritage objects and place still a challenge to scientists in order to provide reliable evidence based on analytical results. A variety of analytical methods has been established to pursue the question of interrelations and origin in a historical context. The investigation of isotopic systems has been applied increasingly and play a key role for age dating, provenancing and authentication of cultural heritage objects. In this context, natural isotopic variations result in a specific fingerprint depending on origin, manufacturing or processing.

Within the last decades, an increasing spectrum of isotope systems has been established [1] and applied in archaeometry for the investigation of cultural heritage objects.

Fig. 1: Isotopic systems applied in archaeometry
In many cases, the classical ‘COHNS’ isotope systems (C, O, H, N, S) have been used successfully. However, by improving the instrumental prerequisites, the natural variability of other isotope systems, often referred to as "non-traditional", has been discovered and the potential for different applications has been recognized. The Sr isotope system is of particular importance for the investigation of ceramics, clay vessels, stones and minerals as well as glass products, but also of objects of animal or human origin. Pb isotopes serve for the assignment of metallic as well as glass objects. Ag, Cu, Zn, Os or Sb have been used for the characterization of metal goods.

While many studies on isotopic tracing have relied essentially on using one isotopic technique, it is the combination of several isotopic techniques that provides more detailed information about the investigated object.

Textile dyeing from Prehistory until the Industrial Revolution – interdisciplinary approaches

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In the field of textile archaeometry research on textile dyeing is based on interdisciplinary cooperation with experts in chemistry, biology, history, archaeology, the history of arts, conservation and restoration. National and international projects deal with the question how cultural textile objects from prehistoric times up to the Industrial Revolution were dyed.

Aim of these research projects is to enlarge the knowledge of dyeing techniques by analyzing the dyes and fibers of textile objects, by studying written sources, such as dyeing recipes and patents, and by performing dyeing experiments. In cultural heritage research the gained knowledge can be applied in order to get information on the history of an object, to clarify causes of color fading, bleeding and fiber degradation.

The first part of the presentation deals with comprehensive research projects on textile dyeing of certain periods and regions. These projects were mainly funded by the Austrian Science Fund (FWF) and took place in cooperation with the Cultural Heritage Agency of the Netherlands in Amsterdam:

• Bronze and Iron Age textiles from the prehistoric salt mines of Hallstatt in Austria, 2002-2012, Natural History Museum Vienna, FWF: L 431-G02, EC project HERA/CinBa [1, 2];
• Scientific investigation of dyes, pigments and paintings on silk fabrics of the T'ang Dynasty (Famensi, Province Shaanxi, China), 2013-2014, Römisch-Germanisches Zentralmuseum Mainz, BMBF der Bundesrepublik Deutschland, No. 01UG1102, [4];

The second part focuses on the research of objects of Austrian museums and collections [7].

During the restoration of the ‘Dr. Johann Fuchsmagen tapestry’ from the Cistercian Abbey Stift Heiligenkreuz, manufactured between 1499 and 1510 in Brussels, dye analyses showed that the colorfast red dye madder was used, but also not colorfast ones, such as redwood and orchil, although their use was prohibited around 1500 [8].

In 1764 the Edelsteinstrauß, one of the most famous objects of the Natural History Museum Vienna, was a present of Maria Theresia for her husband Franz Stephan von Lothringen. The blossoms and insects are made of hundreds of brilliants and gemstones. The originally green color of the silken leaves has been faded now.

The 1854 white ‘wedding-eve party dress’ (‘Polterabendkleid’) of the later empress Elisabeth of Austria, is decorated with green and gold-coloured embroideries and with green silken ribbons. In contrast to the embroideries the ribbons showed a bluish bleeding which could be explained by dye analysis.
The analysis of early synthetic dyes contributed to the history of objects from the second half of the 19th century to the beginning of the 20th century by giving a terminus post quem dating:

- The upholstery of the 1841 Horse-Drawn Railway Carriage ‘Hannibal’ at the Technisches Museum Wien; the identification of the most recently developed synthetic dye allowed to date the greenish-blue upholstery of the carriage interior after 1880 [9];
- Two 1847 folding screens of the Liechtenstein Museum, Vienna; with natural dyes in the front fabric and synthetic dyes in the rear fabrics [10];
- Red silken wall hangings (‘Ananasdamast’ or ‘Hofdamast’) of the Schönbrunn Palace and the Hofburg Palace could be dated in the last quarter of the 19th century;
- Umbrellas and parasols of the Vorarlberg Museum, Bregenz; they contain synthetic dyes and show fiber degradation caused by a dated silk weighting process [11];
- Four embroideries of Emile Bernard (1868-1941) of the Van Gogh Museum, Amsterdam; they are made between 1892 and 1927 and show a shift in the use of earlier discovered less lightfast synthetic dyes to later discovered ones with an increased light-fastness.


Heritage science aspects of early Austrian electrotype artefacts

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This interdisciplinary study aims at the investigation of the art-history and techno-historical reconditioning of numerous objects of the Vienna Technical Museum. The objects were produced in the period between 1839 and 1851 in the first Austrian laboratory for electrotyping [1]. The collection from the laboratory of Franz Seraphin Theyer (1809 - 1871) and Erwin Waidele introduces an interesting topic both historically and technically speaking. It represents a combination of the electrotyping and graphic technique to produce printing plates and other objects due to the excellent mechanical properties of electrolytically deposited copper and a newly perfected ability to copy and reproduce objects [2].

A systematic analysis of materials has been undertaken in order to gain more information about the production processes, the chemical and morphological composition of the plates and their differing corrosion conditions [3]. Application-oriented basic examinations promise to provide a straightforward methodology for the identification of the techniques employed and respective deterioration phenomena, thus facilitate focussed conservation and restoration measures. The 73 metal objects from Theyer’s laboratory require conservation measures in order to make them available for exhibition and research purposes. Particular attention is being paid to the use of non-destructive methods [4].

Fig. 1  (A) Printing plate 225, © Peter Sedlaczek, Technisches Museum Wien
(B) Printing plate 226, © Peter Sedlaczek, Technisches Museum Wien
(C) Graphic print on paper, © Peter Sedlaczek, Technisches Museum Wien
A systematic analysis and characterization of all metal objects from Franz Theyer’s collection is still in progress. Information about the chemical and structural complexity compiled to date gives us an opportunity to understand some of the processes used in the early years of electrotyping. The presented studies have identified a number of chemical and physical markers for the identification of the manufacturing process. Analytical investigations have shown that the concentration of some elements and coatings is very inhomogeneous, and that this concentration depends on the production methods used. Some silver coatings had an exclusive decorative role while some others have been introduced at different stages of the manufacturing process as part of the technology. Examination of the surface morphology using optical and scanning electron microscopy revealed totally different surface structures. This testifies Theyer’s and Waidele’s know-how for perfect replication of diverse graphical techniques.

The conservation treatment concept includes the reduction of soiling and corrosion as well as areas of strong oxidation. Although a primary goal is to free the material of all impurities in order to retard tarnishing and corrosion, the main aim and challenge will be to undertake the interventions without any deterioration such as micro-scratches or reducing the extremely thin silver coating. Therefore, electro-chemical cleaning methods [5] are being developed which can avoid all these drawbacks. Another important issue that will play a significant role in the conservation treatment concept will be the preservation of any traces of printer’s ink that have survived in the depressions of the motif. This manifest aspect of the objects’ historical function should not be lost.

The artifacts from Theyer’s laboratory are documentary evidence of exceptional technological advances in the field of graphic duplication during a relatively short period of free technological experimentation in the first half of the 19th century in Austria. As such, they provide an invaluable opportunity to research a field which until now is far from being completely understood. The study of electrotype printing plates not only promises to provide fertile ground for the research of refined cleaning and conservation practices but also the chance to relate the artifacts to the prints they produced for comparative studies and exhibitions.

Viennese Minnow – the blast from the past

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In 1836 Johann Jakob Heckel described a new species of minnow from the “clear brooks of the surroundings of Vienna and beyond, Austria” and named it Phoxinus marsilii [1]. However, in congruence with the current trends at the beginning of 20th century, this species was together with several others synonymized under Phoxinus phoxinus – European minnow. As it can be speculated from its name, European minnow was believed to be distributed all across Europe.

It was not until the beginning of 21st century, when the researchers started to doubt this ubiquitous distribution and in 2004, Bogutskaya and Naseka [2] reestablished one species of Phoxinus – Phoxinus colchicus, while Kottelat [3] revalidated three and newly described additional three Phoxinus species in 2007. However, the morphological traits (such as selected body proportions) used for species delimitations and descriptions appeared somewhat problematic, as not all morphologists agreed with the validity of the described Phoxinus species [4] and even described several additional/alternative ones [5]. Moreover, molecular studies revealed additional genetic linages [6, 7] pointing to even greater biodiversity in the European genus Phoxinus as previously expected.

With the advances of the modern techniques, we were able to genetically analyze the type material of P. marsilii collected in 1836 and compare it to freshly collected minnows from the surroundings of Vienna [8]. The study shows that a separated genetic linage is present in this area, thus we reestablished P. marsilii as a valid species.

This presentation explores how climate change affects the micro-climatic conditions in museums and on monuments and how these changes influence and most probably increase the growth of microorganisms (fungi and bacteria) as well as insect pests and their potential to cause damage to museum collections. We have been monitoring the diversity and activity of both agents of deterioration in Austrian museums for over 10 years and can see trends of newly introduced pest insect species as well as fungi in parallel to poor indoor climate. Climate change is expected to bring more frequent flooding events, higher temperatures and less freezing events, resulting in a generally more humid and warm environment favourable for all kinds of microbes and pests. This will pose new threats to the preservation of cultural heritage and should be investigated soon. Statistical relationship between climate change and enhanced fungi growth and museum pest insect populations can be established this way. Simple climate models can help to estimate costs for climate regulation and detect hotspots for damage. Fungi and insect pests in museums are rarely investigated in parallel as they come from two separate fields and education, but in the light of climate change and indoor environment, the comparison can help to find long-term and sustainable solutions [1, 2]. In order to develop risk management plans, preservation and treatment methods and to implement suitable precaution measures in museums, a strong commitment is necessary both from the side of scientists and from the side of politics!


Cultural heritage is a tangible representation of identity of humanity, an exceptional testimony illustrating milestones in history and an irreplaceable source of the value systems, traditions, beliefs, and lifestyles from the past to the present. As our cultural heritage is inherited from past generations, unique and invaluable, it is our responsibility to preserve and protect these cultural artefacts for future generations. Objects of art and cultural heritage are constantly under attack, exposed to in- and/or outdoor environments, affected by environmental degradation, climate change and accelerated pace of urbanization. As our atmosphere contains increasing concentrations of pollutants those valuable heritage objects are highly in danger to be destroyed and lost forever. Conventional environmental parameters that affect material degradation comprise weathering factors (temperature, moisture, light irradiation, wind velocity etc.), air pollutants (H₂S, SO₂, CO₂, O₃, NOₓ etc.) and aerosols [1-4]. The interaction of these atmospheres with works of art is challenging scientists and conservators dealing with objects in museums, of private collections, exposed outdoors or archaeological findings. Therefore, a fundamental understanding of the surface chemistry (durability and natural ageing behavior) of art materials and heritage artefacts is needed in order to be able to control material degradation in the near future and find approaches for preventive conservation.
For this reason highly sensitive multi-analytical set-ups (Figure 1) are implemented to investigate deterioration behaviour of metals, pigments and polymers used for works of art while exposed to controlled environments such as relative humidity (%RH), pollutant gases and light. Additionally, the influences of photo catalytic reactions caused by light are studied.

