



HSAcademy

2nd Doctoral
Summer
School

17-21 JULY 2023

ZAG, Ljubljana (Slovenia)

final programme



ENVIRONMENTAL IMPACT ON BUILT HERITAGE AND ITS DIGITALIZATION

ZAG, Dimičeva 12, Ljubljana, Slovenia
17-21 July 2023



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ENVIRONMENTAL IMPACT ON BUILT HERITAGE AND ITS DIGITALIZATION

ZAG, Dimičeva 12, Ljubljana, Slovenia
17-21 July 2023

PROGRAMME

Day 1: 17 July, Monday

13:30 - 15:00 Registration

15:00-16:00 Condition assessment of Renaissance bronze statue of Neptune 30 years after the first restoration intervention: characterization of the evolution of outdoor bronze corrosion patinas and performance evaluation of applied protective coatings

Rocco Mazzeo, University of Bologna (IT)

16:00-17:00 Slovenian node of E-RIHS - who are we and what do we do?

Matija Strlič, University of Ljubljana (SI) and Polonca Rupret, IPCHS (SI)

17:00-18:00 Investigation of 9-year-old patinas on bare and artificially patinated bronze in an urban environment

Tadeja Kosec, ZAG (SI)

19:00-21:00 Social event: boat tour on Ljubljana river

More information: [page 14](#)



Day 2: 18 July, Tuesday

9:00-10:00 Digitization of cultural heritage: HBIM and openBIM

Katja Malovrh Rebec, ZAG (SI)

10:00-11:00 Surveying and digitizing of cultural heritage by geomatics techniques

Gabriele Bitelli (ONLINE), University of Bologna (IT)

11:00-12:00 Going beyond the idea of digital building logbook: a project to interconnect tools, stakeholders and multi-scale data around buildings

Noemi Friedman, SZTAKI (HU)

12:00-13:00 Medieval ruins - technical, economic and social aspects

Jakub Novotný (ONLINE), ITAM CAS (CZ)

13:00-14:00 Using environmental data to understand the state of conservation of a sheltered archaeological site

JoAnn Cassar, University of Malta (MT)

14:00-15:00 Lunch break

15:00-19:00 Ljubljana excursion: on-site short lectures about heritage related topics

More information: [page 15](#)



Day 3: 19 July, Wednesday

9:00-10:00 Identification of natural stone in interiors: challenges and opportunities

Hof, Jan van 't, RCE (NL)

10:00-11:00 Modeling and understanding of the behavior of salt mixtures in the built environment

Scott Allan Orr (ONLINE), UCL(UK)

11:00-12:00 Museum Building Management - Perspectives from Alexandria, Egypt

Abdelrazek Elnaggar, University of Ljubljana (SI)

12:00-13:00 The use of X-ray computed microtomography to explore microstructure of materials in cultural heritage, archaeology and civil engineering

Lidija Korat, ZAG (SI)

13:00-15:00 Lunch break

15:00-16:00 Consolidation of mineral substrates

Andreja Pondelak, ZAG (SI)

16:00-17:00 Decay of wooden heritage: degradation, detection and prevention

Miha Humar, University of Ljubljana (SI)

19:00-21:00 Social event: running tour in Tivoli combining some easy exercise with sightseeing

More information: [page 14](#)

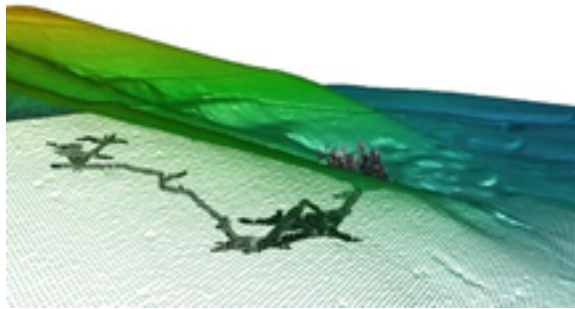


Day 4: 20 July, Thursday

9:00-16:00 Sitarjevec excursion.

