VirtualArch

Visualize to Valorise – For a better utilisation of hidden archaeological heritage in Central Europe

O.T.1.3. – Regional Strategy for pilot site 1 Hallstatt Prehistoric Saltmine

Project

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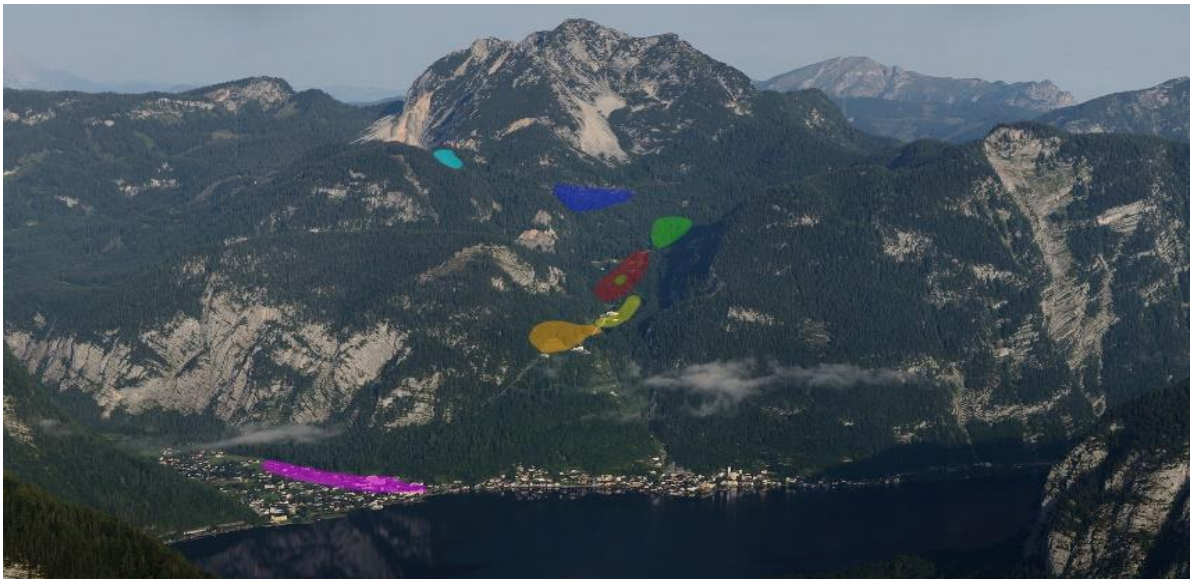
Table of content

1. Description of the pilot site of Hallstatt Saltmine and initial situation

Hallstatt is a historic mining landscape in the Region of Salzkammergut, Upper Austria, 400 meters above lake Hallstatt including the world´s oldest known salt mine. The prehistoric mining activities here began in the Middle Bronze Age. Due to the conserving features of salt, a great number of unique archaeological finds, such as textiles, tools, backpacks and the world oldest wooden staircase, were well preserved and discovered almost undamaged.



Hallstatt High Valley with its archaeological sites – most of them underground. (D. Brandner - NHM Vienna)

In the salt valley numerous remains of the salt production from the Middle Ages up to the present are found as well as the important Iron Age cemetery of the miners, which was eponymous for a complete prehistoric culture. Most of the graves contain large quantities of the different goods and precious items from almost all regions from all over the world known at the time, so a prehistoric period and culture is named-after it. Thanks to its uniqueness Hallstatt became a part of the UNESCO World Heritage Sites Hallstatt-Dachstein-Salzkammergut.

Due to its long tradition of mining, the region of Salzkammergut and its people identified themselves with this professions and conditions of thousands of years. With increasing industrialization, the landscaped and its culture and people changed their focus from mining to tourism. So currently thousands of people are visiting Hallstatt each year, most of them without noticing the existence of archaeological sites and traces. A main goal of Hallstatt research and this project was, to raise the awareness for the long tradition of mining, its

hidden traces inside the mine and on the surface of the High Valley and to visualize and valorize this hidden heritage for the inhabitants and people all over the world.

Archaeological research has also a long-lasting tradition in Hallstatt, as well as the cooperation between research and mining. First people to explore prehistoric Hallstatt in the 19th century were high-ranked miners and until today, though the research is under the leadership of Natural History Museum Vienna, the mining company Salinen Austria AG is an important partner. Without the support of the modern mining activities, research especially underground would not be possible. For visualisation, cultural education and public relations, the cooperation with Salinen Austria AGs subsidiary Salzwelten GmbH, responsibly for the touristic part of mining, is specifically necessary and fruitful.