Fig. 2: Set-up of the IRRAS/QCM weathering cell and resulting time-lapse in-situ IRRAS spectra.

The available methods such as InfraRed Reflection Absorption Spectroscopy (IRRAS), Raman spectroscopy, Scanning Kelvin Probe (SKP), Atomic Force Microscopy (AFM), Quartz Crystal Microbalance (QCM) and X-Ray Fluorescence (XRF) are applied to perform time-lapse in-situ degradation studies (Figure 2) of the mentioned materials while exposed to different controlled environmental parameters [5]. These innovative set-ups and methods are not only enlightening the exact reaction mechanisms of material degradation, but also help to define measuring protocols and threshold levels for different environmental parameters. This is the only way to take appropriate action to preserve these valuable treasures for the future.

As part of a pilot project between Schloss Eggenberg (Universalmuseum Joanneum) and Mudri Messtechnik, investigations of the architectural substance have been carried out using infrared thermography since 2014. Thermal radiation images provide a view behind the plaster layers, permitting an exact location of otherwise invisible architectural details. Sand, brick or quarry stone are characterized by their different thermal conductivity or specific thermal capacity, as are building seams, beams or beam holes, changes in storey heights or chimney drafts. The analyses produced not only surprising results about Schloss Eggenberg’s predecessor building, but also a mass of new indications on the history of the construction and function of the princely residence.

This non-invasive investigation method is an inestimable tool for research, especially in the particularly sensitive field of protected architectural monuments, since there is no need for interventions in the substance, which by necessity always involve destruction. The data obtained also constitutes an extremely precise basis for all further invasive investigations. The view behind the plastered or painted surfaces also permits a rapid visualization of larger architectural history contents in a building complex.
Lasers in Cultural Heritage Science: Cleaning and Stratigraphy

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Preservation of cultural heritage artefacts involves increasingly laser techniques for e.g. cleaning and also diagnostics (Fig. 1) [1,2]. Particulate removal from fibrous, polymer [3-6] or painted substrates [7] has been studied systematically.

The treatment of organic materials such as paper is characterized by the limitation of photochemical and photothermal destruction. This is minimized when visible laser wave-lengths are chosen such as the second harmonic (532 nm) of a Nd:YAG lasers [8-10].

Ultraviolet laser radiation, on the other hand, provides minimized light penetration depth and can serve as a quasi ultra-precise non-contact scalpel [11-13]. Yellowing is a side effect of laser treatments [6,14]. Paper cleaning studies showed that yellowing could be minimized choosing 532 nm.

Fundamental investigations combining e.g. laser pulse interactions with atomic force measurements lead to thermomechanical models [15-18].

Stratigraphy on the other hand is an indispensable technique in the preservation praxis. A laser-induced breakdown spectroscopy stratigraphy is been developed allowing depth profiling down to single micrometre ranges (Fig. 2) [19,20].


Materials of Contemporary Art - A Challenge for Analytical Chemistry

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Modern and contemporary art consists of artworks made of a large variety of materials, mostly synthetic organic materials such as celluloid, nylon, and polyurethane used for sculptures and nitrocellulose, alkyd, acrylic, and polyvinyl acetate (PVAc) applied as binders. These materials have been produced since the beginning of the 20th century, originally for industrial and domestic use, and subsequently employed by numerous different artists. The characterization and identification of these materials for restoration and conservation purposes represent a challenge for analytical chemistry, due to their very complex composition. Furthermore, during exposure to light and temperature at ambient conditions, synthetic organic materials are prone to deteriorate by interacting with oxygen under the influence of humidity and UV light, which rips off electrons from their polymer chains, causing the break-down of the chemical bonds and leading to smaller molecules and the formation of new degradation products. This process is usually displayed as weakening of the material’s composition in form of increased brittleness, cracking, dripping, etc., thus compromising the aesthetic and optical appearance of the art object.

Analytical chemistry plays an important role in the investigation of the chemical composition as well as of the degradation processes occurring in modern materials, sometimes even before they become visible to the naked eye, if a proper periodic investigation of the artwork is carried out. Therefore, in order to preserve modern and contemporary artwork, investigation with different types of analytical techniques is indispensable. For such studies mainly colour measurements in the visible range and compound specific methods such as infrared and Raman spectrometry as well as pyrolysis-gas chromatography in combination with mass spectrometry (Py-GC/MS) or thermal analyses (differential scanning calorimetry – DSC and thermogravimetry – TG) are applied.

Preserving modern and contemporary art involves the collaboration of different disciplines such as conservation-restoration, art history, archaeology etc. and sciences. Through the cooperation of the professionals working in these fields several research projects have been created to address specific conservation issues of modern and contemporary artworks such as the POPART (Preservation of Plastic ARTEfacts in museum collections) project from 2012 to 2016 and the current NANORESTART project started in 2015. The Cultural Heritage Agency of the Netherlands (RCE, Amsterdam – NL), the Getty Conservation Institute (GCI, Los Angeles – U.S.A.), the National Gallery of Art (Washington DC – U.S.A.), and the TATE (London – UK) have been particularly active in their contribution to the preservation of modern and contemporary works of art.

Our institute, the Institute of Science and Technology in Art (ISTA) at the Academy of Fine Arts Vienna, has also been actively involved in the field of modern and contemporary art, starting with the national research project “Analysis of synthetic materials in contemporary art” (FWF project no. L699-N17)
This project mostly focused on the stability of synthetic organic binding media mixed with inorganic pigments (Fig. 1) when exposed under artificial accelerated sunlight outdoor conditions by means of many analytical techniques such as UV/Vis, FTIR and Raman spectroscopy as well as by Py-GC/MS and DSC and TG in cooperation with the Department of Chemistry and Nanostructured Interfaces and Surfaces-Centre of Excellence in the University of Turin. Our expertise is currently expanding to the stability of those materials when exposed to indoor conditions, particularly by our collaboration with the Light and Colour Science Research Laboratory in the University of Pannonia, Veszprem, Hungary on the bilateral research project of the OeAD (Austrian agency for international mobility and cooperation in education, science and research, Project No. HU 08/2016). In this project, Light Emitting Diode (LED) systems, currently broadly used in museums because of their long lifetime and reliable operating characteristics which avoid radiation in the damaging ranges (UV and infrared), have been tested on modern paint materials and their chemical behaviour is currently under investigation by different analytical methods.

The present work aims to discuss the most widely used materials in modern and contemporary art, their main degradation phenomena and the importance of analytical chemistry for studying their main chemical composition as well as their degradation processes for preservation and conservation purposes.

Fig. 1: Commercial acrylic paints used for the analytical investigations performed within the FWF project no. L699-N17.

Clothing remains between 2000 BC and 1000 AD.
Interdisciplinary research and dissemination concepts

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_Natural History Museum Vienna, Burgring 7, 1010 Vienna_

Clothing as an important non-verbal medium of communication is a strong identity-creating element. It tells details about its wearer such as their social status, age, gender and group membership. The use of garments and jewellery as communication medium can be grasped at the latest from the Bronze Age (c. 2000 BC) onwards, especially as indicator of power and social status, and belongingness to different regional groups. Clothing also concerns today's discourses about individuals, group identities and lastly about our European cultural heritage.

Archaeological textile finds [1] are rare in Central Europe due to the very selective conditions of preservation – they easily disintegrate, especially if buried in the ground. However, in some rare cases we find the remnants of clothing in prehistoric and early medieval graves, corroded on metal artefacts. Frozen or waterlogged environment, such as in the case of Ötzi (the c. 5500 year old Man in the Ice) or the bogs in Scandinavia, also enables the preservation of garments. For Central Europe, salt mines also provide a rich source of prehistoric textiles. Important key finds derive from the salt mine Hallstatt, dating from 1500-400 BC, which are stored at the Natural History Museum Vienna.

**International and interdisciplinary research**

Research on textiles from archaeological excavations is carried out in Austria mainly by museums and universities. Methods applied are textile analysis and fibre analysis with SEM to gain knowledge about textile qualities used by certain past societies. Dyestuff analysis with HPLC, carried out in close cooperation with universities and specialised laboratories, enable us to understand the use of colours and colour patterns to enhance the garments. Further recent advances are radiocarbon dating, and strontium isotope analysis that is promising to allow provenancing of textile fibres such as wool, flax or nettle. Various branches of archaeological and historical disciplines (e.g. Experimental Archaeology, Epigraphy, Art History etc.) are also combined for certain research questions concerning textiles and clothing.

The most important research questions are:

- Technological, social and economic background of textile innovations in Central European prehistory
- Creativity and design; appearance of textile surfaces and patterns
- Resource management, use – re-use – “recycling”
- Potentials and limitations of dress reconstruction – based on textile finds, dress fittings in graves and contemporaneous iconographic evidence
- Dress and identity: social value of clothing and textiles from the Bronze Age to the Medieval period, representation and appearance

At the Natural History Museum Vienna textile research focuses on prehistoric, Roman and early medieval graves, but especially on the textiles from the salt mines in Hallstatt. This wide range of archaeology has been explored in various international research projects within the last ten years.
Dissemination concepts

An important task are also different dissemination concepts to make the clothing and behind hand craftsmanship of pre-historic societies both accessible for the scientific community as well as visible and understandable for the wider public.

The latter ranges from special exhibitions like “Colours of Hallstatt” (2013-2014 at Natural History Museum) to textile objects included into the new permanent exhibition of the Prehistoric Department of the NHM (since 2015). Within exhibitions, but also for other dissemination work, reconstructions of garments and complete dress ensembles, both virtual as well handcrafted, are an important tool. They are also used for films (e.g. UNIVERSUM or BBC documentaries) and Historical Fashion Shows. Such events – usually producing a wide media coverage – the NHM has already presented in many cities in Austria, but also e.g. at the Festival 2012 in London of the HERA Joint Research Programme or 2017 in Varazdin within the framework of the “Cultural Year” between Austria and Croatia 2017.

Also workshops about historic textile craft techniques and prehistoric garments are useful to give people a direct “hands-on experience”, accompanied with information about recent research. Now, also two Citizen Science projects [2] are running for the reconstruction of historical handwork techniques.

Changes in technology and media in the last two centuries have also been used for dissemination work about textile research – namely the internet and tutorial as well as picture sharing platforms such as youtube and pinterest enable us to get into contact with people world wide.


