Danube Geo Tour

Valorisation of geo-heritage for sustainable and innovative tourism development of Danube Geoparks

New competences in geoheritage interpretation

Code: 5.1.

Composite report representing 8 outputs:

Output 5.1.1. New competences in geoheritage interpretation: Tectonics
Output 5.1.2. New competences in geoheritage interpretation: Volcanology
Output 5.1.3. New competences in geoheritage interpretation: Geohazards
Output 5.1.4. New competences in geoheritage interpretation: Geology over time
Output 5.1.5. New competences in geoheritage interpretation: Water in time
Output 5.1.6. New competences in geoheritage interpretation: Metamorphic rocks& processes
Output 5.1.7. New competences in geoheritage interpretation: Geomorphology
Output 5.1.8. New competences in geoheritage interpretation: Dialoque between Earth & Human

"Project co-funded by the European Union"

Programme: Interreg Danube Transnational Programme
PA2: Environment and culture responsible Danube region
Project Duration 01/2017 to 06/2019

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Date: 15.12.2017
Version: 2.0

List of Abbreviations

DTP	Danube Transnational Programme
JS	Joint Secretariat
LP	Lead Partner
PP	Project Partner
WP	Work Package
ASP	Associated strategic partner
AHI	Association for Heritage interpretation

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1. Introduction

Geology is scientific study of the origin, history and structure of our planet Earth. It is one of the most important sphere of Earth science, but often neglected, while geology-related topics are not properly explained to general public. With the use of appropriate interpretation technique often too complicated geological phenomena can become more interesting and easier to understand.

In general, there are two reasons why we need interpretation of geological heritage. Firstly, our geological heritage is important in underpinning the famous landscapes and biodiversity that we have. Despite this fact, the geological heritage is further from the hearts and minds of the population than other more easily identifiable aspects of the natural heritage, namely the flora and fauna. However, in similarity with the biodiversity, the geological heritage is vulnerable to the activities of mankind which may damage it. Therefore only those people and local communities, who know their geological heritage and can both identify with it and relate to it, can contribute to its conservation and sustainable development. Geological heritage interpretation has a clear role in establishing the real links between the bio- and geodiversity and the need to preserve them both equally. The second reason for the requirement of geological interpretation is the opportunity the geodiversity offers in touristic efforts at local or national level. An interesting geological interpretation will enhance the visitor’s experience and help to boost geotourism[1].

Nowadays Geoparks have a significant role in the geo-interpretation and geotourism. Geopark is a territory with a great geological heritage, important not only at the national level, but also globally. Geoparks are a relatively young form. The European Geoparks Network was established in year 2000 by four Geoparks: Reserve Geologique de Haute-Provence (France), Natural History Museum of Lesvos Petrified Forest – Lesvos island (Greece), Geopark Gerolstein/Vulkaneifel (Germany) and Maestrazgo Cultural Park (Spain). In 2004, when 17 European and 8 Chinese geoparks came together, the Global Geoparks Network (GGN) was founded.

UNESCO’s work with geoparks began in 2001. In November 2015 the 195 Member States of UNESCO ratified the creation of a new label - the UNESCO Global Geoparks. According to definition UNESCO Global Geoparks are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development[2].

At present there are 127 UNESCO Global Geoparks in 35 countries. 70 Geoparks from 23 European Countries today form European Geopark Network.

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[1] http://www.interpretacija.si/arhiv/geoloska_dediscina.pdf

[2] http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/

An important component of geopark activities is applying for funding to support regional development through transnational cooperation between European Geoparks or through geopark-specific projects[3]. An example of transnational cooperation is the Valorisation of geo-heritage for sustainable and innovative tourism development of Danube geoparks project. Eight Geoparks of the Danube region participate in this project with the acronym Danube GeoTour, implemented in the Interreg Danube Transnational Programme 2014-2020.

The main result of the project will be a joint Danube GeoTour designed to strengthen cooperation between Geoparks in the region and act as an innovative tourism product to stimulate visibility and increase tourist visits in the geoparks. Common strategy for sustainable management of tourism pressures will form the basis for creating innovative geoproducts. Sharing experience, testing pilot geotourism products and new interpretative approaches should increase local inhabitants' engagement, Geopark management capacities and lower the quality gap between Danube and other European Geoparks.[4]

The output New competences in geoheritage interpretation is a part of WP 5 - GeoInterpretation. The output document consists of two different deliverables within the WP 5; deliverable 5.1.1 – Best practices and new trends applicable for geointerpretation (report) and on the deliverable 5.2.1 – Joint geointerpretation training material developed and training implemented (report of the geointerpretation training implemented, training program, presentations during training, presentations of selected geological challenges as well as the vocabulary of commonly used terms in geointerpretation in easy to understand language in English and in project partners languages). The objective of WP 5 is to improve skills and quality of the heritage interpretation in the participating Geoparks and to complement the uniqueness and character of the overall Danube GeoTour product. **The present output consists of various output reports based on common findings and recommendations; 8 separate output reports present the results of learning interaction, dedicated to one of the geointerpretation fields, i. e. tectonics, volcanology, geohazards, geology over time, water in time, metamorphic processes and rocks, geomorphology and dialogue between earth & humans.**

1.1. Background information

With this document we want to introduce new interpretation trends, techniques and methods which are used for interpretation of geoheritage and which were recognized inside and outside the participating geoparks. The main objective of this project is to improve management capacities and strategies and to develop practical solutions for the activation of geodiversity/geoheritage as well as to seize positive market trends for sustainable tourism development in 8 Geoparks of the Danube region. Within our Output "New competences in geoheritage interpretation" we wish to achieve our

[3] http://www.europeangeoparks.org/?page_id=1507

[4] http://www.interreg-danube.eu/approved-projects/danube-geotour

main project objective through discovering and exchanging contemporary interpretation methods and technologies, especially for interpretation of selected geological challenges.

The goal is to improve the skills and quality of heritage interpretation in participating Geoparks by transnational learning interaction as well as to complement the uniqueness and character of the overall Danube GeoTour product.

The history of Earth, geology over time, its processes, etc. are difficult to understand and interpret. For Geoparks and Danube GeoTour, it is critical that Visitor Centres and guides are able to present a true geological story and the value of its geoheritage. Although there is planty of scientific information available, the quality of interpretation among participating Danube Geoparks still lags behind more advanced Geoparks.