Entire day tour + ZAG lectures at site

More information: [page 16](#)



Day 5: 21 July, Friday

9:00-10:00 The Analysis of Architectural History Within the Conservation Practice: the Case of Jože Plečnik's Architecture

Tina Potočnik, ZAG (SI)

10:00-11:00 IPERION HS services towards a permanent E-RIHS infrastructure. The case of Molab access on Giotto's wall paintings in the Bardi Chapel in Florence

Jana Striova and Antonina Chaban (ONLINE), CNR-INO (IT)

11:00-12:00 Preserving Cultural Heritage: Innovations for Sustainable and Socially Impactful Future Approaches

Jana Kolar, ESFRI & CERIC-ERIC

12:00-13:00 Open discussion and closing of the summer school.
Delivery of attendance certificates



Abstracts of lectures

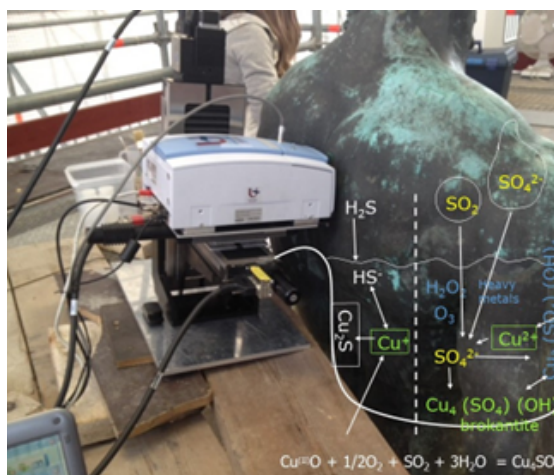


1. Prof. Rocco Mazzeo University of Bologna, Italy

TITLE:

Condition assessment of renaissance bronze statue of Neptune 30 years after the first restoration intervention: characterisation of the evolution of outdoor bronze corrosion patinas and performance evaluation of applied protective coatings

ABSTRACT:



The restoration intervention carried out in 2016 on the bronze statue of Neptune, symbol of Bologna, has been an extraordinary occasion to evaluate the evolution of the corrosion patina formation as well as the performance of the protective coating applied on the occasion of the previous restoration performed in 1989. To this purpose, Non-invasive analytical techniques such as portable XRF and macro Mid-Infrared total reflection (MA-FTIR) have been used. In particular for the first time it has been possible, by means of MA-FTIR, to chemically map the uneven presence of the acrylic protective coating applied in 1989 and the almost disappearance of the sacrificial wax layer as a result of the lack of maintenance the bronze surface suffered along 30 years of exposure to the environment.

2. Matja Strlic (University of Ljubljana) and Polonca Ropret (Institute for the Protection of Cultural Heritage, IPCHS), Slovenia

TITLE:

Slovenian node of E-RIHS - who are we and what do we do?



Abstracts of lectures

3. Dr. Tadeja Kosec

Slovenian National Building and Civil Engineering Institute (ZAG), Slovenia

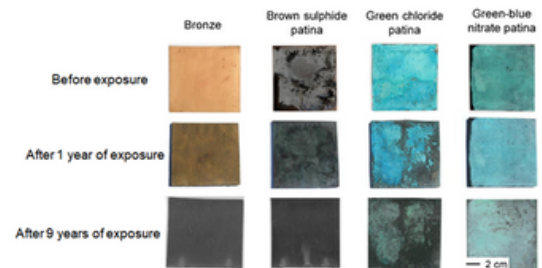
TITLE

Investigation of 9-year old patinas on bare and artificially patinated bronze in an urban environment

ABSTRACT

In the lecture a study on natural and artificial bronze patinas developed through exposure to a real-life urban environment over a period of 9 years will be presented. Different types of patinas on bronze will be studied, namely natural patina on bare bronze, brown sulphide patina, green chloride-patina, and green-blue nitrate-patina. Visual assessment at defined periods will be shown.