Reconstruction of a hallstatt period garment with reference to textiles from Hallstatt and a belt plate from Vače, c. 500 BC (© NHM Vienna).
European Research Infrastructure for Heritage Science

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The European Research Infrastructure for Heritage Science (E-RIHS, [ˈiːris]) entered the European strategic roadmap for research infrastructures (ESFRI Roadmap) in 2016, as one of the six new projects. E-RIHS supports research on heritage interpretation, preservation, documentation and management. Both cultural and natural heritage are addressed: collections, buildings, archaeological sites, digital and intangible heritage. E-RIHS is a distributed research infrastructure with a multi-level star-structure: facilities from many Countries will be organized in national networks, coordinated by separate National Hubs, and the E-RIHS Headquarters will provide the unique access point to all E-RIHS services, by coordinating the net of National Hubs. E-RIHS will provide state-of-the-art tools and services to cross-disciplinary research communities of users through its four platforms:

• MOLAB: access to advanced mobile analytical instrumentation for diagnostics of heritage objects, archaeological sites and historical monuments. The MOBILE LABoratories will allow its users to carry out complex multi-technique diagnostic projects, allowing effective in situ investigation.

• FIXLAB: access to large-scale and specific facilities with unique expertise in heritage science, for cutting-edge scientific investigation on samples or whole objects, revealing micro-structures and chemical composition, giving essential and invaluable insights into historical technologies, materials and species, their context, chronologies, alteration and degradation phenomena.

• ARCHLAB: physical access to archives and collections of prestigious European museums, galleries, research institutions and universities containing non-digital samples and specimens and organized scientific information.

• DIGILAB: virtual access to tools and data hubs for heritage research – including measurement results, analytical data and documentation – from large academic as well as research and heritage institutions.

E-RIHS will help the preservation of the World’s Heritage by enabling cutting-edge research in heritage science, liaising with governments and heritage institutions to promote its constant development and, finally, raising the appreciation of the large public for cultural and natural heritage and the recognition of its historic, social and economic significance.

E-RIHS started in February 2017 its preparatory phase supported by the EU project E-RIHS PP (H2020-INFRADEV-02-2016). Representatives of sixteen countries (15 from EU plus Israel) are working together to prepare E-RIHS to be launched as a standalone research infrastructure consortium in 2021. http://www.e-rihs.eu/
In recent years, our world has undergone deep and far-reaching transformations brought about by new technologies and new media. The ubiquitous presence of the Internet and digital applications have changed the way we do research and introduced new methods, new media and new tools. These days, not only natural and life sciences require specialised digital infrastructures. More and more scholars in the humanities have started to make use of digital tools and data and consequently need infrastructures to deal with their digital data.

Countless projects on the local and European levels have been building and making available digital infrastructure components. However, by virtue of their transient nature, projects are not an effective way of sustaining infrastructures in the long run. One answer to this dilemma was the establishment of a new legal construct, the so called European Research Infrastructure Consortia (ERIC), full legal entities under EU law which have legal personality and full legal capacity recognised in all member states of the Union. These consortia are supposed to operate over longer periods of time and thus ensure a higher degree of sustainability. During the past decade, two such ERICs were set up in the humanities: CLARIN (Common Language Resources and Technology Infrastructure) and DARIAH (Digital Research Infrastructure for the Arts and Humanities). As the names suggest, CLARIN represents the community of researchers working with and on digital language resources. DARIAH has a wider scope and targets the humanities at large.

Right from the start, Austrian scholars were involved in setting up these two ERICs and participated in the arduous path of long preparatory phases. With the support of the then Ministry of Science and Research we became a founding member in both of them. Both ERICs have been in operation for a couple of years now. After the official launch, they substantially contributed to the build-up of the infrastructures through actually building infrastructure components and serving in the various bodies of the consortia. Meanwhile, many more countries have joined (also some from outside of the EU) and their concerted efforts have already yielded a wide range of convincing and demonstrable results.

What made Austria different from the very beginning was the integrated and collaborative approach. Recognising the high potential of coordinated work and harmonised infrastructure build-up, the Austrian representatives decided to work together as a single group, generating greater synergies and reaching out to a considerably larger group of potential contributors and users.

The presentation will touch on the particularities of infrastructures in the humanities, on the importance of technical and social innovation in research, on standards, interoperability of data and tools and the concepts of open access and open source. The picture of the Austrian RI landscape will be completed by examples of what has been achieved in the last few years.
Development of E-RIHS France, the French national infrastructure for Heritage Science

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The deployment of new instruments of analytical investigation and data processing is profoundly changing the field of Heritage Science. On 10 March 2016, ESFRI, the European Strategy Forum for Research Infrastructures, announced the selection of the future European research infrastructure E-RIHS (European Research Infrastructure for Heritage Science) as Project.

This unique infrastructure will contribute to major research projects in cultural heritage, archaeology, and palaeontology carried out by European research teams. Consortia associating the various disciplines will benefit from an exceptional array of instruments and competencies, interdisciplinary expertise and research resources in the form of databanks of sector-specific high-level knowledge held at world-class institutions. E-RIHS will address outstanding long-term projects, where national initiatives alone or access to a single tool would not be sufficient to address needs.

France carried out a national process of construction of its roadmap and announced in March 2016, the parallel selection of the French national infrastructure E-RIHS France [1]. On 16 March 2017, the French Ministry of Higher Education, Research, and Innovation, the Ministry of Culture, CNRS, Inria, the National Museum of Natural History, and Fondation des Sciences du Patrimoine signed a Memorandum of Understanding that formally launched the development of E-RIHS France [2].

This presentation will present the progress of creation of E-RIHS France, the main achievements thus far, the first recommendations of the E-RIHS France Working Groups, and the questions raised in this process.

The various expectations from Cultural Heritage

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The appreciation of cultural heritage is an expression of a civilized society, and its destruction arouses widespread outrage. Why is it then on the other hand so difficult to ensure the preservation of cultural heritage, in particular when one can expect no immediate benefit from it? Indifference to the gradual decay of cultural property is confronted with complete disbelief in the light of the barbaric vandalism of the Islamic State. It should be beautiful, it should bring money and prestige, but nevertheless it should not cost us anything. This circumstance is particularly evident during competition for the status symbol of “World Cultural Heritage”, with the goal of being accepted into this prestigious UNESCO list. For this aim, a financially extensive and time-consuming application process, a demanding evaluation procedure, yet also an unscrupulous political lobbying is understood to be necessary.

Taking Ephesos as an example, the aim is the reproduction of a ruined city in its natural state, up to its admission into the list of world cultural properties; during this process, the diverse expectations and the perspectives of politics, economics, tourism, research and historic preservation should all be addressed. In addition, the focus will be directed towards the immediate consequences of the label “World Cultural Heritage” for all of the groups named. With Ephesos as a starting point, an additional arc should be traced in order to elucidate the phenomenon of “World Cultural Heritage” from a number of perspectives.

The phase of the application thereby constitutes a crucial aspect; this phase requires a diversity of resources, and therefore a priori places countries with meagre financial means or lacking (affordable) expertise at a disadvantage, if not completely excluding them. In addition, differing national strategies are to be observed, which extend from a more aggressive “World Culture Ambition”, down to disinterest, or to a shifting of competencies to provinces or communities. The national exertion of influence is also reflected in active political lobbying, which often contradicts expert evaluations and attempts to reverse them.

A very inconsistent monitoring of already existing cultural heritage sites nevertheless confronts the extremely high demands for the attainment of world cultural heritage status. Whereas some cultural heritage sites actually are observed, in contrast others appear to deteriorate without any attention and to slowly (or even quickly) to fall into ruin. Large-scale tourism projects are often not in accord with the world cultural heritage criteria, and yet are nevertheless instituted without much regard or criticism. On the other hand, the value of the world cultural heritage is often measured by numbers of visitors and not by the fundamental awareness to preserve cultural heritage for subsequent generations. An interesting point in this context is the fact that the “marketing” of cultural heritage is frequently aimed at the visitors arriving from elsewhere, and not at the population living with the cultural heritage; this frequently results in a conflict between these two groups.

The attention of the world, moreover, is directed towards a few prominent examples of “world heritage in danger”. Naturally in this regard we must mention Palmyra in Syria, whose destruction as a barbaric act of vandalism experienced great media response. At the same time, however, numerous
additional cultural heritage sites and other cultural treasures are destroyed by war or are severely damaged, without the general public ever hearing about it. Whereas in the first instance a rapid reconstruction has been demanded and funds have been made available, the latter cases are probably irretrievably lost.

Of course, the wish for reconstruction and the recreation of the original state is consistent with the reflex of an educated society; nevertheless, this requires a critical confrontation with what has occurred. Precisely archaeological sites have a long settlement history, one which was characterised over and over by destructions. Although it is the aim of monument preservation to represent this process and to leave destruction and decay as they are, now the act of reconstruction is confronted with the political-social insistence on rapid clearing up. Do not these measures therefore conflict with the strategic goals of monument preservation? Does not modern destruction also represent a further phase in the existence of these sites, therefore deserving of conservation? What has been done cannot be undone by clearing up. Sites of memory must be created in order not to forget. This is particularly valid for the Near East at this point in time.

In conclusion the question ought to be addressed whether something like “World Cultural Heritage”, in the sense of global responsibility, actually exists, and whether the national administration of the world heritage sites in fact excludes this aspiration. Ultimately the overriding question is raised as to how a consciousness for cultural heritage, apart from touristic-economic incentives and beyond national (in many cases regional) borders, can be created.
New Need for Old Sciences:
Diplomatic and Epigraphy and their Contribution to an Interdisciplinary Reassessment of European Cultural Heritage

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With an ever increasing mass of image data relating to historical documents provided online, scholars of history and humanities in general have at hand a vast and extending corpus of sources for their research. This open access based approach to records held in archives and libraries or displayed in public space (as e.g. in the case of inscriptions) seems at first glance perfectly supportive to what has repeatedly been called citizen science, with non-experts (or not academically trained staff) contributing to the assessment of written cultural heritage.

Since a remarkable share of archival image data is not backed with sufficient textual meta data, mere image repositories tend to turn into data graveyards of historical scholarship. Thus, studies into handwritten pre-modern records still require expertise from especially skilled palaeographers and diplomats in order to read, transcribe, date, contextualise and evaluate historical inscriptions, acts and charters.

The paper gives an overview of large-scale investigations in the field as carried out at the Austrian Academy of Sciences and shows how interdisciplinary approaches contribute to a deeper understanding and evaluation of Austria’s cultural heritage.
The digital turn has provided researchers with many new opportunities and, in many instances, has already changed research practices. Among the humanities, archaeologists have been early adopters of digital tools and methodologies, often ‘borrowing’ from other fields or from outside academia. This has made many processes, such as archaeological fieldwork, more efficient and new methodologies have provided us with unforeseen opportunities to research the past. However, going digital has also increased the challenges of data management with creation of new types of data and increase of size of data collected and analysed. New threats arise because of issues of preservation of digital resources, which, if not curated properly may become inaccessible resulting in loss of knowledge about our cultural heritage.

The internet has provided us with the opportunity to make digital resources accessible for others. Sharing of data that have been prepared for re-use may help others to make their research process more efficient and it can provide access to resources for researchers who may not be able to afford subscriptions or travelling. It is argued that open data leads to a democratization of knowledge. Open data, together with open access to publications and making scientific workflows more transparent and available for others have been identified to be the open science practices most relevant for individual researchers in archaeology [1].

In this talk we will present two case studies where we address questions of long-term preservation and homogenization of digital archaeological resources. Both projects apply principles of open science when publishing the resources online, making data, research processes and codes available for others.