To sum up, we gained insight into new interpretative trends, shared concrete practical examples from other parks, learned new interpretation and communication methods, as well as laid foundations for implementing a park's own pilot interpretation action, which will significantly open perspectives and strengthen the competences and the capacities of individual parks and of the Danube Geopark Tour partnership as a whole.

1.2. Methodology

Different methodologies concerning output „New competences in geoheritage interpretation" were used in order to find out new trends and competences in geo-interpretation, geo-communication and specific methods of interpretation of selected geological challenges in the Danube region. We, ERDF PP4 Geopark Karavanks as the coordinator of WP5, prepared a questionnaire concerning geointerpretation practices, which was sent to all partners in Danube GeoTour project within Geoparks. With this questionnaire we received a better insight into existing interpretation methods and technologies used in participating Geoparks and into quality of interpretation.

Screening of most recent developments, technologies and best practices of interpretative methods applicable to Danube Geoparks was carried out and shared within the geointerpretation training.

As a coordinator of Workpackage 5, concerning Output 5.1. New competences in geoheritage interpretation, we also visited the following three visitor centres:

- Nationalparkzentrum Hohe Tauern, Mittersill, Austria;
- Spring Water Museum Wildalpen, Styrische Eisenwurzen UNESCO Global Geopark, Austria:
- Visitor centre Erz der Alpen, Erz der Alpen UNESCO Global Geopark, Austria.

Leadpartner of the project, i.e. Idrija Heritage Centre also visited examples of best interpretation practices in geological, natural and cultural heritage in visitor centres and museums in Slovenia.

Besides the already mentioned methodologies, online research method was carried out, to find examples of best practice in the interpretation of selected geological challenges all over the world. Each of the participating geopark addressed one geological interpretation challenge (problem) that is common, well investigated and interpreted in the partner territory. At the same time all selected challenges are typical for the Danube region geoparks.

As “learning interaction” between PP is one of the main ideas of the Danube GeoTour Project, the geointerpretation training was carried out as part of this output in the Karavanke/Karawanken UNESCO Global Geopark. During the geointerpretation training participants shared best practices and methods they use for interpretation of geological heritage, especially for their selected geological challenge. After the training all participants provided a more detailed descriptions of challenges they are responsible for, rather they defined the geological background of the area, possiblle methods for interpretation, best practices and lessons learned for selected geochallanges. Furthermore, both Associated strategic partners (ASP), Naturtejo UNESCO Global Geopark and Rokua UNESCO Global Geopark, also shared with us their best practices for geointerpretation. The conclusions are presented in this composite document composed of 8 individual output documents, each addressing a specific geological challenge. The participating Geoparks will spread the acquired information, competences and knowledge to their geopark staff – geoguides and similar protected terriotires and organisations in their countries.

1.3. Summary

Geology is a scientific study of the origin, history and structure of our planet Earth. It is one of the most important sphere of Earth science, but often neglected, while geology-related topics are not properly explained to general public. With the use of appropriate interpretation technique a complicated geological phenomena can become more interesting and easier to understand. Nowadays UNESCO Global Geoparks have a significant role in the geo-interpretation and geotourism. At present there are 127 UNESCO Global Geoparks in 35 countries. Although there is ample scientific information available, the quality of interpretation among participating Danube Geoparks still lags behind more advanced Geoparks due to lack of experience and good examples for different kinds of geointerpretation. That is why one of the main goal of so-called Danube GeoTour project is to improve skills and quality of heritage interpretation in participating Geoparks. It is crucial for Danube Geoparks that Visitor Centres and guides are able to present a true geological story and the value of its geoheritage. In the composite Output document “New competences in geoheritage interpretation” different methodology were used in order to find out new trends and competences in geo-interpretation and geo-communication and specific interpretation methods of 8 selected geological challenges (e.g.: tectonics, volcanology, geohazards, geology over time, water in time, metamorphic processes and rocks, geomorphology and dialogue between earth & humans) in the Danube region. This research helped us to create several conclusions and recommendations which are useful for project partners and also for

partners outside the project partnership. Although the geo-heritage interpretation today uses a range of media and it is delivered in many different ways, it is observed that the direct person-to-person contact still the most efficient. Danube Geoparks require very skilled guides - interprets who are able to explain a complex geological processes in language which is easy to understand. Personal interpretation still has an important priority in geointerpretation, but it is recommended to be mixed with so-called non-personal (use of illustrations, audio-visual equipment, multi-media, …). As old Romans said "*Verba docent, exempla trahunt*" - Words instruct, illustrations lead.

Through desk research, exchange of practices and trainings Geopark guides achieved knowledge about different methods used for geointerpretation, observed successful combination of personal and non-personal interpretation methods, became familiar with different approaches of geointerpretation – interpretation for kids and interpretation for adults, observed effective personal interpretation, found out how geointerpretation can be more effective with the use of interactive, constructive learning and discovered how to explain complex topics and ideas connected to a site's main themes in simple words and images that are easily accessible for non-expert audiences. The idea was to learn interaction and to share concrete practical examples from other parks. All this lead to better insight into new interpretative trends and improved practical interpretation skills though learning new interpretation and communication methods. This will significantly open perspectives as well as strengthen the competences of individual park management and the Danube Geopark Tour partnership as a whole in comparison to other more advanced geopraks within the EGN/GGN network.

2. General trends in methods of geo-interpretation

A number of trends in interpretation over the last few decades which have led not only to change in the objectives, content and emphases of interpretation and the techniques employed to interpret, but also to change in self perception of interpreters themselves and in particular their role and responsibility in society can be identified. Interpretation has always been seen as a tool for management. In some cases this has taken a 'soft' form by attempting to raise awareness levels and persuade people to change their attitudes and behaviours towards 'at risk' sites. In other cases 'hard' management devices, such as using trails to steer people away from endangered areas, have been employed. Indeed, the rationale for interpretation has been heavily loaded on its visitor management role (Uzzell, 1988)[5].