2. Set objectives to visualize and valorize Hallstatt Saltmine

The main goal of the project was, to improve the capacity of Hallstatt reseach and its partners to apply and use innovative digital and VR approaches to present and visualise the hidden archaeological heritage for creating awareness, for later use in the economy, tourism, management of land-use conflicts, risk assessment, site preservation, regional identity and cultural participation. This should be achieved by targeting stakeholders, responsible for the management and enhancement of the archaeological heritage in the participating regions

3D visualisation and VR shall be used to reveal the heritage as a resource for possible economic exploitation and how visualisation can support management of land-use conflicts and the promotion of regional identification and cultural participation. Different tools and methods should be developed, tested and adapted to the different heritage sites and its participating institutions.

Main income in Hallstatt changed from mining to tourism within few decades. (C. Fasching - NHM Wien)

In order not to let the mining in Europe and its importance for European history be forgotten, and in order not to lose sight of

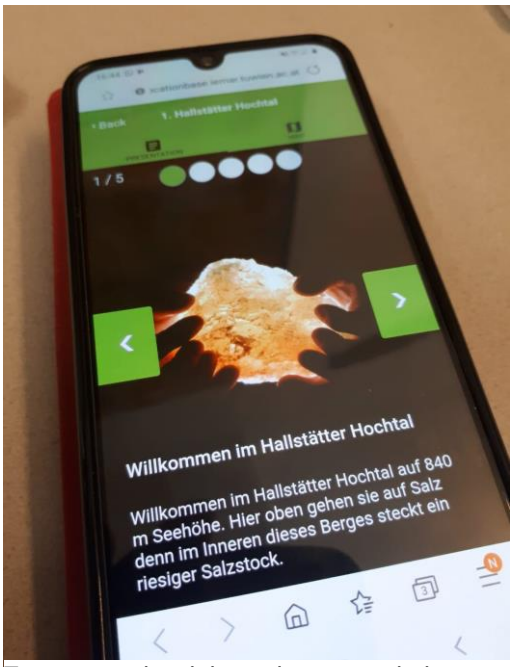
the problems of the current ore and raw material extraction, it is necessary to visualize the still existing mining relics.

The mining industry often effected the development of whole territories in terms of infrastructure, expansion and economy. To exploit the natural resources many people were employed, settlements were established and transport routes were built.

The wealth and authority of regions like Hallstatt would not have been possible without mining industries. So, it formed the landscape as well as the culture. Over decades, centuries and even millennia it influenced the history and progress of whole societies. In times of growing automatization, mining loses its meaning, many regions changed their main income to tourism.

3. Tools developed and adapted in the project

The methods and techniques used for the visualisation of Hallstatt salt mine were diverse. They ranged from methods commonly used and proven in archaeology, such as field survey, to innovative approaches such as 3D laser scanning and structure from motion 3D modelling, to highly specialised approaches such as the development of mobile applications and virtual reality.



Transnational mobile application including diverse visualisations.
(F. Poppenwimmer - NHM Wien)

In the project it was managed to scan and digitize the full network of modern tunnels connecting the prehistoric sites. These sites were not only documented with several ten thousands of pictures and visualised by structure from motion into 3D digital models, but also the original cavities were reconstructed and georeferenced inside the model. In this model, one can find every information that led to the reconstruction of the prehistoric mining activity, e.g. old mining maps, geological data, results of 50 years of excavation and new survey data. The model is available as a short film ("fly-through") but also as interactive virtual tour.

Also, 3D models of various findings and tools were generated via structure from motion to visualise their unique character, since none of these tools is found anywhere else in the world. These models can be shown as movies or as interactive 3D objects, they are embedded in the Virtual Reality and virtual tour.

A transnational mobile application was programmed, in a method so that all partners can adapt it to their individual circumstances and continue to use and design it in the future. A lot of the different processed data and elaborated visualisation can be embedded in this application. So, parts of all outputs are implemented, along with pictures, panoramas and texts to impart the hidden world heritage.

4. Challenges faced and experiences made within the project

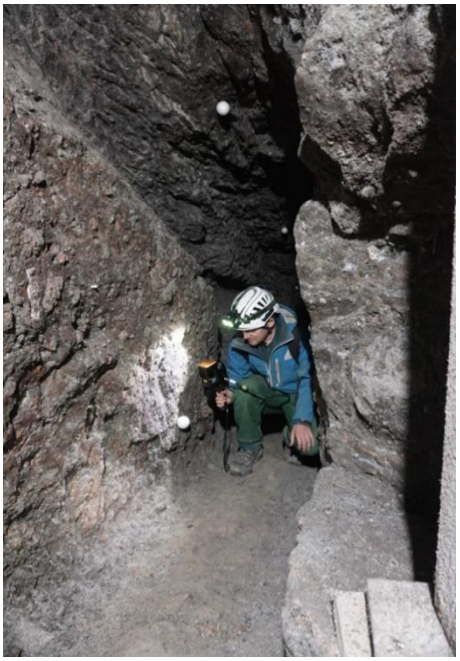
Although the importance of some mining regions is taken into account by the UNESCO Commission it is extremely difficult to explain mining. The challenges are manifold: The traces of historical or prehistoric mining are usually difficult to see and are often found in remote regions.