The aim of the ‘A Puzzle in 4D’ project is to provide long-term preservation for the rich archaeological resources of the Austrian excavation project at Tell el-Daba in Egypt [2]. The project is a case study for the development of a repository for archaeological data at the Austrian Academy of Sciences. Digital and non-digital excavation data are enriched with metadata and prepared for long-term archiving and open-access online publication. In this project, an innovative approach to the creation of metadata and integration of resources has been created. To express the complexity of archaeological excavation data we have used the ontology CIDOC CRM, an international standard for Cultural Heritage documentation as a data model and we use semantic technologies to implement the ontology and store the data. One area of the excavations (F/I) has been used as a case study for detailed digital reconstructions based on original field documentation, testing hypotheses of interpretation (Figure 1).

In the Digitising Early Farming Cultures project we have created a standardised and integrated research dataset of Neolithic and Chalcolithic sites and finds of Greece and Anatolia (c. 7000–3000 BC according to Greek terminology) [3]. Non-digital and digital sources have been integrated and are now accessible via the so-called DEFC App, a web application to query data about sites and finds, an extensive bibliography and 3D models of pottery.
Fig. 1: 3D model of Tell el-Daba F/I-j/21 tomb 8 (©: Stefanie Fragner, OREA ÖAW).


IAEA support to study of tangible cultural heritage

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Through the Nuclear Science Programme the IAEA carries out activities to assist and advise its Member States (MSs) in assessing their needs for capacity building, research and development in the nuclear sciences, as well as in supporting the MSs’ activities for deriving benefits in specific fields.

During the last 20 years, the IAEA Nuclear Science and Instrumentation Laboratory (NSIL) has contributed to capacity building (knowledge and expertise) in the effective utilization of X-ray spectrometry techniques using a variety of laboratory and portable instrumentation, including Ion Beam Analysis (in cooperation with Institute Ruđer Bošković, Zagreb, Croatia) and advanced synchrotron based techniques (in cooperation with Elettra Synchrotron).

The different X-ray micro-analytical techniques have been applied to a wide range of objects, including metal artefacts, ceramics, glass beads and pigments in paintings. NSIL has collaborated in the development of a transportable micro-XRF spectrometer for the Vienna Kunsthistorisches Museum and taken part in different investigations carried out by KHM, the Weltmuseum Wien, the Institute for Conservation and Restoration of the Academy of Fine Arts, and the Vienna Institute for Archaeological Science.


Poster contributions
Investigation of illuminated manuscripts by microdiffraction using an aircooled X-ray microfocus source

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In recent years the interest in the non-destructive investigation of cultural heritage objects has risen strongly. Besides infrared and optical imaging and spectroscopic methods, X-ray methods like X-ray fluorescence, X-ray diffraction, X-ray radiography and X-ray imaging (e. g. tomography) are often used for the analysis of paintings and books.

Using XRF analysis of paintings generally provides information about the possible presence of elements on the surface of art-objects due to pollution (e.g. sulphur or chlorine), about the elements and pigments used by the artist, about previous restored areas detected by the presence of “modern” elements like titanium or zinc, and identification of fraudulent submission. In combination with X-ray diffraction (XRD) also the crystallographic composition of the used pigments could be characterized. A study about the alteration involved the oxidation of cadmium yellow (CdS) to CdSO₄ . 2H₂O under the influence of light, oxygen and moisture is an example of the use of this technique in the investigation of paintings [1].

In the study shown here a medieval book painting was investigated using XRF and XRD techniques simultaneously. While with XRF the elemental composition of the used pigments is analyzed, with XRD crystallographic information could be revealed. Using both methods, the chemical composition of the pigments could be analyzed. Here an X-ray microfocus source with Mo radiation and a focusing optics was used. The XRD patterns were recorded with a CCD detector in transmission geometry, XRF signals were measured with an energy dispersive detector arranged in 90° to the beam direction. A sample area of about 130 µm x 130 µm was illuminated with the X-ray beam. Using this setup, XRD frames were recorded within 30 seconds exposure time, the XRF measurement was done simultaneously. In an overnight-scan (approx. 18 hours) an area of several square millimeter and a resolution of 150 µm could be investigated.

This study shows, that it is possible to obtain high quality results even with a quite simple setup. The air-cooled microfocus source IµS, the sample and the XRD detector were just aligned on an optical bench while the XRF detector was just placed on a shelf in a suitable position.

Some further examples of customized solutions with the IµS demonstrate new experimental possibilities for the measurement of sensitive materials with methods like microdiffraction, crystallography and small angle scattering.

The sixteenth century glass jewellery collection of Archduke Ferdinand II –
A great challenge for semi-quantitative XRF investigations

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The glass jewellery collection of Archduke Ferdinand II, now on display in the Collection of Sculpture and Decorative Arts of the Kunsthistorisches Museum Vienna, is very unique in many ways. First of all it is a rare example of a bigger collection of early modern lampworked glass, secondly, although it was produced at the glasshouse of the Innsbruck ducal court, operating between 1570 and 1591, Venetian glassblowers were engaged for limited periods.

In the course of the examination of this collection X-ray fluorescence (XRF) analyses, using the PART II (Portable Art Analyser) system, were performed. This method was chosen because of its non-destructiveness and the non-portability of the objects. Nevertheless, analysing glass using XRF has to cope with the problems of absorption of the radiation of light elements (especially Na) in air – although the air path is only about 1 mm using the PART II – and the corrosion of glass-surfaces, leading to a depletion of Na (visible on several items of the collection, especially some hues of blue). Regarding the glass jewellery collection there were additional problems due to extremely varying thicknesses of the glass parts and complex shapes of the objects, complicating the access for analysis. Nevertheless, 32 objects could be analysed with the aim of achieving semi-quantitative results. For the evaluation of the data two software packages were available. First the XRSPF program of Amptek. This program showed difficulties when Ca was evaluated in the presence of Sn, leading to an extreme overestimation of Ca. As the opacifier in all opaque glasses is PbO and SnO2 this program was not suitable for the analysis of the glass jewellery items. The second Program was WinAxil of Canberra. With this program all components could be evaluated in a semi-quantitative way with the “Compare Mode”, as can be shown by evaluating some standards. Nevertheless, as the calculation cannot be done in the form of oxides the conversion has to be done in another step, complicated by the output format of the program (both % and ppm is used). Evaluating the analysed glasses, it became evident that, although mostly surfaces without visible corrosion were chosen, a depletion of Na was present. Also for thin glasses the sum of analysed elements was much less than 100 %. Therefore, as for reasons of comparison of the glasses a normalization was necessary, it was decided to neglect Na for this procedure. This could be done, because additional investigations on fragments using scanning electron microscopy (SEM/EDX) showed quite small ranges for the Na concentrations within the respective colour-shades. The glass mostly used is soda-lime-silica glass. Additionally, there are some items where mixed alkali glass could be found. Cristallo could also be identified in the colour-shades blue II and blue III. As cristallo possesses a very low Ca content, and therefore a low amount of stabilizer, this glass is very prone to corrosion – and this is what could be observed on the objects. In summary, it can be stated that the semi-quantitative XRF results are in good accordance with the results of SEM/EDX.

The analysis of the codices Millenarius Maior and Millenarius Minor with complementary techniques

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Two precious Carolingian manuscripts kept in the library of Kremsmuenster Abbey in Upper Austria were subject of investigation. The well-known codices Millenarius Maior and Millenarius Minor were studied within the framework of the Centre of Image and Material Analysis in Cultural Heritage (CIMA) in Vienna. The manuscripts are especially famous for their precious and colorful miniatures of a very early medieval period. The aim of the work was the material identification (colors and inks) used for the illumination of the two codices in order to gain a better understanding of their evolution and their provenance.

The instrumentation available in the CIMA laboratories allowed performing in situ measurements using non-destructive and non-invasive analytical methods. The investigations comprised a combination of three complementary methods: X-ray Fluorescence analysis (XRF), Fourier Transform Infrared spectrometry in the reflection mode (rFTIR) and Raman spectrometry. In addition to the identification of the pigments and inks also a detailed characterization of the parchment concerning its manufacturing process was achieved by that combination. The identification of calcium carbonates (CaCO₃) on the surface of the parchment is an indicator for the liming of the animal skin, whereas the polishing process of the parchment surface with pumice stone left traces of silicates detected by rFTIR. The combination of XRF and Raman spectrometry enabled the characterization of black/brown inks in the text revealing the usage of iron gall inks. For the red inks applied for text and initials vermilion and red lead were applied in both codices. Furthermore, the pigment palette used for the illumination could be identified: lead white, orpiment/realgar, red lead, vermilion and red iron oxides as well as azurite and indigo, together with the rather rare copper chloride hydroxide were detected. Furthermore, in both gospels the application of metal leaves as well as powders made of silver-copper and gold-copper alloys could be determined by XRF on several folios.

(a) Folios 109v and 110r of Codex Millenarius Maior compared to (b) folio 73v of Codex Millenarius Minor. The similarities in the colors can be documented in the green areas as a copper based pigment, the red parts with minium as well as the yellow areas with orpiment/realgar.
This paper gives an overview of our results of a comprehensive on-going research project regarding scientific investigations of coatings and foundations of selected exceptional pieces of Asian interiors, richly decorated furnishing and decorative objects from the sixteenth to the nineteenth century, which helped to prepare, and accompanied the subsequent conservation.

Lacquer artefacts from the collections of the Kunsthistorisches Museum Vienna, Schönbrunn Castle as well as from Austrian private collections will be discussed. According to the provenance, the selected objects can be divided into three groups: Japanese, Chinese, and European origin, respectively.

Chemical examinations of the lacquer objects revealed that besides of Asian lacquers a variety of other materials was used to obtain a durable lacquer layer. Diverse drying oils, proteinaceous or polysaccharide based materials applied as organic binding media – together with various substrates and pigments – occurred when studying the grounds, lacquer layers or upper coatings. Combining optical microscopy and GC/MS technique appeared to be a suitable analytical approach to detect and identify such complex organic mixtures [1].

Microscopic investigations (LM, SEM-EDX) gave not only reliable results on the composition and layout of pigments, but special wet-microchemical tests then proved the presence of binders in each layer [2]. In addition, simultaneous spot tests were used for material characterisation to detect the presence of starch or blood as a binder in the ground layers.

The analyses of western lacquers based on resinous or oleo-resinous varnishes were performed by means of gas chromatography-mass spectrometry technique (GC/MS) while the pyrolysis (Py-GC/MS) enabled to differentiate aged Asian lacquers according to their various chemical compositions, and so to trace the trade and production of the lacquers [3].

The results revealed that the objects of Asian origin were often restored using European materials as well as pieces of Asian artefacts were incorporated during production of the European imitations. In addition, the study unveiled an interesting fact that the ground layers of Chinese pieces often contain blood while the Japanese ones are rather based on animal glue or starch.

Electrochemistry in conservation science: Reduction of silver tarnish with an electrochemical pencil

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Electrochemical techniques play an attractive role in conservation praxis and have been used for a long time in the treatment of metal artefacts [1-2]. A prominent application example is the electrochemical reduction of silver corrosion and conversion products:

\[ \text{Ag}_2\text{S} (s) + 2\text{H}_2\text{O} (aq) + 2\text{e}^- \rightarrow 2\text{Ag} (s) + \text{H}_2\text{S} (aq) + 2\text{OH}^- (aq). \]

An electrochemical pencil for the cleaning of tarnished silver as an alternative to the common mechanical methods and electrochemical cleaning of silver artefacts by immersion has been developed [3]. The suitability of this setup involving a potentiostatic three electrode system for the removal of corrosion products from historical metal artefacts was assessed (Figure 1).