Since interpretation has become increasingly popular amongst the public, it has become an attraction in its own right. Visitors often attend sites in order to visit the visitor centre, perhaps giving minimal attention to the resource the centre is actually interpreting. Rather than being the inspiration and impetus for an enquiring visit to a heritage site it becomes the centrepiece. Only a decade ago, when two or more interpreters gathered their talk, it was very much about techniques and the latest technologies. In more recent years interpreters have responded to the challenges

[5] Uzzell, D. (1988): The interpretative experience. In: Ethnoscapes II: Environmental Policy, Assessment and Communication. 248-263.

posed by rapid political, social, economic and technological change by questioning and considering 'why' and 'what' rather than 'how' of interpretive practice. This change in emphasis has resulted in concern with 'social' issues involved in interpretation rather than with the techniques of presentation. Accordingly many interpreters have undergone a noticeable philosophical change in relation to their perception of their role in society and the purpose of their professional practice. Having the technical knowledge and experience to design exhibits that communicate information and entertain visitors is less likely to be seen as the central characteristic of a competent interpreter. Nowadays many interpreters see themselves as accountable for the content and appropriateness of the message as well as its impact upon visitor behaviour in society. It is a concern with accountability to society that has made interpretation mature as a profession and fuelled the need to ground practice in theory. It is a concern for the impact of interpretive messages on human behaviour that has led interpreters to confront controversial and emotive issues. And it is a growing emphasis on the social dimensions of interpretation that has compelled interpreters to broaden their understanding of responsiveness and involvement with their audience (Uzzell and Ballantyne, 1999)[6].

Heritage interpretation can be delivered in many ways. Personal interpretation involves people such as tour guides, rangers and museum guides explaining to individuals or groups the significance of their site. The essential element of this type of interpretation is the opportunity for it to be a 'two-way'. It allows the interpreter and the audience to ask questions and to engage in conversations about the site, to share knowledge and experiences and to be fully immersed in its features. Personal interpretation though always involves staff or volunteers and is therefore 'resource intensive' in revenue budgets. Most guided activities need the visitors to join a visitor group and often they need to plan their visit in advance in order to arrive at a certain meeting point on time. Non-personal interpretation includes leaflets, guidebooks, exhibitions, interpretation panels, digital presentations, websites, recorded audio guides, models and other types of media with text and / or images. This type of interpretation tends to be 'one-way' with explanations about the site delivered to the visitor. Nonpersonal interpretation can be delivered more widely without staff or volunteers being involved in the delivery process. It is usually capital intensive with limited revenue costs. Media-based interpretation is often preferred by visitors who want to experience a place individually without being part of a group at their own pace.

Interpretative methods can be divided into two categories: *In situ* interpretive form, which are implemented at the geosites and provides direct and visual aspect (panels, paths, guided tours, etc.) and *Ex situ* interpretive form, which are used in related facilities (visitor centres, museums, etc.), such as popular lectures, interactive and video presentations, museum artefacts, laboratories, etc. (Tomič et al, 2015)[7].

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[6] Uzzell, D., Ballantyne, R. (1999): International Trends In Heritage And Environmental Interpretation: Future Directions For Australian Research And Practice.

[7] Tomić N., Marković S.B., Korać M., Mrđić N., Hose T.A., Vasiljević, et al. (2015): Exposingmammoths – from loess research discovery to public palaeontological park. Quaternary International, 372, 142–150.

By means of the questionnaire, which was send to all partners within Geoparks in Danube GeoTour project, we established that Geoparks mainly use different methods for geointerpretation, different personal and non-personal methods, which are many times combined. In principle, regardless of which geological challenge is being interpreted, the guide or interpreter must put himself/herself into a position of a non-geologist and try to explain difficult geological processes and facts in an easy-to-understand language, supported by illustrative materials, other interpretative tools and technologies.

3. New trends and competences in geo-interpretation and geo-communication

There are various different theories about what a term interpretation really means, but the father of interpretation is definitely Freeman Tilden, who defined interpretation as ‘an educational activity which aims to reveal meanings and relationships through the use of original objects, by firsthand experience and by illustrative media, rather than simply communicate factual information’ (Tilden, 1967)[8].

Based on The Interpretive Guide a heritage interpretation is deeply linked to the history of national parks as well as Geoparks. Since 2010 we have in Europe our own organisation, the European Association for Heritage Interpretation also called Interpret Europe, where professional interpreters share and develop their work. Heritage interpretation uses a range of media but it is best, when there is a direct person-to-person contact. In various interpretations, also in the interpretation of geological heritage, the four aces are basic qualities of different interpretative activities.

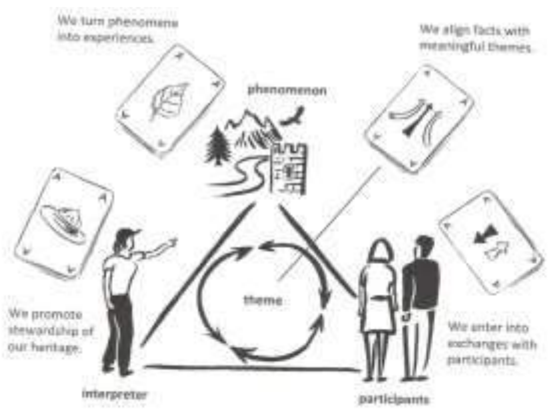


Figure 1: The interpretive Guide – Sharing Heritage with people, Thorsten Ludwig

[8] Tilden, F. (1967): Interpreting our heritage (3rd Edition). The University of North Carolina Press: USA.

The aim of any interpretive experience, e.g. an interpretive talk or walk, indoors or outdoors, is to bring life to the space between each of the corners of the triangle, while in the centre of the three corners a strong theme is located.

The four aces resulting from the four elements connected to the triangle – the interpreter, the phenomenon, the participants, and the theme – are:

- to promote stewardship of our heritage;
- to turn phenomena into experiences;
- to enter into exchanges with participants;
- to align facts with meaningful themes.

A systematic communication model for the Interpretation of Geoheritage in Geotourism is also very important for geo-interpretation. Geotourism is a segment of tourism that has in recent years been developed worldwide. Sites, such as Geoparks with outstanding geological heritage, rich natural resources, cultural and geological heritage, offer great potential for sustainable development through geotourism, geointerpretation and geoeducation. Geoparks are best practice examples in geotourism and an example of sustainable local development. Geoparks want to raise geodiversity, geoconservation, biodiversity awareness through new ways of interpretation with specific methods and qualified guides.

The development of Geoparks also goes hand in hand with the vision of Interpret Europe (European Association for Heritage Interpretation). High quality heritage interpretation is the key to foster broader understanding of ‑ and respect for ‑ all natural and cultural heritage. This opens up new possibilities for cooperation in the field of environmental education and interpretation between Interpret Europe and the Geoparks, as well as the European Geoparks Network. Geoparks must look forward to developing new networks to foster creativity and to drive innovations in heritage interpretation (Hartmann, 2012).[9]

In the figure 2 there is a simplified model of the communication process in geotourism (developed and based on the common communication model from Craig (1999)[10] and information design theory from Redish (2000).[11]

[9] Hartmann, G., Fajmut Štrucl, S., Bedjanič, M., Rojs, L. & Vodovnik, P. (2012): Načrt upravljanja Geoparka Karavanke-Karawanken. Mežica: Geopark Karavanke-Karawanken.