Lighting system for structure from motion documentation. (C. Fasching - NHM Wien)

Before the mining relics can be communicated, detailed documentation is necessary. Here too, the challenges are manifold - both for underground and above ground mining relics. The difficulties of working inside the mountain are often immense. It is narrow, dark, humid, often wide and the connection to a surveying network is not always easy.

Classical surveying and documentation are used as well as 3D laser scanning and image-based modelling. For the last-mentioned it is necessary to take thousands of single pictures under the confined space and difficult light conditions.

In order to develop a data basis, various aspects of prehistoric mining were digitised. For the planned models of the entire network of tunnels connecting the sites and the detailed



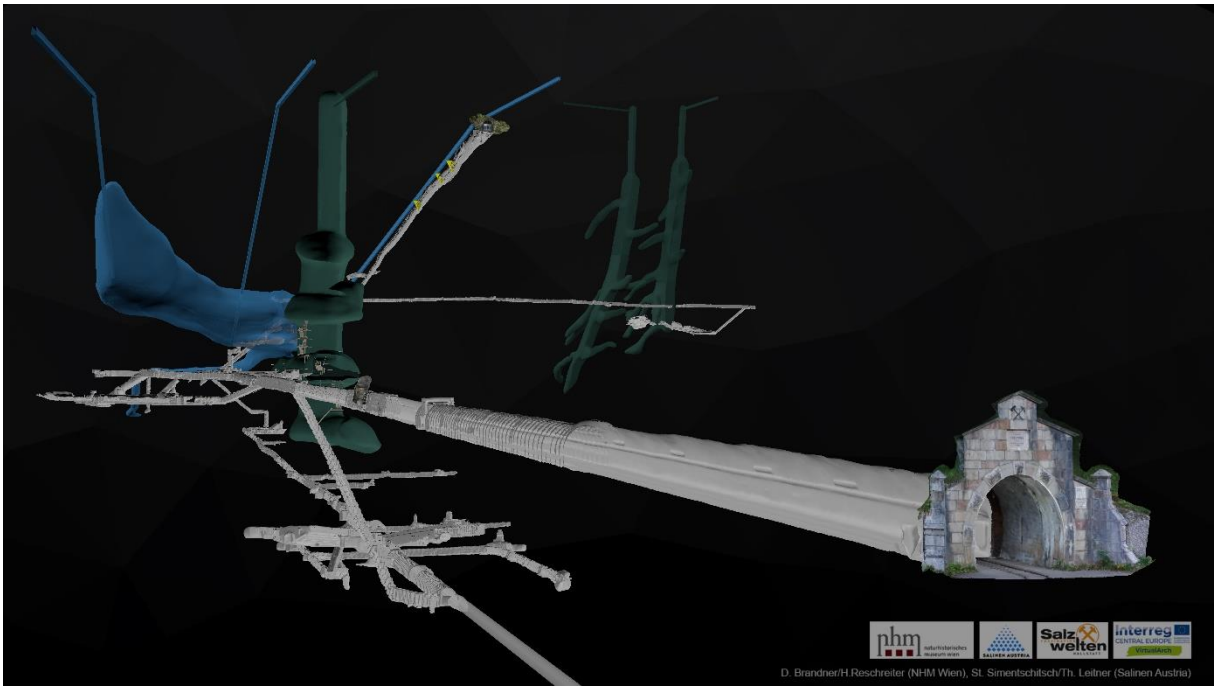
Scanning the modern tunnels and prehistoric sites. (D. Brandner – NHM Wien)

representation of individual sites, an immense amount of data processing and storage was necessary.

Several 10.000 photos had to be taken for the high-resolution modelling of the excavation sites. On the one hand, this is necessary because the photos must have a certain overlap. On the other hand, in the narrow research tunnels it is usually not possible to keep a larger distance to the object. This and the inadequate lighting were the greatest challenges for the structure-from-motion method of digitisation and had to be overcome by developing our own methods and procedures.

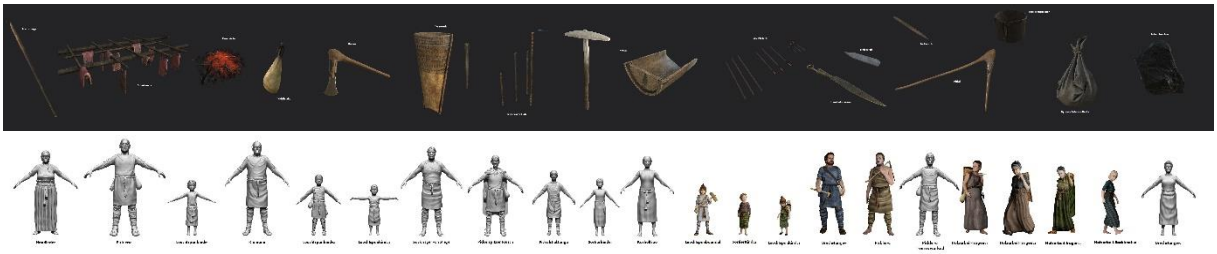
In addition, special equipment was often required, as in the case of the handheld scanner (ZEB-REVO) provided by Salinen Austria AG to record the tunnel network.