After 9 years of exposure, an electrochemical study was performed to investigate the electrochemical activity of the patinas in artificial urban rain. Additionally, the patinas were characterized using a variety of techniques, including metallographic examination, scanning electron microscopy/ energy dispersive X-ray spectroscopy, Raman spectroscopy, X-ray diffraction analysis and X-ray-photoelectron spectroscopy. The surface morphology, chemical composition, stratigraphic features, and evolution of the natural bronze patina as well as the artificial patinas will be presented.



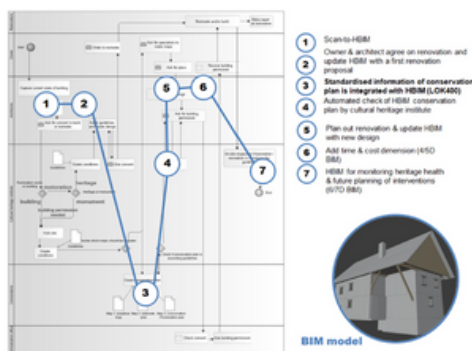
4. Dr. Katja Malovrh Rebec

Slovenian National Building and Civil Engineering Institute (ZAG), Slovenia

TITLE

Digitalization of cultural heritage: HBIM and openBIM

ABSTRACT



Cultural heritage building information models (HBIMs) play a crucial role in supporting workflows and decision-making within heritage studies. HBIM might ensure smooth data exchange between different software solutions and mitigate data loss, an openBIM approach is adopted, utilizing the Industry Foundation Classes (IFC) open data exchange standard. In order to facilitate specific data exchange scenarios, an Information Delivery Manual (IDM) can be developed. It provides a framework for supporting the seamless transfer of data between different systems. Additionally, by carefully filtering relevant portions of the IFC schema, a specialized Model View Definition (MVD) is created.

This MVD focuses on the creation of a specialized IDM for the heritage domain, and it is developed in consultation with experts in the restoration and preservation of built heritage. Subsequently, the IDM is translated into a pilot MVD specifically designed for heritage-related projects. The developed methodologies are then put to the test in a practical HBIM case study, which revolves around a historic building. During the lecture we will see an examples of a conservation plan that was translated into semantically enriched BIM, ensuring its alignment with the requirements specified in the IDM, using the developed MVD as a benchmark. IDM and MVD tailored to the heritage domain is crucial for future development of this specific scientific area. This progress might also bring closer together to the standardization of Building Information Modeling (BIM) in the field of digitized cultural buildings.

Abstracts of lectures

5. Prof. Gabriele Bitelli
University of Bologna

TITLE

Surveying and digitizing of cultural heritage by geomatics techniques

ABSTRACT

The lecture deals with the most advanced techniques of Geomatics Engineering for surveying and representing Cultural Heritage in a digital environment. Particular emphasis is placed - starting from selected case studies - on multiscale approaches. These approaches encompass a range from the territory level to individual objects, and involve the integration of various technologies, in particular for the acquisition and management of three-dimensional data.

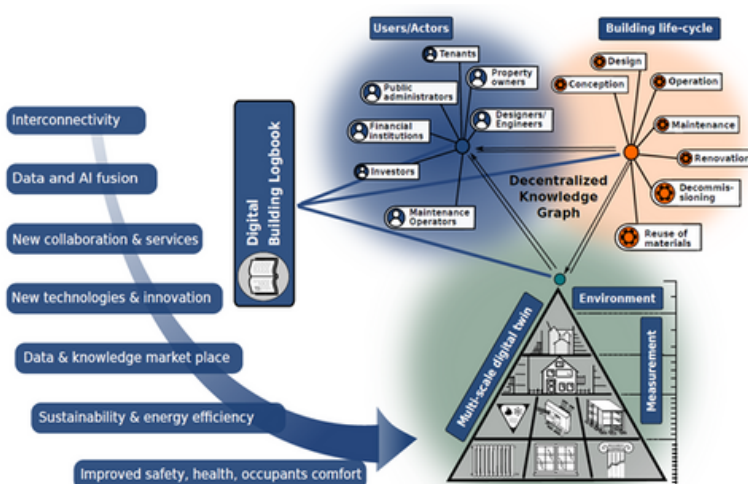
6. Dr. Noemi Friedman
SZTAKI, Hungary

TITLE

Going beyond the idea of digital building logbook: a project to interconnect tools, stakeholders and multi-scale data around buildings