[10] Craig, R. T. (1999): Communication theory as a field. Communication theory, 9(2), 119-161.

[11] Redish, J. C. (2000): What is information design? Technical Communication, 47(2), 163-166.

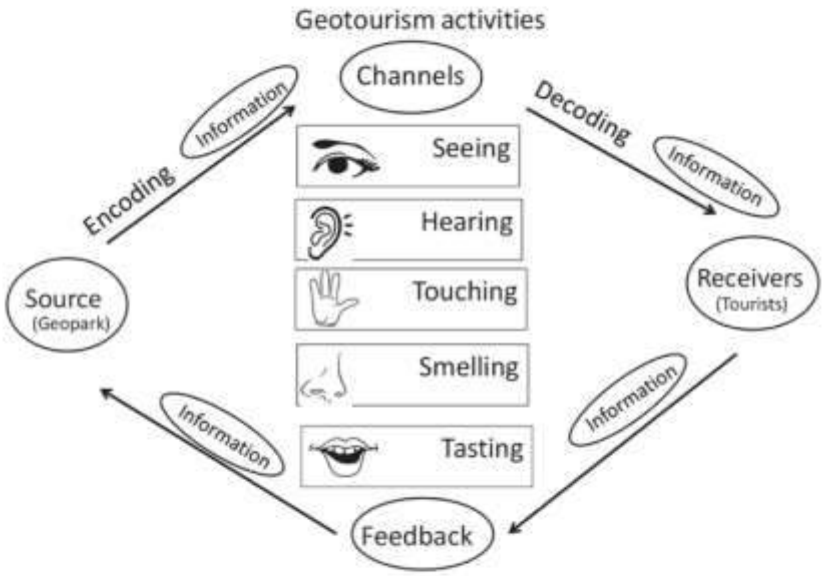


Figure 2: A simplified model of the communication process in geotourism

This model considers geotourism as a dynamic interpretation communication system, including all activities and adventures that a visitor can experience. In the model geopark (source) delivers information about its unique cultural and natural values to target tourists (receivers) through tourism activities (channels). The activities consist of what visitors do, sense, feel and learn such as behaviors, sensory experiences, emotions and knowledge in geopark. Geotourism is a system that comprises the geological elements of 'form and process' and the components of tourism such as attractions, accommodations, tours, activities, interpretation as well as planning and management (Dowling, 2011)[12]. Geotourism depends for its success upon identifying and promoting its physical basis (especially geosites). It is necessary to get advanced knowledge of resources of a geopark to help connect resource meanings with tourists interests and points of view (Ren, Simonson, Pan, 2013)[13].

In some cases, especially in cross-borders Geoparks, the communication process in geointerpretation can be complicated. Specific methods, concerning communication - audience development can be observed in the case of cross-border Karavanke/Karawanken UNESCO Global Geopark, located between Austria and Slovenia, managed by ERDF PP4. A significant challenge in effective communication and interpretation is the cross-border character of the region. In the official bilingual area on the Austrian site multilingualism plays an important role. Here the geo-education and geo-interpretation are a priority and can be reached through effective communication process. The multilingualism makes interpretation

[12] Dowling, R. K. (2011): Geotourism's global growth. Geoheritage, 3(1), 1-13.

[13] Ren, F., Simonson, L., Pan, Z. (2013): Interpretation of Geoheritage for Geotourism – a Comparison of Chinese geoparks and National Parks in the United States. Czech Journal of Tourism, 02/2013, 105-125.

and education indeed more interesting but also demands careful planning and consideration. Therefore all texts and spoken activities are prepared and carried out in both languages. All interpretation activities are carried out under the slogan *"It's fun, it's educational and no chore".* Within this framework there are educational programmes and courses for teachers and workshops, guided tours, visits for kindergarten and school children. In the interpretation it is very important that interpretation addressed to children isn't a dilution of the presentation to adults, but should follow a fundamentally different approach. As part of the educational and interpretation strategy of the Geopark several publications, folders, teaching tools, materials and geo-games have been produced under the same slogan and accompanied by two main characters of the cross-border Geopark - Marica and Franz. These two mascots have been created and named with the help of children from within the Geopark area. On the other hand, the Karavanke/Karawanken UNESCO Global Geopark tries to encourage schools and kindergartens from the Geopark region to achieve national education goals by using the natural and cultural attributes of their regional on site examples, and to freely use the Geoparks facilities. A Geo Project Day concept was developed in 2011. It is based on independent activities of each school/kindergarten supported by the Geopark. Each year a geology related topic is suggested (Volcanoes - The Earth erupts, on the surface something is brewing!", "We are UNESCO", "The pulse of nature",...) to kindergartens and schools so that they can organize a Geo Project day. Schools are responsible for the organization, methods and execution of the day. The Geopark's educational group provides training for school and kindergarten teachers, gathers the results, organises the final event and publishes a Geo journal, where all results are presented at the end of the school year. (Bedjanič and Rojs, 2014)[14]

In the last decade the multi-medias increasingly impact the way of knowledge information spreading and representing a new modern approach in geo-interpretation. It is important to select the most appropriate means of communication for a particular audience. Nowadays we live increasingly in a digital society. If we want to reach and engage this wide audience we must adapt our interpretation and narrative to meet their expectations. This does not mean abandoning old methods, but rather the development and introduction of additional approaches. Digital technologies can provide offline and online interpretation, as well as onsite or offsite experiences. It is a major and growing trend in museums and education. The onus is on the interpreter to choose the most suitable tool – or a mixture of them – in order to include as many people as possible and to encourage their active participation. Numerous recent digital heritage projects have demonstrated the usefulness of ICT (information and communications technology) (Boile, El Raheb and Toli, 2013)[15].

Nowdays the new technologies enable the creation of virtual databases using virtual globes – e.g., Google Earth – and other personal-use geomatics applications

[14] Bedjanič, M., Rojs, L. (2014): Geo-interpretation: The interpretation of the geological heritage of Karavanke Geopark

[15] Boile, M, El Raheb, K, Ioannidis, Y & Toli E (2014): Valorisation of EU project results in the area of access to cultural content: D.5.1 – Vision Paper.