This fast, uncomplicated method was necessary in order to be able to depict the complexity of the network of galleries and to locate the sites with a reasonable amount of work.



Threedimensional scanned tunnels with reconstructed Bronze Age and Iron Age sites. (D. Brandner - NHM Wien/ S. Simentschitsch - Salinen Austria AG)

The structure-from-motion modelling of the findings was not trivial, especially due to the partly complex surface of the pieces. Detailed and highly movable surfaces like skins and rawhide can hardly be changed in their position without distorting the final result, which means a considerable additional effort when taking the photos.



Overview of visualised prehistoric tools and reconstructed miners. (I. Slamar, J. Prenner – Scenomedia/ H. Reschreiter, D. Brandner – NHM Wien/ Salzwelten GmbH)

The virtual reality visualization of Bronze Age mining was probably the biggest challenge. As a basis, the entire cavity reconstructed from survey data, test drillings and other excavation data had to be digitally constructed in realistic geometry and filled with appropriate textures.

Virtual Reality of the Bronze Age mining - man, women and children working in the mine with original tools in an authentic and realistic surrounding. (I. Slamar, J. Prenner – Scenomedia/ H. Reschreiter, D. Brandner – NHM Wien/ Salzwelten GmbH)

Since these surfaces are not available for download in the toolboxes commonly used in the industry, they also had to be photographed and modelled first. The same applies to the prehistoric tools, clothing and equipment. The characters (men, women and children) and

their movements also had to be generated first, which was done with scientific cooperation by means of motion-capturing.

Close cooperation between scientists and game designers was essential in all these steps, as this was the only way to create a scientifically correct, realistic but at the same time visually appealing image that reflects the current state of the art. As a result, virtual reality still requires a lot of maintenance and is bound to expensive equipment, which restricts the public presentation and use, i.e. it is only accessible during special tours of the Salzwelten and the NHM. The expansion of the offer in NHM is in progress.

The main requirement for the app was that it could be used and filled by scientific institutions without programming knowledge. However, this also required the development of a completely new system that would allow easy operation and maintenance.

In the case of all visualizations, a major difficulty is the handling of the immense amounts of data. On the one hand the processing and storage, on the other hand user-friendly preparation, for example the possibility of displaying the data on different end devices.

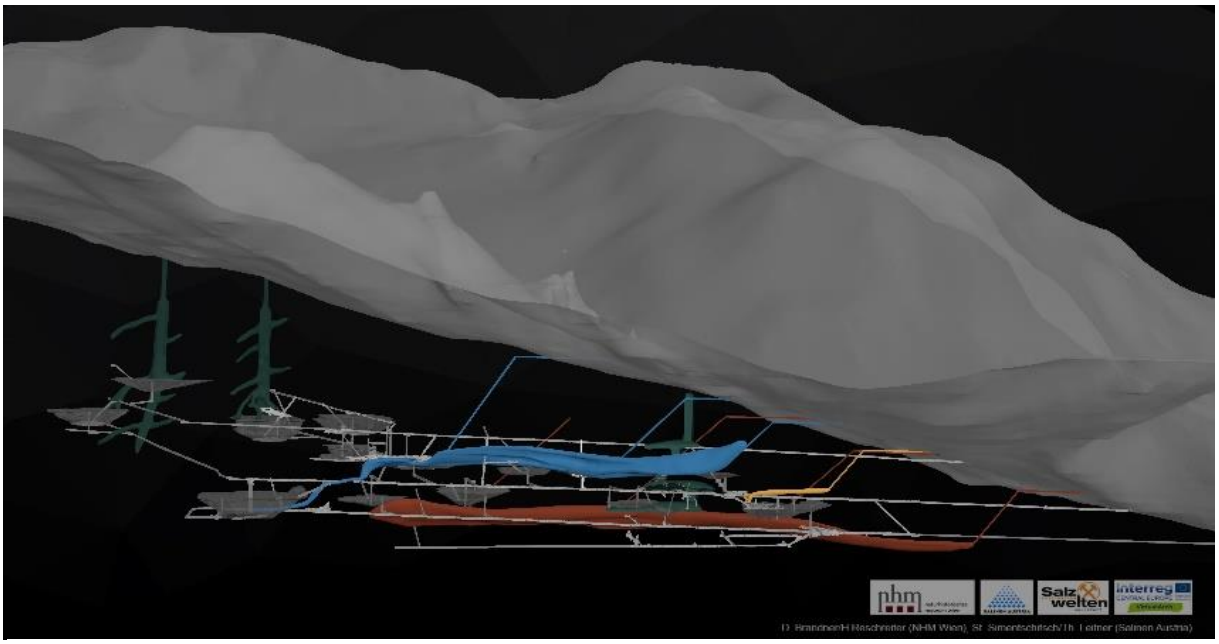
Modern research tunnels, documented and turned into a 3D model. Green is the Bronze Age Mining chamber, reconstructed on the resent results of research. (D. Brandner - NHM Wien)