ABSTRACT

The presentation will give an insight into the main ideas of the project BUILDCHAIN, targeting to develop technological solutions that will enhance data exchange and transparency in the building sector of the EU aiming at sustainability, resilience, and energy efficiency. The project will build a knowledge base with the help of a Decentralized Knowledge Graph (DKG) that will be used by various actors to trace all activities related to the complete life-cycle of buildings. The DKG will be integrated with several new functionalities that will assure a high interoperability between legacy systems and existing tools (e.g. BIM, HBIM), compliance with standards, providing automated warning and alerting system with the help of machine learning tools, digital twinning, and decision-making support.



The talk will give an insight into the goals of the project, present the idea of digital twinning that can track the behaviour of built structures, the BIM integration advantages for design, visualization and management, and show the great potentials of the DKG blockchain-based solution, providing mechanisms and interfaces to publish, trace, share, tokenize, end even trade models in a market economy.

Abstracts of lectures

7. Dr. Jakub Novotny
ITAM CAS, Czech Republic

TITLE

Medieval ruins - technical, economic and social aspects

ABSTRACT

The aim of the lecture is to briefly discuss the complexity of monument care of medieval ruins and its management. An empirical reflection on problems connected with historical ruins management will be presented first. Subsequently, an international project RUINS will be briefly presented. The audience will be introduced to its methodological outputs—rules and model forms for ruins. The conclusion of the lecture will then be devoted to examples of good and bad practice in the management of medieval ruins.



8. Dr. JoAnn Cassar
University of Malta

TITLE: Using environmental data to understand the state of conservation of a sheltered archaeological site

ABSTRACT

The UNESCO World Heritage Sites of Hagar Qim, Mnajdra and Tarxien, located in the Maltese Islands, were constructed between the mid-4th and mid-3rd millennia BC. These prehistoric Megalithic Temples were covered with a protective, temporary, open-sided shelter between 2009 and 2014. The aim was to shield the structures from environmental factors which were identified as leading to accelerated deterioration of the materials (limestone megaliths) and the structures (unroofed structures, built without mortar and a few meters in height).

The sheltering was preceded by intense environmental monitoring which lasted for 1 year; this is still continuing and is now focused on the Mnajdra site, to help understand its state of conservation and to evaluate the performance of the shelters, comparing recent results with those obtained before the sheltering took place. Environmental monitoring is being supported by the modelling of data (past and present) and goes in parallel with the study of the effects of salt weathering on the limestones, to define how the salts present within the megaliths are bringing about their deterioration.



Abstracts of lectures

9. Dr. Jan van 't Hof
RCE, The Netherlands

TITLE

Identification of natural stone in interiors: challenges and opportunities

ABSTRACT

In Europe, natural stone has been used for all kinds of interiors and within these, for all kinds of elements. Sometimes whole churches were clad in stone, in other cases just specific elements like chimney pieces or altars were executed in stone. This contribution starts with a concise overview of several elements or moments in time where and when stone was used. Several churches from around 1900 will be looked into, but also other examples. And we will look into the various sources we can rely on to identify the specific stones or the designs elements were based on. We will also look into the state of play regarding the techniques available to identify stones, and if these need extra elaboration. This contribution wants to address research questions in this regard, but also if the existing repertoire is already sufficient.