(smartphones, tablets, PDAs) for accessing geological heritage information in "real time" for scientific, educational, and cultural purposes via a virtual geological itinerary. With these technologies Geoparks and other relevant institutions can create mapped and georeferenced geosites for use in map layers used in geological itinerary stops for different applications. For example, they can also develop a virtual tour which uses geological layers and topographic and digital terrain models that can be overlaid in a 3D model. Also the Google Earth application can be used to import the geosite placemarks. For each geosite, a tab can be developed, which shows a description of the geology with photographs or diagrams and evaluates the scientific, educational, and tourism quality (Martinez Grana et al., 2013)[16].

As best practice examples, the Geoparks must try to bring geointerpretation to the next level with the use of new technology for explaining difficult geological phenomena and processes – the latest trends in geointerpretation show that this is possible with innovative methods such as augmented reality. Using the mobile information technologies augmented reality adds information right into "our" reality. By explaining phenomena such as geohazards with augmented reality, visitors can be a part of the event itself, they can see the course of these dramatic phenomena from a safe place and they can easier understand the causes and consequences.

Augmented reality allows the user to access these georeferenced thematic layers and overlay data, images and graphics in real time on their mobile devices. For example, in Azores UNESCO Global Geopark (Portugal) some of educational and interpretive panels describing some of the geosites were designed and tagged with a QR code that could be printed at each stop or in the printed itinerary. These QR codes can be scanned with the camera found on most mobile devices and video virtual tours can be viewed on these devices.

To sum up, the **key new trends** in the geo-interpretation are the following:

- Personal interpretation has more important role and priority in geointerpretation but it is recommended to be mixed also with non-personal methods of interpretation such as different kind of digital and audio technologies, publicitations, apps, etc.;

- Raising the multimedia and new technologies, such as QR codes and augemented reality, simplifies the way of interpretation of geological heritage and enables explanation of difficult geological phenomena and processes; this does not mean abandoning of old methods but development and introduction of additional approaches;

- Geoparks need educated guides and education for them has to be guaranteed; geopark staff must be trained as geoguides and interprets to assure high quality guiding and programmes. A good guide can encourage excitement and curiosity, link interpretation to personal everyday life experience,stimulates disclosure of new insights and wider sense, using different and as effective communication tools as possible, with all the senses involved.

[16] Martinez Grana A.M., Goy J.L., Cimarra C.A. (2013): A virtual tour of geological heritage: Valourising geodiversity using Google Earth and QR code, Computers & Geosciences

Through research and training implementation, Geopark guides obtained several new competences in Geointerpretation, such as:

- they became familiar with best practice examples of geointerpretation from all over the world;
- they gained knowledge about different methods used for geointerpretation;
- within the framework of joint geointerpretation training, which took place in Karavanke/Karawanken UNESCO Global Geopark, they observed successful combination of personal and non-personal interpretation methods;
- they became familiar with different approaches of interpretation – interpretation for kids and interpretation for adults;
- they observed effective personal interpretation, different ways of how to be personal, enjoyable, relevant and well organised;
- they found out how geointerpretation can be more effective with the use of interactive, constructive learning;
- they discovered how to explain complex topics and ideas connected to a site's main themes in simple words and images that are easily accessible for non-expert audiences;
- how to develop and make appropriate use of props and supporting media that illustrate the content;
- how to deliver an interpretive narrative in a flexible way that relates to the visitors' backgrounds while keeping on track regarding theme, timing and learning goals.

The idea was to learn interaction beetween partners and the result was an insight into new interpretative trends, sharing concrete practical examples from other parks, learning new interpretational and communicational methods. This will significantly open perspectives as well as strengthen the competences of individual parks and the Danube Geopark Tour partnership as a whole.

3.1. Best practices from third countries (outside the project partnership)

The (geo)interpretation was firstly initated outside Europe, therefore it is important to get familiar with the developments and best practices also in third countries. At this point we have to mention some turning points in the history of interpretation. First, the US National Parks Service saw the value in programmes which encouraged people to respect their surroundings and to take care of themselves when visiting their parks. In 1957 this approach was set down on paper by Freeman Tilden in his Interpreting our Heritage and have defined heritage interpretation for more than 50 years.

The development of a profession

Others learned fast from the experience of the US National Parks Service. The UK and Canada were two of the countries which started to introduce interpretation along conservation - first in natural surroundings and later in towns and historical sites. In year 1975 the Society for the Interpretation of Britain's Heritage was founded which later became the Association for Heritage Interpretation.

In the United States of America, the National Association for Interpretation was establish in year 1988. They provide training and certification programs. The association is recognized as a major source for professional expertise and training in this field. The Association also publishes the Journal of Interpretation Research, a peer-reviewed academic journal and provides professional development, collaboration and networking opportunities with annual conference and workshop.

In the United Kingdom the Association for Heritage Interpretation (AHI) is a membership based organisation for people actively involved or concerned with heritage interpretation. AHI began as the Society for the Interpretation of Britain's Heritage in 1975 and later became the Association for Heritage Interpretation. The association brings together people who are actively involved or concerned with interpretation of heritage. AHI also publishes its journal Interpretation three times a year and organises a series of training events each year.

Nowadays interpretation is a recognised skill and an essential part of managing special sites and protected areas. In many countries there are degree and post-graduate courses in interpretation which include interpretation along other subjects. Courses and programmes are run for professional interpreters and for volunteers at heritage sites, museums and visitor centres.

This development of heriatge interpretation as a proffesion indicates that interpretation of geological and other heritage is very strongly developed in the United States of America, Canada, Australia and United Kingdom.

In this countries studying of interpretation proffession is also available at universities. All this associations organise different training courses for heritage interpretation. In the 1990s the most advanced training programm on heritage interpretation worldwide was the Interpretive Development Program (IDP) of the US National Park Service.

In other parts of the world, for example in some Geoparks In China, interpretation is just emerging and in many geoparks there is no scientific wayside exhibition, maps and brochures and there are no education programs for children and no interpretation which would target different age groups. Most of the interpreters have only few chances to accept the regular training. Generally speaking, there is a lack of scientific interpretation in many Geoparks in China. The Geoparks face the multiple challenges on how to establish a scientific interpretation system, how to know the pros and cons of the interpretive service, how to improve the quality of interpretation and provide better management (Wei, 2013).[17]

Further on, some of the best practice examples from countries outside the project partnership are presented. An overview of methods and topics of geointerpretation of best practices below is given in Table 1 and the approach/type for which they are considered as best practice.