One of the central points to be conveyed in the prehistoric mining of Hallstatt for the last years has been the size and extent of the Bronze and Iron Age mining chambers. This is already very difficult to convey during special guided tours at the excavation site in the mountain, as most people's imagination reaches its limits in the narrowness of the research

tunnels. In lectures, guided tours, articles, blog posts and on homepages it is practically impossible to convey this in a realistic way. The lack of possibility to understand this basis of mining makes it much more difficult to grasp and understand archaeological features such as the work process that can only be reconstructed in Hallstatt.

All this is made possible by virtual reality as well as the underlying 3D model of the tunnel network and the prehistoric sites. Through the digital reconstruction of the Bronze Age cavity based on findings, it is possible for the first time to realistically imagine the dimensions, the spatial layout and thus the required amount of personnel, tools and other resources. The representation of different persons also makes it possible to visualize details such as the distribution of gender, age and work in prehistoric society, costume reconstructions, use of tools, nutrition and transportation in a simple and understandable way.

The visual, three-dimensional and very life-like interactive impression promotes interest and understanding much more intensively than films, pictures and lectures can. People grasp considerably more details, approach real reconstructions more naturally in order to try them out and ask deeper and more precise questions of the mediators. In all appearances, virtual reality leaves a much more personal and lasting impression than all previous impartion methods. This is also supported by the recorded spatial sound of working noises in the mine.



The archaeological sites in Hallstatt deep underground, made visible by 3D modelling. (D. Brandner - NHM Wien/ S. Simentschitsch – Salinen Austria AG)

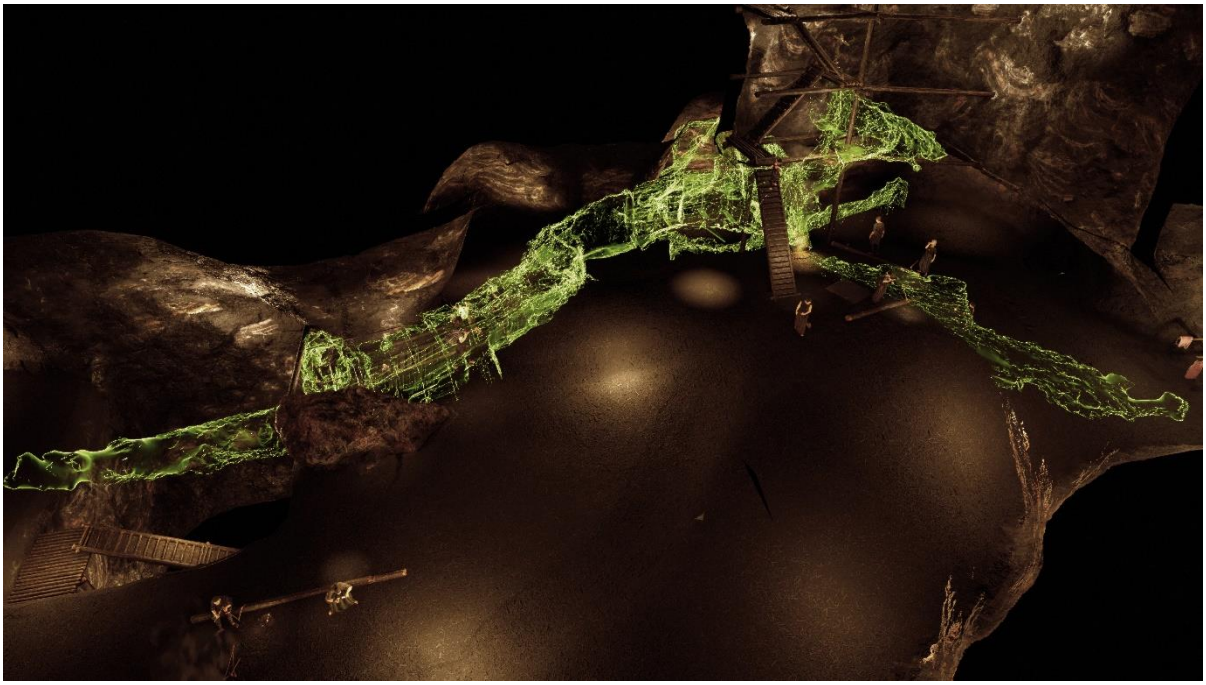
Scene of Virtual Reality of the Bronze Age mining in Hallstatt. (I. Slamar, J. Prenner – Scenomedia/ H. Reschreiter, D. Brandner – NHM Wien/ Salzwelten GmbH)