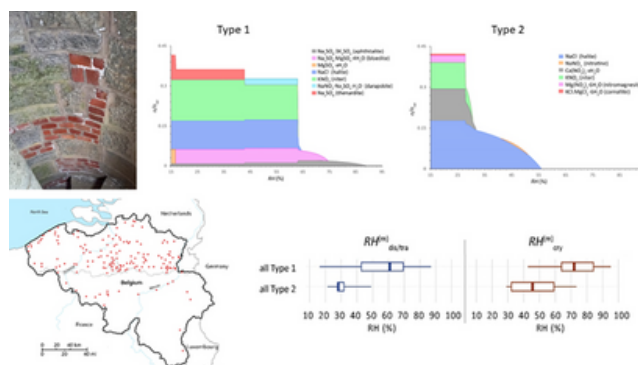
9. Dr. Scott Allan Orr
UCL, United Kingdom

TITLE

Modelling and understanding of the behaviour of salt mixtures in the built environment

ABSTRACT

The mobilisation and crystallisation of salts in porous media, such as masonry and other geomaterials, is a significant deterioration mechanism in the historic built environment. This session will introduce the fundamentals of the equilibrium behaviour of salt mixtures in the built environment. This understanding is underpinned by an established thermodynamic model (ECOS) that can be used for both context- and site-specific analysis, to understand how salt mixtures are likely to respond to fluctuations in temperature and humidity. This session will also introduce state-of-the-art research that has leverages automated modelling approaches for a large cohort of salt mixtures present in the built environment, more broadly demonstrating the potential for computational approaches to addressing physical heritage management challenges. Out of this, broad guidelines for minimising salt crystallisation risk will be covered, which are particularly useful for ensuring heritage is sustainable and resilient.



Abstracts of lectures

11. Dr. Abdelrazek Elnaggar
University of Ljubljana, Slovenia

TITLE:

Museum Building Management - Perspectives from Alexandria, Egypt

ABSTRACT

The impact of climate change on cultural heritage materials, human comfort and mass tourism in historical building museums is severe, leading to an accelerated material degradation, loss of value, increasing cost of preservation and climatization along with other socio-economic risks. Simulated prediction models have assessed the long-term climate change-induced outdoor and indoor risks for historic buildings and collections in Europe and the Mediterranean region, indicating Egypt to be at high risk. Preventive conservation management in Egyptian museum buildings remains unplanned and requires in-depth research to improve the preservation process and increase the public engagement and human comfort. The lecture will shed light on the Museum of Fine Arts in Alexandria as a case study presenting the impact of preservation status of the museum collection and of the building spaces on artwork sustainability and human thermal comfort. The optimization of museum environmental conditions using an integrated risk analysis and appropriate preventive conservation actions will be presented as part of an IPERION HS project the Museum and the Heritage Science Lab Ljubljana (University of Ljubljana) and the Preventive Conservation Lab (University College London, UK).

12. Lidija Korat

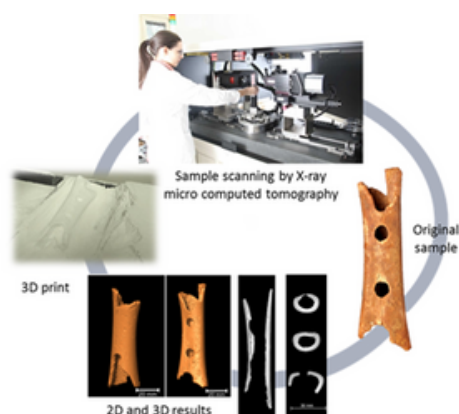
Slovenian National Building and Civil Engineering Institute (ZAG), Slovenia

TITLE:

The use of X-ray computed microtomography to explore microstructure of materials in cultural heritage, archaeology and civil engineering

ABSTRACT

X-ray micro computed tomography (microXCT) is a high resolution non-destructive materials imaging technology and is emerging as a powerful tool for industrial and scientific research applications.