[17] Wei, D. (2013): Building an evaluation framework of environmental interpretation for Chinese geoparks-case study of Yuntaishan world geopark. Graduate work, University of Missouri.

Table 1: Best practices from third countries

No.	Best practice	Location	Type of interpretation	Type of best practice
1	Dynamic Earth - Home of the Big Nickel - Earth sciences centre	Ontario, Canada	Exhibition Earthquakes of Canada; creation of earthquakes by experimenting with tectonic plates, use a seismometer to measure their jump impact	Best practice for direct linkage with scientific labs
2	Geologic Exhibit	Central Washington University Science II, United States of America	The exhibit maps to an actual scale model of the timeline built into the floor of a 58.5-meter-long corridor	Best practice for school workshop and digital interpretation
3	The Trail of Time	Grand Canyon, United States of America	A giant geologic timeline, where every meter along the trail, each of which is identified by a bronze marker, represents one million years of Earth's history	Best practice for interpretation route
4	Dynamic Earth - Home of the Big Nickel - Earth sciences centre	Ontario, Canada	Erosion Table; discover simple principles about erosion and force	Best practice for children interpretation and children workshops
5	Hong Kong UNESCO Global Geopark mobile app	Hong Kong UNESCO Global Geopark, China	An excellent interpretation example, which contains pictures, text, maps, and different videos for interpreting	Best practice for mobile application interpretation

Best practice for direct linkage with scientific labs

Example 1: Dynamic Earth - Home of the Big Nickel - Earth sciences centre, Ontario, Canada

Exhibition Earthquakes of Canada

Webpage: http://sciencenorth.ca/dynamic-earth/exhibits/details/index.aspx?id=4242

This place gives quite a lot of chances to experience geology live!

Through attractive areas visitors can create their own earthquake by experimenting with tectonic plates, use a seismometer to measure their jump impact. Everybody is involved – especially families which are the main target group. Addidional school groups, who are just learning on the topic geology, are finding the best place to learn and experience more at the exhibition. They can also monitor real current earthquake activity happening in Canada and learn how scientists measure the strength of earthquakes on large visual scales. So science becomes something clear, touchable and interesting. Children are meant to be self–creativ by playing with a digital globe to create different geological and meteorological events on our planet. Children nowadays like to do experiments and to try out different things – and so they get aware of the possibilities of natural hazards!

There are stories told to children which are easy to understand. Especially families with children will enjoy the journey that resonate across five billion years of Earth's history in the rocks of Sudbury. Embark on an underground tour that takes you 7-storeys below the Earth's surface! Unbelievable experiences are here to be explored together with experts on the topic of geology! Everybody can explore the geological story of Planet Earth, including the unique geology and rich mining heritage of Northern Ontario combining both above and underground experiences that allow you to work and play with real mining equipment and technologies! All in all the awareness for the natural and cultural heritage of this region is well transported!

Figure 3: Exhibition Earthquakes of Canada, Dynamic Earth - Home of the Big Nickel - earth sciences centre, Ontario, Canada, Source: https://sciencenorth.ca/dynamic-earth/exhibits/details/index.aspx?id=4242

Best practice for school workshop and digital interpretation

Example 2: Central Washington University Science II – Geologic Exhibit, Washington, United States of America

Webpage: https://www.cwu.edu/sciences/

The exhibit maps to an actual scale model of the timeline built into the floor of a 58.5-meter-long corridor. A pair of touchscreens helps round out and localize billions of years of geologic history. A lighting system with 2' x 2' Plexiglas panels enable students and faculty to change and update related subject content.

Figure 4: Geologic Exhibit, Washington, United States of America, Source: http://www.helveticka.com/work/work-3d.php

Best practice for interpretation route

Example 3: The Trail of Time, Grand Canyon, United States of America

Webpage: http://tot.unm.edu/

The Trail of Time is a giant geologic timeline, where every meter along the trail, each of which is identified by a bronze marker, represents one million years of Earth's history. The timeline is situated on the highly visited south rim, between the newly renovated geology museum at Yavapai Point and the historic lodges of Grand Canyon Village. It follows the paved, wheelchair-accessible Rim Trail, offering all manner of opportunities for multi-generational family exploration. The walk from the "Today" marker near Yavapai Museum to Grand Canyon's oldest rock at the east end of the village is a 1,840-meter (1.1 mile) timeline trail that covers 1.84 billion years. Amazingly, it's another 2,720 meters (1.7 miles) along the timeline to the 4.56-billion-year-old age of the Earth, near Maricopa Point. After walking these distances visitors express a visceral understanding of geologic time saying, "It's a long time, the Earth is really old!" or "I knew the number, that [the oldest rock] was 1.8 billion years old, but you don't really get a grasp of how much that is until you've walked 1.8 billion years!" Interpreted along the timeline are Grand Canyon rocks, wayside exhibits, and viewing tubes that relate Grand Canyon's history and landscape to geologic time. Boulder-sized examples of each of Grand Canyon's rock layers, many collected by raft from the canyon's bottom, have been placed along the trail at their "birthdays." People talk about and touch these beautiful examples of 1.7-billionyear-old folds, 1.2 billion-year-old mud cracks, 800-million-year old algal reefs, and 270-million-year-old fossils. Viewing tubes connect time along the horizontal timeline trail to the specific rock layers down in the canyon. Wayside exhibits explain key events that helped produce the landscape visitors see today at Grand Canyon. One key exhibit, just six meters from the start of the main trail, explains that the Colorado River has carved Grand Canyon in the last 6 million years or six long steps on the timeline. The main trail also has an introductory trail segment or “on ramp” where the first million years is stretched out to link human timescales (e.g. visitors’ birthdays and key events in early Grand Canyon explorations) with geologic timescales (e.g. climate change and Grand Canyon’s recent volcanic eruptions). The trail is also being using as an instrument to research how people from all walks of life comprehend geologic time and geologic processes. This research is helping identify what conceptions and misconceptions people start with. Onsite evaluation shows that 90 percent of respondents used one or more elements of the exhibition and that many were inspired to think about geology and engage in meaningful geology-related conversations. Many also came away with increased geologic reasoning skill, increased geologic vocabulary, and a visceral understanding of geologic time. The Trail of Time has been called the largest geoscience education exhibition at the world’s grandest landscape. As such, it is uniquely posed to make a difference for informal geoscience education and interpretation (Crow et al., 2011)[18].