During guided tours to the site in the mountain with a previous visit to the VR station, we found that the visitors are much better prepared for the conditions and special research circumstances in the salt mine. They ask more specific and detailed questions and have a better basic understanding of the prehistoric working conditions.
This is also due to the fact that this VR was developed not only for entertainment, but mainly for education. This is reached with its attention to detail and the built-in "research tool" with which the visitor can obtain information on various topics.

It turned out to be essential for us to have enough time for all applications of these visualizations. Especially virtual reality has to be explored by the visitors themselves, whereas a too strict time limit is very obstructive.

A special feature for mediation, especially with pre-trained persons, is the function to be able to fade in the current research tunnels in the VR version of the Bronze Age mining. This facilitates the connection between the accessible part of the mountain and the cavity reconstructed from it, and the location in it, and also shows the state of research and the difficulties it faces through direct size comparison.

"Research tool" to get information in the VR to several topics of the prehistoric life in Hallstatt. (I. Slamar, J. Prenner – Scenomedia/ H. Reschreiter, D. Brandner – NHM Wien/ Salzwelten GmbH)



The research tunnels superimposed on the reconstruction show the current status of the excavations and allow a localisation within the site. (I. Slamar, J. Prenner – Scenomedia/ H. Reschreiter, D. Brandner – NHM Wien/ Salzwelten GmbH)

The developed VR does not only serve the purpose of public relations and impartion, but due to the detailed processing and the exact development with all currently known research results it is up to date with the latest state of knowledge and therefore a

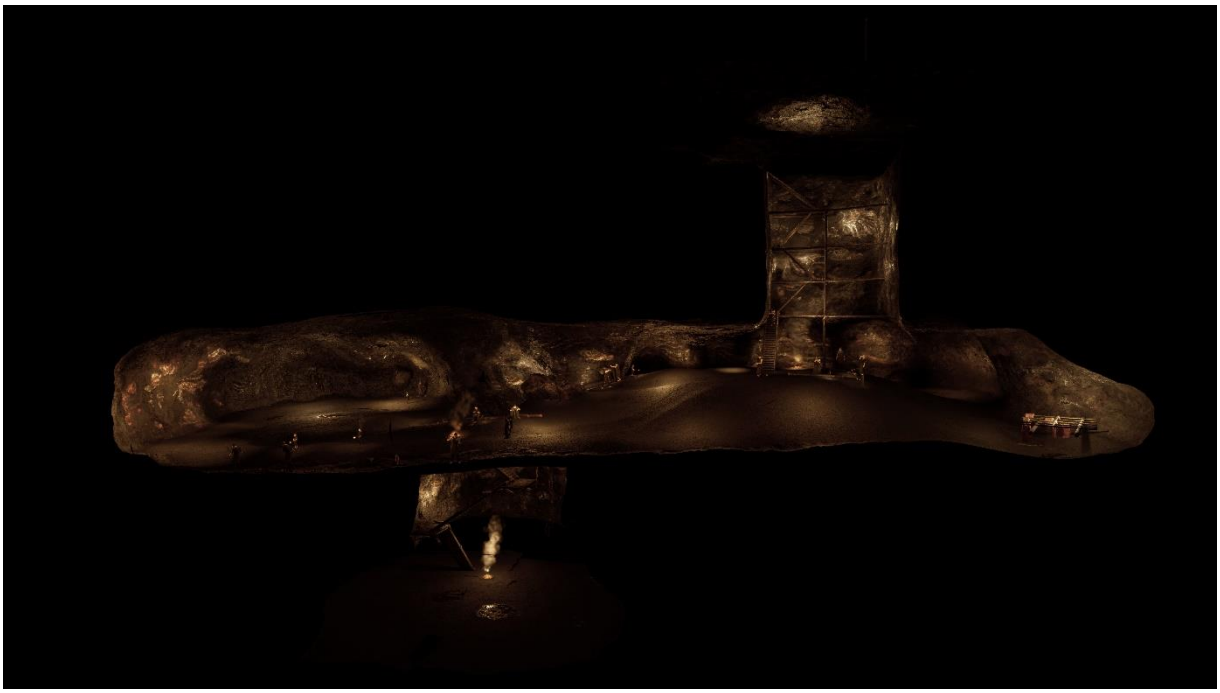
valuable tool for the education of young scientists and detailed information of research partners and colleagues.