The technology uses X-rays to create 3D images, which allows visualization and accurate dimensional analysis of the exterior and interior of all kinds of materials. The aim of this presentation is to present the capabilities and potential of this technique within scanning important Slovenian samples from cultural heritage, archaeology and civil engineering, and determine their microstructure. Also the method will be presented as high-accuracy method for the integrative restoration of samples by using reverse engineering techniques and additive technologies. This provides a wider understanding of the opportunities and capabilities of this technique and how it can benefit researchers and local museums.

Abstracts of lectures

13. Dr. Andreja Pondelak

Slovenian National Building and Civil Engineering Institute (ZAG), Slovenia

TITLE

Consolidation of mineral substrates

ABSTRACT

In the lecture, consolidants that have been used in the past and are currently used for consolidation of carbonate based historic materials will be presented. Criteria for the effective consolidation of the original material will be presented - the so-called consolidant requirements. Different non-destructive and micro-destructive methods for evaluation of consolidant efficiency will also be presented. Consolidant effectiveness will be shown on laboratory model substrates as well on different real case studies.



14. Dr. Miha Humar

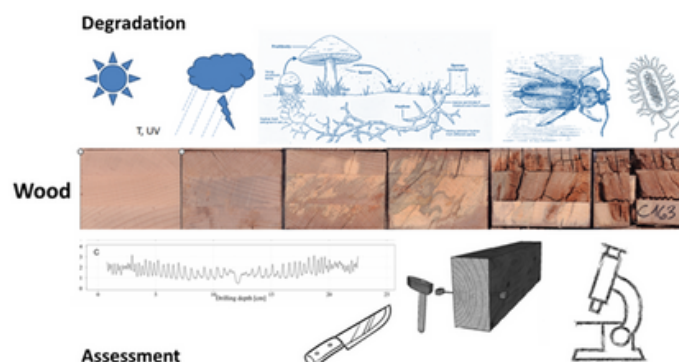
Slovenian National Building and Civil Engineering Institute (ZAG), Slovenia

TITLE

Decay of wooden heritage: degradation, detection and prevention

ABSTRACT

Considerable amounts of cultural heritage objects are entirely and partially made of wood. They are exposed to wide spectra of biotic and abiotic degradation organisms, that will be briefly outlined. To protect cultural objects to our ancestors, we have to understand the possible threats, and apply necessary protection measures to limit and slow down degradation. One of the first steps is usually analysis of the wood, that needs to be performed through non-destructive or semi-nondestructive methods. In case of severe infestation by biological organisms, non-biocidal measures should have priority to biocidal ones. Monitoring of the microclimate in the objects helps us to assess the efficacy of performed measures. At the end of the presentation, few case studies will be presented.



Abstracts of lectures

15. Dr. Tina Potočnik

Slovenian National Building and Civil Engineering Institute (ZAG), Slovenia

TITLE

The Analysis of Architectural History Within the Conservation Practice: the Case of Jože Plečnik's Architecture

ABSTRACT

Within the conservation practice, the analysis of architectural history is frequently necessary when intervening in built heritage. To assess the significance of details, parts of a building or even a setting in question, as well as to determine what to preserve, what can be altered and to what degree, often even to specify where further research (i.e. sondages) is needed, at least essential examination and interpretation of archival documents has to be carried out. The use of scientific methods within this pursuit is as significant as in any other field of heritage science. Thus, the importance of thorough analysis in architectural history will be illustrated with examples, ranging from castles to post-war architecture, and looked into more precisely in the case of the architecture of Jože Plečnik, whose works in Ljubljana have been recently included in the UNESCO World Heritage list. The impacts of the studies focusing on Baraga Seminary, Navje Memorial Park Cemetery and Stadium on planning interventions in those monuments will be demonstrated.

16. Dr. Jana Striova and Dr. Antonina Chaban

Italian National Research Council, National Institute of Optics (CNR-INO), Italy

TITLE

IPERION HS services towards a permanent E-RIHS infrastructure. The case of Molab access on Giotto's wall paintings in the Bardi Chapel in Florence

ABSTRACT

IPERION HS project (Integrated Platforms for the European Research Infrastructure ON Heritage Science, G.A. 871034) is a consortium of 24 partners from 23 countries that contributes, together with E-RIHS Implementation Phase project (G.A. 101079148), to establishing a permanent European Research Infrastructure on Heritage Science (E-RIHS ERIC).