![Fig. 1: Computer aided design of the electrochemical pencil.](image)

The suitability and user-friendliness of the pencil for the work on various shapes and surface morphologies was optimized [4].


“All Heavenly Motions Daily in View”:
Interdisciplinary Approaches to the Conservation of Philipp Imser’s Planetary Clock in the Technisches Museum of Vienna

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The project brings one of the most ingenious and beautiful machines of the Renaissance to center stage: the Imser Clock in the Technisches Museum in Vienna (Inv. No. TMW 11.939/22). Work on this “planetary clock,” a clockwork-driven planetarium signed by Philipp Imser (1500-1570), was begun in 1555. Besides Imser, a mathematician at the University of Tübingen, the Augsburg clockmaker Gerhard Emmoser (d. 1584) was also involved in its construction. Elector Ottheinrich of the Palatinate (1502-1557) commissioned and paid for the clock, which was later given to Emperor Friedrich I. It has been in Vienna for two centuries.

The central purpose of a planetary clock is to indicate in real time where the seven classical “planets” – Mercury, Venus, Mars, Jupiter, and Saturn plus the Sun and Moon – are to be found in the sky. Unlike many other contemporary clocks with astronomical indications, which merely depict the mean motion of the planets, a planetary clock aims to replicate subtle aspects of their non-uniform motion. Worldwide only four such heavenly automata are extant from the 16th century: in addition to the Imser Clock in Vienna, one each in Paris (Bibliothèque Sainte-Geneviève), Kassel (Astronomisch-Physikalisches Kabinett), and Dresden (Mathematisch-Physikalischer Salon).

An interdisciplinary research team composed of historians of science, clockmakers, and media-based computer scientists from Dresden, Kassel, and Lisbon has set about to comparatively analyze these four immensely complex machines. Toward this end they have received support from two German foundations: the Museum & Research Foundation and the Federal Foundation for Culture (Kulturstiftung des Bundes). The team’s approach reveals how questions about the conservation of such highly refined artifacts are inextricably linked to an understanding of their astronomical and cultural aims. Thus, in addition to expertise from the fields of precision mechanics and antiquarian horology, knowledge of the fine points of Ptolemaic planetary theory has proven necessary in order to assess the clock’s current condition, the correctness of its settings, and the urgency of conservational intervention. The team’s collaborative study of the Imser Clock has not only laid a foundation for its conservation treatment, but also offers the opportunity to interpret and display this landmark of European cultural heritage in a new way.
Emperor Ferdinand I (1793–1875) and the medal production between 1835 and 1848 in art historical/historical context

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The research project deals with medals in the Coin Collection at the Kunsthistorisches Museum Vienna (KHM) representing the reign of Emperor Ferdinand I between 1835 and 1848. This selection of around 300 pieces includes gold, silver and bronze medals as well as models and casts. They reflect important stages of the Emperor’s life, e.g. his coronation as younger King of Hungary in 1830, his marriage to Maria Anna of Savoy (1803–1884) in 1831, the homage of the estates of Lower Austria in 1835, the bohemian coronation in 1836 and the lombardo-venetian coronation in 1838. There were also some issued to his abdication in the course of the revolution of 1848, as well as to his death in 1875. In addition, there are numerous event-related pieces, as well as merit and mercy medals.

As for artistic style these medals are in the tradition of late classicism and tendencies of romanticism can be found. Their pictorial principle essentially comprises a combination of a laurel-wreathed or crowned profile portrait and an obeisant inscription on the obverse. The reverse portrays historical scenes, insignia, allegories, still lifes or genre motifs. They were usually made in very high relief on even ground. By comparing these medals to paintings as well as sculptural portraits of the emperor, parallels and differences in his image are pointed out. Additionally the significance of medals for imperial representation is investigated.

The process of medal production was closely linked to the court system and its institutions. As the Central Mint in Vienna is in charge for creating medals and coins, their development from initial concepts and sketches to the production itself is examined on the basis of primary sources in Viennese archives. Medallists and their education at the Academy of Fine Arts as well as their artistic development are taken into account.

Therefore, the main goal of this dissertation project is to provide a comprehensive picture of status and function of medals between 1835 and 1848. By combining numismatic, historical and art historical sources, the production at the Central Mint in Vienna during this period shall be reconstructed and a complete picture of the various purposes and significance of the medal as medium of representation will be drawn. Furthermore, the project contributes to current research in this field.
Searching for blood in Chinese lacquerware

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In various historical Chinese sources pig’s blood is described as a binding medium of ground layers of Chinese lacquerware [1, 2, 3]. This paper gives an overview about some approaches to verify pig’s blood in Chinese lacquer, especially in so-called Kanton lacquer, and discusses the reasons for its use.

During the conservation and restoration of the Vieux-laque-room, Palace of Schoenbrunn, Vienna, between 2001 and 2005 samples of the Chinese lacquer panels from the beginning of the 18th century were tested with benzidine and luminol by the Institute for Forensic Medicine in Vienna – with unclear results. Other tests in 2011 with benzidine on a Chinese tea box from the 19th century and a Chinese jewellery box from Qianlong time were positive and more promising, as they were accompanied by GC/MS analyses and histochemical tests, proving the presence of protein [4, 5].

Later, in 2006, analyses at the University of Veterinary Medicine in Vienna, could verify pig’s DNA by real-time PCR; recent DNA analyses at the Chinese Cabinets, Palace of Schönbrunn, Vienna, and recent results by the Austrian Central DNA Laboratory in Innsbruck showed that all 5 samples from Chinese lacquer panels contain DNA of Sus scrofa (wild pig), but in two samples also human DNA could be detected. Accompanying cross-sections and histochemical staining with amido black AB2 were helpful tools to proof the presence of protein in ground layers, GC/MS analyses detected amino acids.

THM-Py-GC/MS analyses showing blood and glue markers give a clear indication of the use of blood [6], but not the species [7]. The impact on conservation is significant: the identification of the binding medium of ground layers has an influence on the choice of the consolidation medium. Further tests of consolidation media using samples with pig’s blood foundation should be executed.

The goal of this project was a systematic documentation of wall paintings in four earthen Buddhist temples at the Nako monastery located in the Indian part of the Western Himalayas. The research was not only meant to perform an assessment of the materials used since the 12th century in the Tibetan art, but also aimed to facilitate the work of art historians and guide conservators/restores during the conservation treatments.

The technical study was conducted by non-invasive methods in-situ followed by non-destructive and destructive elemental, molecular and crystallographic analyses on micro-samples. The coupling of all methods and the results obtained delivered a relatively comprehensive picture of the painting techniques and materials of both the original and secondary wall paintings. In particular, this presentation will focus on GC-MS and LC-MS/MS instrumentations, which revealed the proteinaceous binding material applied and even indicated a possible animal source of the proteins – the glue tempera based on bovine (or similar animal) glue – used in original murals. In addition, the results also indicated a plant gum possibly present besides a glucose-based material.

Nevertheless, it would be necessary to study even more samples to provide all the fine details, since Tibetans have been versatile masters in the use of paintings materials.
The forgotten Papyrus

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During an inventory review for the Egyptian and Near Eastern Collection and the move of objects from the basement repositories in May 2013, the animal mummies were conscientiously examined. These included a group of conical clay vessels that served as sarcophagi for mummified ibises. A previously unknown papyrus scroll was discovered beneath one of these mummies.

Because some hieratic signs were easily recognisable, an important difference in age between the mummy and the scroll appeared. Samples were hence taken from the mummy wrapping and the linen textile around the papyrus to determine their ages using Carbon-14 dating. It was to be clarified whether the ensemble had already been assembled during antiquity or perhaps only in the 19th century.

After extensive preliminary research and testing, during the spring of 2014 the papyrus was restored at the Kunsthistorisches Museum Vienna. The outer layers had broken away in twenty-two pieces but the rest of the papyrus still formed an intact scroll. The priority was to restore the flexibility of the fibers before starting any unrolling. As this is not an everyday procedure, the methods were in part developed and refined during the restoration process. Following the treatment of the individual fragments, the opening of the scroll was begun. The papyrus was in such a good condition that it was done in a few days. After the reassembly of all the pieces, the papyrus again has its original length of 2.50 m and both inscribed sides are visible with the frame that we let design.

First picture after discovery of the papyrus scroll. Scroll during treatment, with a part already unrolled.
Interaction of pulse laser radiation of 532 nm with model coloration layers for medieval stone artefacts

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Laser cleaning has been established as a practicable method in conservation science of stone artefacts [1]. Multilayer polychrome coatings on medieval and Renaissance stone artefacts have exhibited substantial challenges in the context of this conservation strategy [2,3]. Modifications of pure pigment powder tablets treatment were studied after 1064 nm [4,5] and after sequential and synchronic treatment with 1064 and 355 nm [6]. Such pigment powder samples treated at 1064 nm and a single repetition frequency (N = 100) were also analysed by colorimetry, reflectometry, and x-ray analyses [7].

Commercial laser cleaning of stone normally involves the usage of Q-switched Nd:YAG lasers emitting at the fundamental wavelength of 1064 nm. In this case, incrustations are commonly intentionally wetted by the conservation operators so that not only dark contamination components but also the high humidity content can strongly interact with the near-infrared radiation [8].

In the present study, polychromic models with classical pigments, minium (Pb₂⁺ Pb⁴⁺ O₄), zinc white (ZnO), and lead white ((PbCO₃)₂·Pb(OH)₂) in an acrylic binder, were irradiated with a Q-switched Nd:YAG laser emitting at 532 nm.

The studied medieval pigments exhibit strongly varying incubation behaviours directly correlated to their band gap energies. Higher band gaps beyond the laser photon energy of 2.3 eV require more incubative generation of defects for resonant transitions. A matching of the modification thresholds after more than four laser pulses was observed. Laser cleaning with multiple pulsing should not exceed ca. 0.05 J/cm² when these pigments coexist in close spatial proximity.

Conservation practice has frequently shown that ready-mix mortars rarely provide an optimal solution for the restoration of historical masonries. In several cases the best practice and most authentic way is to produce the required mortar by using self-made mixtures of binder, aggregate and possibly additives. This approach, however, does not only require the right know-how and experience, but – especially in the case of air lime-based systems – also the use of appropriate materials, among other things the right sand. Another common problem is that most building supplies stores often sell exclusively washed or sieved aggregates mainly for cement-based mortars and concretes; therefore conservators and craftsmen often require other sources of materials. This study is aimed at establishing a data base containing different sandy sediments, mainly of fluvial and alluvial origin, which can be purchased from operating sand pits or quarries from all-over Austria. Based on geological and geomorphological considerations each Federal Land has been divided into so-called sand regions, where different sediments with appropriate sand fractions from the hinterland have been deposited by glacial or fluvial processes. However, due to economical and practical considerations the project is not dealing with the exact sedimentological characterisation and all-over sampling of these regions, but focusing on a comprehensive collection of available sandy aggregates for restoration purposes.