Figure 5: The Trail of Time, Grand Canyon, United States of America, Source: http://tot.unm.edu/

[18] Crow, R., Karlstrom, K., Crossey, L., Semken, S., Perry, D., Williams, M., Bryan, J. (2011): It is about time. Innovations in Geoscience Education at the Grand Canyon. The magazine of the National Association for Interpretation, 22/1, 26-27.

Best practice for children interpretation and children workshops

Example 4: Dynamic Earth - Home of the Big Nickel - Earth sciences centre, Ontario, Canada

Erosion Table

Webpage:https://sciencenorth.ca/sciencenorth/exhibits/details/index.aspx?id=3117&category=nature&floor=3

The visitor can explore Earth sciences with the help of this giant stream table. Children especially enjoy playing with water and sand to discover simple principles about erosion and force. Simple but effective. Little children get in touch with the main topics in an easy way to understand – and not just the children will find out, how often to parents learn from their children while looking after them. Here they manage very well to transport exactly this circumstances.

Figure 6: Erosion table in Home of the Big Nickel - Earth sciences centre, Ontario, Canada.

Best practice for mobile application interpretation

Example 5: The Hong Kong UNESCO Global Geopark mobile app

Webpage: http://www.geopark.gov.hk/en_index.htm

The Hong Kong Global Geopark and its mobile app is an excellent interpretation example. It was created for the Geopark early in 2011, and contains pictures, text, maps, and different videos for interpreting. Hong Kong Global Geopark is the pioneer not only in geoconservation but also in geo-education and geo-popularization of China. The main interface of the mobile app included Geo-Area, Geo- Route, Geo-Centre, Animation Route Mode and News. It took full advantage of interactive maps. Taking Geo-Area for example, when the spot is touched, the two main scenic regions are seen. Next, four geo-areas appeared. When the site of geo-area is touched, some detailed descriptions about this geo-area in terms of words, pictures, audio materials, and short videos are shown. Commonly, it was the simple browsing route of the app. Especially, the audio material was very convenient, because it did not only convey accurate information, but was also suitable for multiple audience objectives. In addition to the apps, Hong Kong Geopark has also produced a series of engaging e-books, available for download from their website, to meet the needs of various groups exploring scientific geological knowledge. Their model is considered an advanced pioneering model for other geoparks in China to emulate (Li, Q. et al., 2015).[19]

Figure 7: Hong Kong Geopark mobile app (Li et al., 2015)

3.2. Key competences of Geopark staff engeged in geo-interpretation/ geo-communication

Heritage interpretation is deeply linked to the history of Geoparks. It has also a clear role in establishing the real links between the bio- and geodiversity and the need to conserve them both equally and it is the opportunity the geodiversity offers in touristic efforts at local or national level. Good geological interpretation will enhance the visitor experience and help to boost geotourism. This requires well educated, trained and skilled Geopark Staff – interpretive guides. It is very important that interpretive guides engaged in geo-interpretation have a conversation, a dialogue with participants and not just deliver messages. They also need to be aware of non-verbal communication, for example body language. They also need to have a high level of competence in understanding the subject of their talk or tour, including an understanding of the different interpretations that exist (or have existed) of the heritage asset in question and principles of heritage interpretation and an ability to apply those principles so that the tours they deliver are engaging, relevant and provoking. To summarize, there is a need for high-quality geo-interpretation in Geoparks but for it to work it will be necessary to have active programmes of staff and tour guide training. Geotour guides need to be encouraged to update and upgrade their knowledge and improve their skills. In order to reach this aim, regular education, training and qualification programs including wide information on geology, geomorphology, geography and local life are neccessary. Each year Karavanke/Karawanken UNESCO Global Geopark (ERDF PP4) offers a training to

[19] Qian Li, Mingzhong Tian, Xingle Li, Yihua Shi, and Xu Zhou (2015): Toward smartphone applications for geoparks information and interpretation systems in China. Open Geoscience,1663-1677.

those tourist guides, mountain guides and interprets who are interested to assure quality guideing and programme development. The training consists of an expert geological module and an interpretation training module, with special emphasis on geology interpretation. Other Geoparks participating in Danube GeoTour Project also offer trainings for their guides, which are involved in the interpretation of geological heritage mainly one, two times per year or once in two years. IPA PP1 Public Enterprise National Park Djerdap offers training for eco-guided tours but not for interpretation of the geological heritage.

Within Geointerpretation training ERDF PP4 Geopark Karavanks shared experience with other participating Geoparks in the training of Geopark guides - training programs, different methods and modules used by training implementation were presented.

3.2.1. Geotour guide

We can define geotour guide by adopting the definition of geotourism that was put forward by Hose (2000)[20]: "A geotour guide is a person who interprets geological and geomorphological sites and their materials, promotes geoconservation in order to ensure sustainable tourism, and increases the tourists' knowledge and awareness of geological heritage and geodiversity as well as ensuring quality tourist nexperience".

Table 2: Geotour Guide´s Roles

	Outer Directed	**Inner Directed**
Leadership (focus on group)	*Instrumental* • Direction • Access • control	*Social* • tension management • intergration • morale • animation
Mediatory (focus on individual)	*Interactionary* • representation • organisation	*Communicative* • selection • information • interpretation • fabrication
Resource Manager (focus on geosite/geopark)	*Motivator* • modification of tourist behaviour and impacts on geosite/geopark	*Geosite interpreter* • promote long-term environmental behaviors

[20] Hose T.A. (2000): European geotourism—geological interpretation and geoconservation promotion for tourists. In: Barretino D, Wimbledon WP, Gallego E (eds) Geological heritage: its conservation and management. Instituto Tecnologico Geominero de Espana, Madrid

As it is seen in Table 2, GEOtour guides were added roles as motivators and geosite interpreters. Guides play motivator role in order to provide motivation for environmentally friendly behaviour and to control their behavioral impacts on geosites and geoparks. They play geosite interpreter role for promoting long-term environmentally responsible behaviors at geosites and geoparks through interpretation. Consequently geotour guides motivate tourists to respect the environment, including geosites and geoparks and to contribute geoconservation and discourage their potentially harmful behaviors. They also stress the natural resources fragility at these sites and their significance for the local community (Dr. Nuray Tetik, 2016)[21].