5. Communication, stakeholder involvement and reached target groups


Old as well as young people find it fascinating to explore the virtual bronze age saltmine. Details can be explained also to bystanders, who watch the events on a monitor. (C. Fasching – NHM Wien)

The experiences of the last years speak strongly in favour of the use of virtual/ augmented reality and other visualisations in the impartion of archaeological content.

Since the visualisations were in an advanced state from 2018 on Hallstatt research presented them in over 20 events and reached thousands of people. This includes small and private events, like guided tours for school classes, companies, authorities and groups in the NHM



Overview of the entire Bronze Age mining chamber in virtual reality. (I. Slamar, J. Prenner – Scenomedia/ H. Reschreiter, D. Brandner – NHM Wien/ Salzwelten GmbH)

as well as big events like Archäologie am Berg, World Wood Day, 40th anniversary of Salinen Austria AG or European Researchers Night.

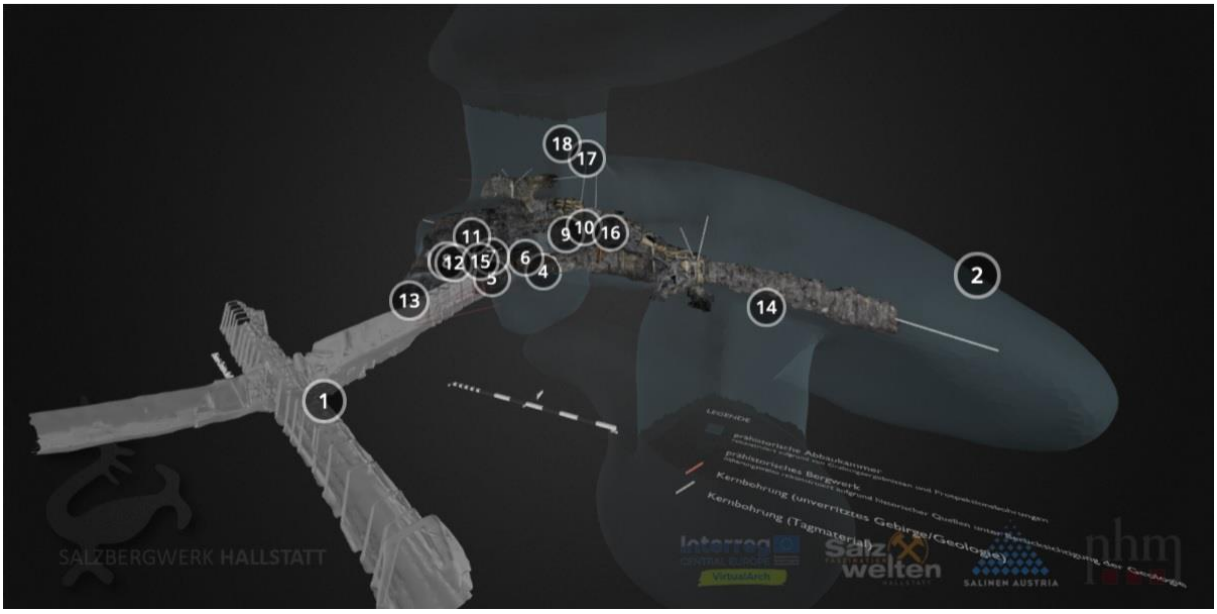
On a regular basis employees of Hallstatt research are doing guided tours with Salzwelten guides, employees of Salzwelten GmbH and Salinen Austria AG, local stakeholders and research partners, mostly in small groups.

Presentation of visualisation to broad public, local and regional stakeholders. (C. Fasching – NHM Wien)

The 3D models, which were necessary as a basis for many things in VR, serve as a practical basis for communicating the current research situation and, above all, the most varied sources and backgrounds. For the first time it is possible to give visitors comprehensive insight into the variety of documents used, such as historical maps, salt mine files, modern geophysical surveys and excavation documentation, and to combine this with the three-dimensional representation of mining.

These new impartion methods have already been demonstrated to local and regional stakeholders, from the mayor of Hallstatt to the heads of the mining and tourism company, the local population and local and regional school classes. The feedback was consistently positive, especially from retired miners, who know the mines very well and who were very surprised how it was possible to visualize such a large part of the mining industry and to make the connection of so many different sources visible.

All this outputs of the VirtualArch project will be used and communicated in the same way by Natural History Museum Vienna and Salzwelten on their proved channels like Weblogs, Social Media and in Events, but will also continue to be developed. First steps were the development of a tour for blinded people to be embedded into the excisting special tour in



Virtual Tour through the excavation and the Bronze Age site, publically accessible on Sketchfab. (D. Brandner - NHM Wien)

NHM Vienna. During COVID-19 lockdown outputs like Virtual Tour, Movies etc. were provided for public access in the world wide web.