The following paper is showing some preliminary results of different aggregates from different regions in Austria where properties such as colour, grain size distribution and shape, as well as mineralogy will be presented. Typical historical applications of certain sand types and the characteristics of aggregates regarding their application in the conservation of historical masonries will also be presented.
Investigating, monitoring and treatment of a so-far unknown surface phenomenon developing on objects in newly installed state-of-the-art showcases

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The Kunstkammer of the Kunsthistorisches Museum Vienna dates back to the private collection of decorative arts of the Habsburg’s imperial family. In the course of the centuries, the assemblage was constantly enlarged with new exquisite treasures. It was not until the reign of Emperor Francis Josef I, when all of the various holdings were brought together at the Kunsthistorisches Museum, which was opened in 1891. This collection, one of the most important of its kind worldwide, had to be temporarily closed for structural and technical renovation in 2002. A fundamental restoration as well as a redisplay and modern presentation of the objects took place. After the re-opening of the new Kunstkammer in 2013 the objects were exhibited in state-of-the-art showcases thoroughly tested for the absence of internal pollutions. Within the last two years, however, a new unwanted phenomenon of a whitish glittering thin film developed on the objects’ surfaces, demanding attention of the conservators. Due to the intensive collaboration of conservators and conservation scientists at the museum, but also internationally, this undesired layer was studied in detail. It not only disturbs the optical appearance of the artefacts, but also implies a risk to attack and harm their surfaces. Within the investigation, the mechanism of the film formation was explained and a new method of analysis and detection of its composition as well as a subsequent monitoring were developed. The presentation will focus on the latest results obtained by this systematic study.

The composition of the organic films was identified as being based on heterocyclic components, namely 2,2,6,6-tetramethyl-4-piperidinol (TMP) and 1,2,2,6,6-pentamethyl-4-piperidinol (PMP), both showing alkaline pH values. The method of sampling the glittering film by WhatmanTM microfiber filters, followed by the extraction into acetone and detection of the piperidinols’ extracts by gas chromatography/mass spectrometry (GC/MS) was developed and further optimised in order to efficiently monitor even smallest quantities of piperidinols, i.e. the very first steps of film formation.

The GC/MS instrumentation not only appeared to be the optimal analytical technique to identify the composition of the organic films. It also helped to monitor the efficiency of the subsequent cleaning methods applied by the conservators on the surfaces of the objects. It turned out that the dry cleaning by PUR sponge was more effective than the wet cleaning using various solvents. The presented facts, resulting from the interdisciplinary collaboration among the conservation scientists and conservators, were the major argument for the modification of the showcases. By implementing new types of adhesive and filter materials, their indoor conditions will be effectively improved avoiding recurring development of pollutant depositions on the object’s surfaces. Besides a better preservation of the artefacts, their exhibition in the adapted showcases will also offer unrestrained enjoyment of the high quality and unique objects by the museum visitors.
Laser-induced particle desorption

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Particle removal by pulsed lasers is of fundamental importance in cleaning technologies and conservation science.

In the case of mechanical desorption processes [1,2] adhesion forces have to be quantified. This was realized by scanning force microscopy (SFM). Polystyrene spheres attached to SFM cantilevers served as model particles. Pull-off forces on polymer and silicon substrates in the range of 50-200 nN were detected, which is about one order of magnitude lower than the predictions by theoretical models [3]. Therefore, multiple contacts, asperities on the spheres, and humidity have to be considered [4].

These investigations are correlated with particle acceleration measurements induced by surface acoustic waves generated by laser pulses. Thus, a quantitative experimental comparison between the adhesion force and repulsive force caused by the surface acceleration becomes accessible.

Particle removal by laser-induced surface acoustic waves (SAW)

NAA for Provenancing of Cultural Heritage Objects

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To provenance objects of the cultural heritage, chemical fingerprinting is a highly reliable and efficient method. Measuring the chemical fingerprint of an object, i.e. its composition of main and trace elements enables the comparison of this chemical composition with other objects. This comparison can easily establish a common origin. Comparison to raw materials can furthermore lead to a defined origin.

For the chemical fingerprint to be useful in provenancing, the elements measured need to be geochemically significant, have a low detection limit and a high reproducibility. The radiochemical method of Neutron Activation Analysis (NAA) offers all of those. Additionally, in comparison to other methods, NAA has extremely low matrix dependency, very simple sample preparation and usually requires less than 200 mg sample mass. NAA has been applied for the provenancing of archaeological artefacts as early as 1957 [1] and is still used extensively (see the compilation [2] and references therein).

One of the biggest challenges to performing NAA is the prerequisite of a research reactor for the irradiation with neutrons. The TRIGA Mk II reactor of the Atominstitut in Vienna has a long tradition of being used for NAA. At the Atominstitut, scientists have worked on the development of the method itself (e.g. [3, 4]) but also for provenancing of geological material like pumice [5] or obsidian [6] and lately for cuneiform tablets [7] and ceramic sherds [8, 9].

For ceramic sherds, an additional step in provenancing or grouping is required where, after measurement of the chemical fingerprint, a multivariate statistical filter is applied to the data. Application of a filtering method developed in Bonn [10] and successfully implemented at the Atominstitut in principle offers high comparability to established international databases.

Multiple wavelength stratigraphy by laser-induced breakdown spectroscopy

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Many modern industrial, medical, and conservation scientific applications require rapid qualitative and quantitative stratigraphic analyses of metal coatings. One promising option to achieve this is Laser-Induced Breakdown Spectroscopy (LIBS). In order to make such applications possible, detailed investigation of ablation and emission behavior is a major task.

This study used Nd:YAG lasers emitting at 1064, 532, 355 and 266 nm for the systematic ablation analysis of a galvanically deposited Ni-Co alloy layer (20% w/w Co, layer thickness 20 µm). The resulting plasma emission data were converted into stratigrams (Fig.) [1,2] employing the linear correlation coefficient method [3]. These were then used to determine the effective absorption coefficients [4], which were compared to theoretical estimations [5]. This approach allowed a systematic insight into both the influence of heat diffusion in the sample and laser-plasma interactions on the ablation rate.

In the year 2010 archaeological excavations in Lower Austria unearthed the grave of a Celtic warrior that could be dated back to the 5th century BC. Part of the burial equipment was an iron sword and its scabbard, which caught the archaeologist's main interest by its unusual style. It is made from two pieces of iron sheet with decorative parts of copper alloy and has been covered before burial with some fabric. Remains of this textile are preserved through mineralization on almost 50% of the surface. The clearly visible structure consists mainly of ferrous corrosion products, sheathing highly disintegrated fibres. The scabbard was broken into numerous small fragments. One of the main tasks in conservation was therefore to join the pieces together and manage a stable bonding. The second challenge was the cleaning of all surfaces, which were distorted by corrosion products and covered with dry earth and a dense layer of calcite sinter. The required cleaning method should be able to remove hard deposits without damaging the fragile organic remains or the thin malachite patina on the copper based parts.

In order to prove whether laser cleaning could be an appropriate alternative to sandblasting, cleaning trials with both methods were carried out on the three main surface types: corroded iron, inhomogeneous malachite patina and mineralized textile. As grit material for sandblasting glass beads (fraction 0-50 µm) were used. The laser cleaning tests were carried out with a Nd:YAG laser emitting at 1064 nm and a pulse duration of 100 ns (El.En. S.p.A., EOS 1000 LQS). The topography of the testing areas was subsequently evaluated by using optical microscopy and scanning electron microscopy.

The investigation showed that the laser caused rather destructive effects on the mineralized textile and also reduced the green malachite layer on the copper alloy parts, both important features of an archaeological object’s authenticity and also of the archaeological record. However, on the calcite covered iron the laser provided the expected positive result. It was possible to flake off the sinter crust precisely leaving sharp edged dull surfaces as a perfect base for a stable bonding.

As a consequence, the final cleaning of the scabbard was carried out by combining both methods, leading to a thoroughly satisfying result that confirmed the benefits of laser cleaning in the conservation of archaeological iron.
What did Bronze Age miners earn for their arduous efforts underground? Was copper mining a part-time activity of peasants, a full-time job of professional miners or was it slave work under the control of elites? Although metal production and distribution are regarded as prime movers of social development during the European Bronze Age, the underlying principles of labour organisation and specialization remain poorly understood. This is partially caused by a lack of in-depth studies of the settlements associated with mining, because archaeologists used to focus on the technological facilities (e.g. furnaces) alone, leaving aside the remains of everyday life and other production activities.

The overall project aim is to investigate the social organisation and the operation of an Alpine copper mine in relation to its networks of communication and exchange. We propose a micro-regional case study of the recently excavated Late Bronze Age mining settlement of Prigglitz-Gasteil (ca 1050 to 900 BC) in Lower Austria, which provides excellent conditions for studying the rise and fall of a mining site. Thanks to its outstanding state of preservation, the site allows for a multi-faceted approach to copper mining, bronze working and its social aspects.

The objectives are: 1) to compare organisational models of Bronze Age copper mines in the Eastern Alps, including cross-craft interactions with the contemporaneous salt mine of Hallstatt; 2) to investigate intra-site activity patterns; 3) to analyse the chaîne opératoire – from copper extraction to the production of bronze objects; 4) to reconstruct food and energy supply at the mining site of Prigglitz-Gasteil. As theoretical basis, the concept of the chaîne opératoire will be introduced to explore the links between technology and society and to investigate knowledge and tradition. A bundle of innovative methods (geochemistry, micro-debris, use-wear analysis) will be employed to study site formation processes for the first time in Central European mining contexts. Additionally, a broad spectrum of methodologies from archaeology, archaeometallurgy, archaeobotany, archaeozoology and geophysical prospection will be combined, including a variety of analyses (trace elements, lead isotopes, metallography, radiocarbon dating, anthracology, core drillings, geoelectric profiles etc.), to highlight the role of small-scale copper producers. For the first time, the process of recycling will be in the focus of archaeometallurgical investigations in Central Europe. Thus, the project output will also substantially advance the methodology of settlement archaeology and improve future excavation strategies.

The main researchers involved are Peter Trebsche (project leader), Andreas Heiss (archaeobotany), Marianne Mödlinger (archaeometallurgy) and Roderick Salisbury (geochemistry, intra-site analysis).

Acknowledgements: This project is funded by Austrian Science Fund (FWF): P 30289-G25
The large canvas (173 x 364 cm) by Paolo Veronese shows the biblical scene of David being anointed as King of Israel surrounded by a group of figures and animals in front of a landscape, buildings and ruins in the Roman style. It is dated around 1555 and was acquired for the collection in 1649.

This exceptional painting was recently treated before it took part in the exhibition Masters of Venice in San Francisco in 2011. Before conservation treatment the painting’s appearance was affected by discolored varnishes and dirt, the surface seemed brittle due to old, overpainted losses and areas of cupped paint layers. It is very likely, that the size of the canvas was changed, since the painting is shown in a historic inventory of the Kunsthistorisches Museum with far more background than today.

The examination by infrared reflectography (IRR) reveals Veronese’s direct approach to the painting process. Whereas on a study on paper he searches intensely for the posture of the figures, on the canvas he hardly uses any lines but just a few brushstrokes for positioning. The X-ray radiographic image shows some changes in the architecture and in the number of figures in the scene.