This lecture will provide you with the overview of the IPERION HS/E-RIHS services including [#HSAcademy training activities](#) and access to a wide range of high-level scientific instruments, methodologies, data, and tools for advancing knowledge and innovation in heritage science. The aim of this lecture is to explain how you can benefit from the access to such expertise, facilities, and knowledge ([#HS Academy](#) and [ARCHLAB](#), [FIXLAB](#), [MOLAB](#)) offered, in the near future, by the [E-RIHS ERIC](#).

One of recent examples of Transnational access to Mobile laboratories (MOLAB) for the subsurface investigation of Giotto's frescoes will be presented to the Doctoral Summer School participants. The lecture will showcase how different state-of-art non-invasive structural tools, such as the Digital Holographic Speckle Pattern Interferometry (DHSPI) combined with Terahertz imaging (TI) and Stimulated Infrared Thermography (SIRT) may contribute to the advancement of diagnostic procedures for the on-going informed restoration intervention on the Giotto's wall paintings in the Bardi Chapel, Basilica di Santa Croce in Florence.

Abstracts of lectures

17. Jana Kolar
CERIC-ERIC, ESFRI

TITLE

Preserving Cultural Heritage: Innovations for Sustainable and Socially Impactful Future Approaches

18. Mateja Golež, Rok Vežočnik
(Sitarjevec excursion, on-site lecture)

TITLE

The heritage of underground architectures and 3D data capture

ABSTRACT

The abandoned polymineral mine Sitarjevec in Central Slovenia has been revitalized for touristic purposes through successful collaboration between the local community and ZAG, where ZAG actively contributes to heritage valuation and interpretation through research activities. Archaeological discoveries in the area reveal that mining activities date back 3,000 years, with the extraction of iron ore, cinnabarite, lead, and barite ore resulting in a network of 43 km of mine shafts beneath Sitarjevec hill. Although abandoned in 1965, a portion of the mine (450 m) was opened for tourism in 2017, offering visitors a unique experience due to the remarkable growth of limonite stalactite structures, which can reach a growth rate of 5 cm per year. The tour of the mine encompasses two floors, with the upper floor featuring a modern underground museum that educates visitors about the mine's geological history, showcases a collection of rocks and mining artifacts, and explores innovative ways of interpreting lighting in the underground space. On the lower floor, visitors can witness the authentic formation of limonite stalactites and the deposition of limonite mud, which is renowned as a high-quality natural ochre pigment. Given the need for modern approaches in managing the mining heritage of Sitarjevec, ZAG is actively involved in promoting the use of 3D data capture technologies to digitally document both the mine's interior and exterior.

Social events

Day 1, 19:00-21:00 - boat tour on Ljubljana river



An organized boat tour on Ljubljana River provides a delightful and immersive experience for visitors. Boarding a comfortable boat with a bar onboard, passengers embark on a journey along the picturesque waterway that runs through the heart of Ljubljana, the capital city of Slovenia. Knowledgeable guides will share captivating stories and historical insights, enriching the tour with fascinating facts about the city's rich heritage and cultural significance. Passing under graceful bridges, such as the famous Triple Bridge and Dragon Bridge, passengers witness the seamless blend of ancient and modern architecture that defines Ljubljana.