6. Action Plan 2020 – 2024

The Salzkammergut region and thus also Hallstatt will bear the title of European Capital of Culture in 2024. In the course of this and in preparation for this event, both the Salzwelten GmbH tourism company and many other tourism providers and cultural institutions are greatly expanding their educational programme. The data compiled and visualised in the project will be embedded and further developed within this framework.

Free access and the internet presence will be improved, the mobile app will be further developed, and from the virtual reality of Bronze Age mining, further information films on various topics of archaeological research will be played out and made publicly accessible. In addition, a digital telescope into the region's past is to be developed and set up, with which prehistoric life worlds and the history of the region will be made visible by means of digital content. Many public events and special guided tours for stakeholders are to make these measures known and disseminate them.

With all these activities, the history of the region and the value of the world cultural heritage should be further anchored in the consciousness and receive a firm place in the culture of the Salzkammergut region.

7. Reached aims and outlook to the effect and use of VirtualArch outputs in the future

Exhibition rooms in the Natural History Museum Vienna. (A. Kaltenberger - NHM Wien)

The actions and outputs of the last three years made it possible to embed the hidden world heritage in the consciousness of the inhabitants and people visiting the region and to connect the prehistoric salt mine inseperable with the history and the culture of Hallstatt, so the region is not only known as a beautiful travel destination, but as the unique heritage it is. This is the basis for every measure of research and protection to be approved by the public. The awareness for heritage protection in the public, is to be developed and improved even more with the help of VirtualArch outputs by all involved institutions.

The Natural History Museum of Vienna is, with a collection of over 30 million objects in more than 50 collections and far over 500.000 visitors per year, one of the most important scientific museums in the world. It has a long ongoing tradition in research, collection and impartment. All kinds of scientific research, from prehistory over zoology, anthropology to geology work together under one roof. Unfortunately, the presentation of this research and the collected objects is still very traditional in many ways. The methods, techniques and experiences acquired in the VirtualArch project will help to get the impartion of scientific research to a whole new level.

All technologies and practices applied in the VirtualArch project can be used for the other departments in the museum as well. Especially the 3D visualisation and presentation of artefacts is a good way to make art and science accessible for everyone.

3D model of the famous Bronze Age carrysack from the Hallstatt saltmine. (D. Brandner – NHM Wien)

The used way, the image-based modelling via structure from motion, is an inexpensive and simple way to produce digital content, that is impressive for viewers on the one hand. But also, to save an artefact and all its visible details digitally and make it possible e.g. for foreign researchers, to get a better impression of a piece from abroad. Archaeological finds as well as minerals or zoological preparations can be digitized and exhibited that way.

Scientifically interesting, but hidden or inaccessible places like the archaeological hotspots in Hallstatt can be shown to a broader public via 3D models or VR technology. 3D models have the benefit of not needing any special equipment to be shown, it is even possible to make it accessible via internet. VR does need special equipment but can be used for a lot of different content and departments, once available in a museum. These techniques can be also used to visualise geological formations, paleontological sites, natural habitats (caves, jungle, deserts) as well as various archaeological sites. But not only the surrounding of the sites and finds, also the scientific work itself can be shown in an attractive way. Laboratories, workshops and other workstations, normally hidden behind the backdoors of the NHM can be made accessible for a large number of visitors without disturbing the daily work.

The experience shows that virtual tours and freely available content is not a competitor for classic tours and museum visits. Quite the contrary, it is a teaser, it creates interest and curiosity for people to visit the sites and museums. Also, it increases the knowledge and understanding for scientific work and research processes. Most of the artefacts in the collections are not displayed to the public but hidden in the depots.

VR Station in the “Hallstattsaal” of Natural History Museum Vienna. (A. Kaltenberger – NHM Wien)

With the digitalization it is possible to show them, even if there is no more room in the exhibitions. With digital tours it is possible to show the whole process of different types of research and to make it accessible and understandable for the public. Also, the connection between the different departments and fields of research can be shown, to underline the importance of interdisciplinary work.

To sum it up, the gained experience in digitizing and visualising can be used for all departments and fields of research in the Natural History Museum Vienna. From this point it is possible to expand and deepen our knowledge and skills with these techniques, to give our best-practices to our research partners and work together on a more extensive and sustainable museum experience for the visitors.

The VirtualArch outputs also play a significant role in some film productions on the Hallstatt theme in cooperation with ZDF, ORF and Terra Mater. With these film productions, Hallstatt Research has gained powerful multipliers who further strengthen the interest and awareness of this cultural world heritage site. With the raised awareness for the importance of the archaeological heritage and the threats the sites are facing, it was already possible, to gain enough budget to start a huge preservation project, to keep Bronze Age and Iron Age sites accessible and useful for the research.