In the frame of a close cooperation with the Conservation Science Department, cross-sections of samples studied by light and electron microscopy revealed the painting technique: on a classical gesso ground. Veronese added, according to the area, either a second, dark layer containing ochre and lead white for dark areas or only lead white for the sky. For the paint layers he used a wide range of pigments including some instable materials like smalt and orpiment. Especially in the different shades of the blue sky the broad palette becomes obvious, as lapis lazuli, ultramarine, smalt and azurite are present in the oil painting. The varnish analysed by gas chromatography-mass spectrometry technique (GC-MS) consists of a resinous varnish based mainly on oxidised dammar, Venice turpentine, pine resin and even amber. Apart from the resinous mixture traces of a drying oil were also observed.

The treatment of this monumental masterpiece started with cleaning off the dirt from the surface. The paint layers were consolidated using sturgeon glue. For the reduction and removal of varnishes mixtures of ethanol and white spirit were used. Several old overpaints were treated with solvent-gels. After consolidation and cleaning, losses were filled and a layer of mastic varnish was applied. Retouchings were executed with gouache to imitate the structure as well as watercolor and resinous glazes on top. Finally, another layer of varnish was sprayed, which enables to enhance the beauty of this outstanding piece of Renaissance art.
Online edition of the file cards from the Central Depot for Confiscated Collections

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In autumn 1938, the Central Depot for Confiscated Collections was established on the bel étage of the Neue Burg in the centre of Vienna, particularly the rooms facing the Burggarten. It contained objects from Viennese art collections that had been confiscated by the Nazis after March 1938 from their Jewish owners and were later to be given to various museums. The Central Depot was managed until July 1940 by the Kunsthistorisches Museum (KHM) in Vienna and thereafter, until its closure, by the Institute for Monument Protection, the present-day Federal Monuments Office (BDA).

The file cards normally have an abbreviation indicating the collection they belong to stamped on them and directly underneath descriptions of the objects from the catalogue of confiscated objects. There are sometimes other stamps and handwritten additions indicating where the object was stored in the Central Depot, and whether it had been photographed, shipped to another repository or given to another institute. Many BDA cards also contain entries and file numbers from the post-war era.

The online edition planned for the end of the 2017 will make the file cards in the KHM and BDA archives publicly available for browsing. An additional source of information will be provided by an annotated catalogue of confiscated objects, which is also in the KHM archive. A full text search of the files will also be possible.

**Financing:** Commission for Provenance Research and Kunsthistorisches Museum Wien

**Project period:** October 2015 – end of 2017

**Project team:** Lisa Frank, Susanne Hehenberger, Peter Kloser, Leonhard Weidinger
This study [1] focuses on the examination and conservation of a mid-19th century painting on a tin-plated iron support. The small-scale portrait was affected by severe paint delamination and cleavages. The damage was treated in 1994, supported by analytical and technical investigations [2]. Selected adhesives and various filler preparations were tested [3]. Finally, Paraloid®B-48N was applied as most appropriate consolidant while a preparation containing Lascaux® Adhesive Wax 443-95 and chalk was chosen for the fillings and Mowilith®20 for retouching. However, about 20 years later separation and lifting of the paint layer were noticed again. UV investigation revealed that the affected areas were almost not identical with the consolidated sections at that time.

The main focus of this study is the re-examination of the painting and the reassessment of the analytical and technical investigations in order to compare the results with the findings of the previous study. It was hoped to verify whether inadequate preparation of the tin-coated iron plate and/or mechanical impacts – as proposed by the author of the 1994 study – might have caused the delamination.

The results of these examinations suggest indeed, that the contribution of mechanical impact might be the initial and decisive factor for the delamination. Presumably, the previous treatment was partially insufficient, since the consolidant was probably not able to penetrate beneath the flakes of the blind cleavages. Before recent treatment, the choice of the already applied conservation materials had been evaluated concerning their condition after a 20 years period. As the instable paint condition might be rather attributed to the impossibility of applying consolidant beneath blind cleavages than to a failure of the consolidant itself, it was decided to use the same conservation materials as in the previous treatment.


The head is an antique, originally male, ideal head with a complicated hairstyle and made for a statue. It was damaged (for example, the curls) and then reworked into a female portrait: affected are the forehead hairstyle, the ivy wreath, the gilding on the forehead and on the hair around the temples. After the excavation (forehead damaged by tool use), the figure was interpreted as Isis and completed with a bust during the renaissance period.

Question: How many phases?

Process: restoration, scientific and art historical investigations; restorative, photographic and scientific documentation.

Goal: integration into a comprehensive inventory catalogue of female portraits.

Special features: In many cases, the history of the objects can only be reconstructed by examining the reworking and additions made to the original antique portraits.

(1) Relevant project: Antique Portraits in Vienna
Rembrandt’s „Old Woman Praying“: A look below the surface using XRF-mapping

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Rembrandt’s painting *Old Woman Praying* is the most valuable and exceptional work of Art of the Residenzgalerie Salzburg (RGS). It is painted on a gilded copper-plate with dimensions of only app. 15 x 12 cm and probably belongs to a series of three small-scaled tronies, all painted on gilded copper plates. This extremely unusual picture support is a special feature both in Rembrandt’s work and in the entire history of art.

One of the comparable paintings, *The Laughing Man*, at the Mauritshuis in The Hague, attributed to Rembrandt, was investigated before by means of cross-section analysis and the study yielded that the gilding of the copper plate was done using a ground of lead white. The same is true for the second tronie, the *Self Portrait*, at the National Museum in Stockholm, also attributed to Rembrandt, which was examined using microscopic techniques.

To be able to characterize also the painting of the RGS XRF-mapping using the ELIO mapping system was performed in a collaboration of the RGS, the XGLab in Milano and the Conservation Science Department of the Kunsthistorische Museum Vienna (KHM) in the course of a bigger research project on Rembrandt and his school.

The results showed a completely different structure for this painting than Rembrandt used for *The Laughing Man* and the *Self Portrait*. The gilding was done directly on the copper plate and, additionally, there are three areas visible where the gilding is missing. It seems likely that in two of these areas the gold was removed on purpose to yield a different, darker appearance of the painting. For the third area the reason of the absence of gold cannot be explained by the execution of the painting and, therefore, remains a topic for speculation.

 Altogether, the XRF-mapping yielded very valuable insights into the structure of the painting as well as the technique and the principal pigments used for its composition. The results were shown in a special exhibition about the scientific examinations on the *Old Woman Praying* from 13.11.2016 - 03.07.2017 at the RGS. [1]

Out of sight, out of mind.
The hidden hazards of historic materials – experiences and strategies at the Vienna Technical Museum

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A thorough knowledge of the museum collections is an absolutely essential prerequisite for all other museum activities: namely targeted collection, preservation and conservation, research, exhibition and mediation. At the Vienna Technical Museum a collections reviewing program was begun in 2003 and is still ongoing. This program is including inventory, basic cleaning of objects, measures for stabilization if needed and improving storage facilities.

It also fruited in an overview of hazardous materials in the collections [1]. Although hazardous materials are often clearly on view, they are not readily recognized and so remain in effect hidden. Once identified, the automatic, knee-jerk response to hazardous materials in collections seems to be dominated by the desire to remove and to avoid rather than to preserve and mediate. Our experience is that this need not be so and that inexperience and a lack of reliable knowledge often make the problems seem far worse and unsolvable than they really are.

The main focus of this paper is to outline the strategies developed over a fourteen-year period to deal with the problems of storing, handling and conserving collection objects containing or consisting of hazardous materials [2].

“VISUAL SCIENCE”:
Fine Art as method of scientific visualization & museums didactics

Stefanie Jovanovic-Kruspel

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No other institution in Austria has such a long tradition of visualization of scientific content as the Natural History Museum Vienna. Thanks to its dual function as scientific institute and public educational institution, the NHM Vienna holds large collections of scientific illustrations and models used for scientific purposes and for museums didactics. Although these objects are not only of historic but sometimes also of very high artistic value, they are still “hidden treasures”. Seen as unexciting research tools they are often consigned to the shadows. Already in the 18th century, scientific illustrations and models were created by the means of the fine arts. Before the invention of photography this was the only way of visually documenting scientific discoveries. But even beside photography, which still has a very special position in the natural sciences, the fine arts kept their function. To date scientists are often working closely with artists. Each artistic representation is the result of a knowledge process, thus adding to the textual interpretation a new meaning. By this, these art works not only document scientific discoveries, but also provide the basis for further creative scientific thinking. Under this new perspective, a completely new field of art historic research opens up, in which the authors of these art works can be categorized in four groups:

(1) Many of the illustrators, painters and model builders are not seen as real artists. Their work had to be realistic and scientifically exact instead of artistically innovative.

(2) Some scientists were able to carry out high-quality illustrations of their scientific research subjects. They had trainings both as painters and as scientists. Examples for this category are the butterfly pictures by the researcher and collector Josef Mann [1], the underwater scenes by Eugen von Ransonnet-Villez [2] or the paintings by the artist-explorer Julius von Payer.

(3) In many cases, however, scientists have sought cooperation with well-known artists. These include, among others, the artists who were involved in the decoration of the NHM Vienna. The paintings and sculptures created by them for the exhibition rooms had didactic function.[3]

(4) A category in itself is the artists who define themselves exclusively as artist and do not want to assign any scientific purpose to their work. They take up scientific topics and use the collections as inspiration. Examples are the fantastic works by Daniel Spoerri, or the photos of Irene Andessner.

The Late Bronze Age and Early Iron Age Cemetery in Kainach near Wildon, Styria.

Computed Tomography and Archaeology: Innovative Application Possibilities for Archaeology, Conservation, Restoration and Anthropology

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The project is based at the Department of Archaeology of the Federal Monuments Authority Austria and is running since 2012. It is concerned with possibilities of computed tomography (CT) and its application for archaeology. The project is directed by HR Univ.-Doz. Dr. Bernhard Hebert, cooperation partners are ASFiNAG and Siemens Austria since 2013. This pilot project aims to perform a first specific study of the evaluability of virtual 3D CT data generated from graves retrieved en bloc for conservation and restoration, archaeology and anthropology [1, 2, 3].

Object of research is the internationally significant cemetery at the “Herrschafstaeccker” (Weitendorf near Wildon, Styria, Plot no. 550, 365/4; Cadastral Unit Kainach, Market Community Wildon). It is distinguished by a multitude of important burial objects, which are challenging to conserve and to restore. The cemetery was excavated from 2004 to 2007 by the association Kulturpark Hengist.

A total of 230 graves were identified. They often contain an extensive inventory of ceramics, and within a great number of graves metal finds such as bronze knives and needles were found. Most of the ceramic vessels and to some extent entire graves were recovered en bloc.

With a selection of four graves the possibilities and limits of evaluating virtual data in comparison to traditional archaeological and anthropological processing is investigated and specific methods of implementation are worked out. [4, 5]. Furthermore, the potential of this examination method for excavation, conservation and restoration is examined [6].

The medal production at Vienna’s central mint during the reign of Maria Theresa (1740–1780)

Anna Fabiankowitsch

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Today, about three hundred different types of medals commemorating Maria Theresa’s political successes as well as family affairs of the House of Habsburg-Lorraine are known. Produced during her reign, they played an important role in the visual representation of the Empress. Nonetheless, the historical background of their production is widely unexplored until now.