Day 3, 19:00-21:00 - running tour in Tivoli



We will organize a running tour in Tivoli combining some easy exercise with sightseeing. A slow jog through the park and a few stops to share some interesting anecdotes and historical insights about Tivoli will create a dynamic and engaging experience. Alternatively, a walking tour in Tivoli will provide a more leisurely pace, allowing researchers and students to soak in the park's serene ambiance and fully appreciate its captivating features. Accompanied by friendly guides from ZAG, the tour will take you to the park's extensive network of trails, beautifully landscaped gardens, and impressive architectural landmarks. You'll have the opportunity to admire notable attractions such as the Tivoli Castle, the iconic Jakopič Promenade, and the exquisite Cekin Mansion. Along the way, we will share fascinating stories about Tivoli's history, art installations, and the significance of each landmark, providing a deeper understanding of the park's cultural and natural heritage. We'll also take time for photos, moments of tranquility, and a chance to connect with nature in the heart of the city.

Excursions

Day 2, Ljubljana half-day city tour

15.00 - Meeting point at Prešern

Most popular meeting place in Ljubljana for tourists, Ljubljana visitors and citizens, students, lovers.

Here, some background of the Prešern bronze statue through cultural heritage perspective will be given.



16.30-17.30 Who is Plečnik?

One of the most prominent architect, who's impact on Ljubljana is enormous. We will walk through/by most known places he had planned and constructed in Ljubljana.



17.30-18.15 Per aspera ad astra. Ljubljana Castle

A steep walk through narrow streets from Ljubljana old town up towards the nicest view of Ljubljana will be organized.

You can enjoy a drink or just a nice view.

Then, you walk down the city center using different paths or use Funicular Railway (<https://www.ljubljanskigrad.si/en/plan-your-visit/funicular-railway-en-us/>)



Excursions

Day 4, Sitarjevec entire day tour + ZAG lectures at site

Lunch at site.

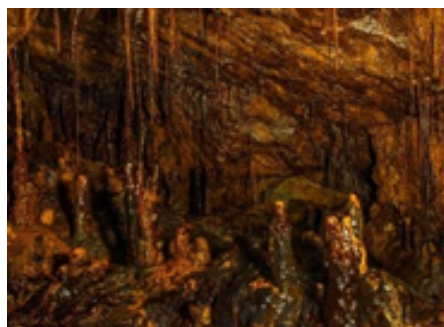
The revitalization of the abandoned polymineral mine Sitarjevec (in Central Slovenia) for touristic purposes is an example of good cooperation between the local community and ZAG the latter with its research activities actively contributing to the valuation of heritage and at the same time to the interpretation of heritage contents.

Archaeological finds in the area of the Sitarjevec mine show that the beginnings of mining go back 3.000 years. Iron ore, cinnabarite, lead and barite ore were mined which is why today there are 43 km of mine shafts under the surface of Sitarjevec hill. The mine was abandoned in 1965 but it was partially opened (450 m) for touristic purposes in 2017 mainly due to the exceptional limonite stalactite structures that grow up to 5 cm per year. Visiting the mine is a special experience as the tour takes place on two floors. The upper one is arranged into a modern underground museum where the visitor learns about the geological past of the creation of the mine, the rock and mining collection as well as the modern ways of interpreting the meaning of light in the underground space. At the lower floor, the visitor can experience an authentic contact with the formation of limonite stalactites and the deposition of limonite mud which was recognized as an excellent natural ochre pigment.

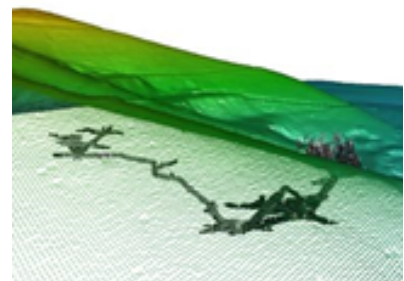
Since the management strategy of the mining heritage of the Sitarjevec mine requires the most modern approaches in the field of heritage science to be included, ZAG is also involved in promoting the use of 3D data capture technologies for the digitalization of both the interior and the exterior of the mine.



Interpretation of the mining heritage as a collection of stones and an artistic picture of the use of pigments from the Sitarjevec mine



Extraordinary forms of limonite stalactites filling empty mine shafts



3D plan of mine shafts that are open for tourist purposes



HS Academy

<http://www.iperionhs.eu/academy-events/>