To fill this gap of research this PhD-project aims to gain information about how the official medal production in the second half of the 18th century manifests itself. By reconstructing modalities of commissioning, genesis of conceptual design, proceedings of production and further functions of medals, various processes, practices and protagonists of these official medals are being analysed.

By evaluating the written sources in the archive of the Viennese central mint, the research focuses on the patrons and on the modalities of their commissions in order to identify and classify the respective share in medal production between the court and of privates. The identity of patrons and their intentions allow us to analyse the function of this artistic medium as a form of princely display and representation. In order to judge the artistic independence of medallists, we investigate, if monitoring bodies evaluated designs and specified motifs. In addition, we examine the production processes at the engravers’ workshop and the minting process by studying the collection of historical minting-dies. The medal’s function completes the circle of research connecting the initial commission and the final recipients. Reconstructing the group of addressees and the modalities of distribution forms the basis for our understanding of the importance of medals. We bring out the genre-specific function of medals by evaluating occasions and intentions that initiated their commission as well as the closely related set of audience.

The project is part of a multi-annual research project at the Art History Department of the Institute for History of Art and Musicology of the Austrian Academy of Sciences entitled “The representation of rulers and the historical culture under Maria Theresa (1740–1780)” (FWF project P27512) directed by Univ.-Doz. Dr Werner Telesko.
The poster discusses the investigation of the upholstery of a horse-drawn railway carriage known as Hannibal (built around 1841 and used until 1872). The carriage is part of the collection of the Vienna Technical Museum, Austria, and was conserved in 2014 to prepare it for long-term display in the permanent galleries. Conservation of upholstery was prioritised because of its poor condition. Conservation condition survey revealed that the interior upholstery was not original and that the carriage had undergone many renovation campaigns making the identification of the original components and layers of upholstery challenging. The reconstructed history of Hannibal highlights its role as an exhibit at international exhibitions in Vienna prior to becoming part of the museum’s collection. This makes the renovations and renewals of upholstery potentially significant. The conservation project aimed to document and preserve the carriage in its current form. To establish the chronology of the upholstery layers, dyes were analysed by ultrahigh pressure liquid chromatography with photo diode array detection (UHPLC-PDA). Analysis of the dyes helped to understand the significance of alterations and restorations in the context of the museum’s earlier practices. The poster presents the most important aspects of this collaborative project.

This project was presented at the 33rd conference Dyes in History and Archaeology, Centre for Textile Conservation and Technical Art History, University of Glasgow, 29-30 October 2014.
Elemental characterization of Roman bronzes from Lauriacum using total-reflection X-ray fluorescence analysis (TXRF)

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This work presents the results of a quantitative elemental X-ray analysis carried out on various Roman bronze fragments from Lauriacum, a Roman legion camp and town situated at the Danube Limes on the area of present-day’s city of Enns in Upper Austria. Among these was a forearm with hand and fingers, a head fragment and various fragments with inscription, probably parts of the municipal charter of the town. From each of these fragments in total 39 samples were transferred to quartz glass sample carriers by wiping. Transferred masses were in the range of 1 microgram (10⁻⁶ grams) and below. The carriers were subsequently loaded into a spectrometer for total-reflection X-ray fluorescence analysis (TXRF) and analyzed using two different excitation conditions. TXRF is a very suitable method for the analysis of samples present in minute quantities, thus allowing the nearly destruction-free analysis of cultural heritage objects, as wiping over the surface already delivers sufficient sample mass.

TXRF analysis revealed that all bronzes contain the three main elements copper (Cu), tin (Sn) and lead (Pb) in variable percentages. Major trace elements include iron (Fe), zinc (Zn), silver (Ag) and antimony (Sb). Pb was very inhomogeneously distributed in the samples taken from the forearm with a maximum of 70 % in the index finger, whereas the samples from the head fragment were less variable with Pb contents mainly between 20 and 30 %. The fragments with inscription also showed variable composition and may be grouped according to the presence and percentage of Sb and/or Ag.

This application proves the power of TXRF as a nearly nondestructive analytical method for the investigation on very small amount of samples of cultural heritage objects.
What does “purple” really mean? Study of the colorants used to dye a mediaeval purple codices, the “Krönungsevangeliar”

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The so-called „Krönungsevangeliar“ is one of the most precious examples of purple codices of mediaeval times. It was used for the coronation of the Emperor of the Holy Roman Empire during swearing the oath and was retrieved from Aachen in 1794 together with other “Reichskleinodien”. Modern science agrees that it is the only manuscript from the “Reichskleinodien” that is definitely connected to the court of Charlemagne (ruler 768 – 814). Today the codices made of 236 purple to bluish coloured parchment leaves is kept in the Treasury of the Kunsthistorisches Museum Vienna.

From 2010 to 2013 scientific and technological studies were performed to answer questions concerning the classification of the artistic décor, its historic influence, and the materials used as well as its state of preservation. One focus of the analyses was the colourant applied for dyeing the parchment leaves. Since late antiquity, the use of purple dyes to impart colour to parchment of precious codices is mentioned, but recipes explicitly describing the practice of colouring parchment are rare. In addition, the sources are sometimes not clear concerning the term “purple”, which is used for the application of Tyrian purple as well as for gaining a purple colour applying other dyeing compounds.

So far, purple codices were rarely analysed and as the analysis is normally limited to non-destructive techniques, no definite colourant or mixture could often be identified. No single evidence for the use of Tyrian purple to dye the parchment in purple codices was found, while all analyses suppose the presence of less valuable alternatives, such as orchil (Roccella, Dendrographa), and Lecanora genera of lichens, folium (Chrozophora tinctoria) or anthraquinonic dyes (kermes or madder), these last possibly in double dyeing with indigo.

The investigations performed at the “Krönungsevangeliar” by different Austrian and international researchers applied solely non-destructive techniques, like UV-visible Diffuse Reflectance Spectrophotometry with optic fibres (FORS) and different X-Ray Fluorescence (XRF) techniques. As the single leaves show different shades of bluish and purple colours the use of Tyrian purple seemed possible in principle, although unlikely from the sheer number of leaves and, therefore, molluscs that would have been necessary for the process. The element bromine (Br) serves as an indicator for the presence of Tyrian purple, as it is present only in this reddish dye chemically based on 6,6’-dibromoindigotin.

Analysing the “Krönungsevangeliar” a small peak of Br was detected applying handheld XRF, which could not be confirmed applying µ-XRF and did also not agree with the FORS studies suggesting the use of a mixture of dyes, most probably containing orchil. By performing further analyses on especially prepared test samples in Austria and Italy and from literature an explanation for the small amounts of Br on the parchment leaves could be gained and the use of Tyrian purple could be definitely excluded.
The Viennese Last Judgement triptych by Hieronymus Bosch

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During a research project The Last Judgement Triptych of the Gemäldegalerie der Akademie der bildenden Künste Wien supported by the Austrian Science Fund (FWF-Project No. P23848-G21, project leader HR Univ.-Doz. Dr. R. Trnek and co-operation Mag. A. Lehner) several scientific investigations could be carried out concerning the materials as well as the painting technology applied by Hieronymus Bosch. Preliminary investigations by optical microscopy in the visible and UV range allowed studying the paint structure and the paint layer stratigraphy as well as later campaigns of overpaint. The differences in the application of paint on the central panel and the wings, which were thereby evidenced, suggest a differentiation of the works between the master himself and his workshop assistants.

Furthermore, a number of samples were taken for cross-sections. Material identification was performed by scanning electron microscopy in combination with energy dispersive X-ray microanalysis (SEM/EDX). This analytical method provides information about the chemical elements present in each pigment grain. These investigations could be performed using a Quanta200 SEM instrument (FEI, Thermo Fisher) at an accelerating voltage of 20 kV and a Genesis system (EDAX, Ametek). Pigments such as vermillion, azurite or lead tin yellow were identified. This method also helped to distinguish apparently similar whitish or greyish paint layers in the area of the coat of arms on the wings’ outsides, by their characteristic microstructure and inclusions of different black and red pigments, shown in back-scattered electron (BE) images, thus clarifying the changes in design of this area at different stages of the triptych’s execution. Some pigments, like red lead and bones black were only found in non-original layers.

As complementary technique, Raman spectroscopy was chosen in order to differentiate between pigments of the same colour by their molecular and structural properties. Two instruments were available: Aramis of Jobin-Yvon, in the Institute of Science and Technology in Art, Academy of Fine Arts Vienna, and the LabRam 800HR of Jobin-Yvon in the Institute of Chemical Technologies and Analytics of the Vienna University of Technology. This investigation allowed not only to confirm that the painting technique and palette are typical for the period, featuring traditional pigments such as lead white and carbon black as well as azurite in the blues, vermillion, iron oxides, and red lakes in the reds, lead tin yellow and ochre in the yellows, but also to study in detail the composition of the green copper containing pigments. The compound specific analytical studies showed that mainly malachite and copper resinate used as green glaze were applied in the painting. Interestingly, copper-resinate was detected in the original green layers, but also in the early overpaint (especially in the paradise wing), thus suggesting that it was executed most probably within the 16th century.

Acknowledgements: Ing. Elisabeth Eitenberger and Dr. Johannes Ofner, Institute of Chemical Technologies and Analytics of the Vienna University of Technology are gratefully acknowledged for their cooperation.
ICP-Materials – an international project of UN/ECE
(United Nations Economic Commission for Europe)

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The International Co-operative Program (ICP) on Effects of Air Pollution on Materials, including Historic and Cultural Monuments is focused on the degradation of materials under the ambient atmosphere in Europe and North America. Already in 1979 the Convention on Long-range Transboundary Air Pollution was signed and ICP Materials started in 1985. It was initiated in order to provide a scientific basis for new protocols and regulations developed within the Convention. Degradation to materials in Europe is today much lower, mainly due to reduction of S pollution. However, air pollution is still a problem but more complicated, where effects are the result of a multitude of harmful air pollutants and effective strategies for reduction need to go side by side with strategies for dealing with climate change.

Our institute (ISTA) has been partner in this ICP since the late 1980s in two different ways:
- exposure of potash-lime-silica (PLS) glass, predominantly used in the Romanesque and Gothic periods for the production of medieval stained glass artefacts,
- exposure site at the Zentralanstalt für Meteorologie und Geodynamik (ZAMG) in Vienna, where various materials of European research centers are exposed under natural conditions and the weathering phenomena are correlated with the environmental data.

The aim of ICP Materials is
- to perform a quantitative evaluation (dose-response functions) of the effects of multi-pollutants such as S and N compounds, O₃ and particles as well as climate parameters on the atmospheric corrosion and soiling of important materials, including materials used in objects of cultural heritage,
- to describe and evaluate long-term corrosion and soiling trends attributable to atmospheric pollution in order to elucidate the environmental effects of pollutant reductions achieved under the Convention and in order to identify extraordinary environmental changes that result in unpredicted materials damage, and
- to use the results for policy purposes for the benefit of the Convention by e.g. mapping areas with increased risk of corrosion and soiling and for calculation of cost of damage caused by deterioration of materials.

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