Interpreters or guides must or can connect with visitors in the following possible ways:
- eye contact
- active listening
- smile
- humor
- looking for similar experiences
- positive body language

3.2.2. Geotour guide interpretation

Interpretation communicates what is significant about places, people or events. The essence of interpretation provides insight for visitors about what is special and how and why it is valued. It is connected to sites and objects, artwork or living things and it can happen anywhere; in parks, visitor centres, historical sites, geological and geomorphological sites, city streets, museums, zoos or galleries, at special events or promotions, and in publications. It has been described as „an educational activity‟, „a communication process‟, „a management tool‟ and „a process of stimulating and encouraging appreciation‟. There is no one definition of interpretation but the well-known definition has been done by Tilden (1967), the pioneer of interpretative philosophy, as; “interpretation is an educational activity which aims to reveal meanings and relationships through the use of original objects, by first-hand experience, and by illustrative media, rather than simply to communicate factual information”.

[21] Dr. Nuray. T. (2016): The Importance of Interpretatıon Role of Tour Guıdes in Geotourısm: Can We Called Them as Geotour Guıdes? and references there in

Geotour guides may follow the interpretation process given below (Figure 8) for providing effective interpretation services (Dr. Nuray Tetik, 2016)[22]

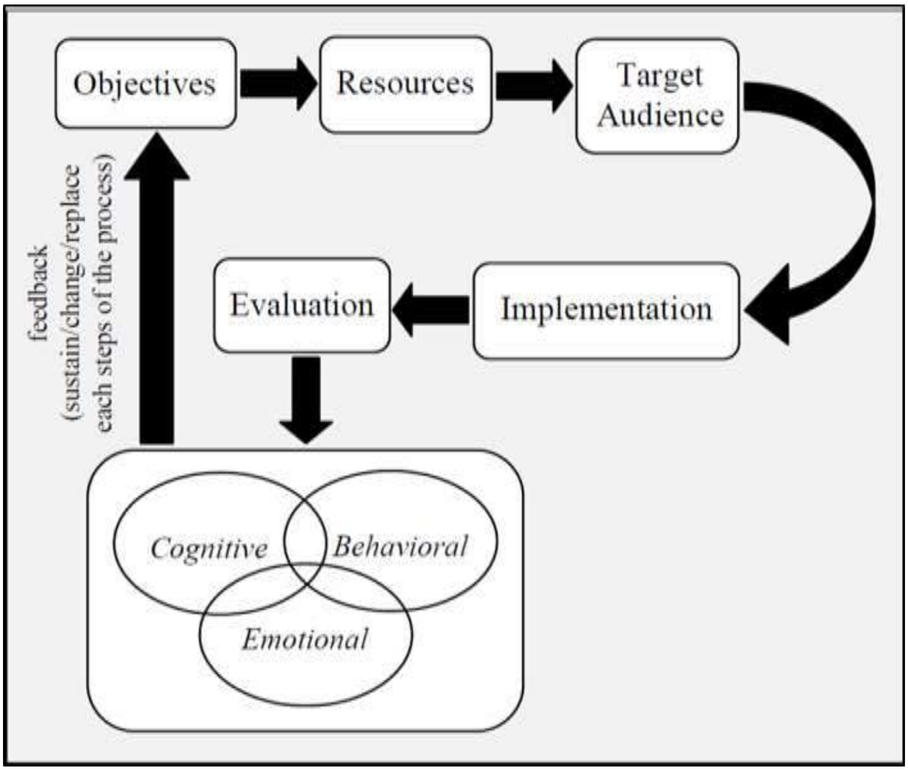


Figure 8: The Process of geotour Guide Interpretation

Indicating Objectives *(why do we want to interpret the geosite?)*

This step represent general objectives and needs. It is important to detail the results and benefits expected to achieve with the combination of following:

- *Educational Objectives*

To stimulate the interest for the visited geosite.

- *Leisure/Entertainment Objectives*

To offer a quality recreational product.

- *Visitors Management Objectives*

To manage to make visitors have a respectful behaviour towards the geosite.

- *Economic Objectives*

To create jobs.

- *Public Involvement Oriented Objectives*

[22] Dr. Nuray. T. (2016): The Importance of Interpretatıon Role of Tour Guıdes in Geotourısm: Can We Called Them as Geotour Guıdes? and references there in

To involve visitors in the management of the visited place.

- Local Community Inclusion Oriented Objectives

To link the local community to its geosite.

- Geosite Conservation Oriented Objectives

Conserve the geosite's value.

Moreover, there are three specific objectives more in geosite interpretation. These are:

- Cognitive Objectives

What visitors might *think*, know or believe as a result of interpretation.

- Emotional Objectives

What visitors might *feel* as a result of interpretation.

- Behavioral Objectives

What visitors might *do* or be *motivated to do* as a result of interpretation.

Analysing Resources (What are we going to interpret?)

The geotour guide must have a very broad and deeper knowledge of the resources to be able to speak with property and rigor. He/she must be knowledgeable about the past and contemporary issues and the condition of the interpreted site and its resources. Moreover, he/she needs to analyse several factors such as security or access, visits impact, the resources attractiveness or if it is subject to seasonality, etc.

Identifying Target Audience *(Who is the interpretation addressed to?)*

Tourists need to be defined, for example as who are they and what they want from the guide and geosite. The geotour guide needs to take into account the following for defining of the audience: socio-demographic features (age, gender variance, education level, occupation, etc.), specific needs (if they have any - i.e. school groups, disables, families, etc.), desires and interests, expectations from guide and site, travel choices and features, previous knowledge - knowledge backgrounds about geotourism, geosites and geoparks, learning motivation levels, number of people in the tour group.

Implementation *- Clarifying Representation Model and Equipment (How, when and where are we going to interpret?)*

The geotour guide needs to decide how, when and where the visitors will establish contact with the interpretive message. People behave according to the situation or environment in which they find themselves. For this reason, geotour guide shouldn't limit himself/herself to referring only to terms or technical information without explaining them. Otherwise people may generally stop paying attention. Good communication is the best way to built an effective interpretation, that is why a guide needs to pat attention to the followings guidelines:

- *be enjoyable:* stimulate the attention, curiosity and/or interest of the audience

- *be relevant:* be related to their lives and experience

- *be well organized:* Strive for message unity – use appropriate materials (sounds, colors, materials, graphics, music, etc. that thematically support the message).

- *thematic:* illustrate a common theme, message or "big picture" concept for the visitor and revolve around it.

Geotour guide needs to know how to express the theme in best possible way in order to attract the audience's attention. To achieve this a guide should give attention to the following points: go from familiar to unknown, use examples, metaphors, analogies, classifications, personification, quotations, humour, legends, stories, anecdotes, props, diagrams and illustrations, pictures and photographs, archives and documents, authentic objects and local memories, give current news and events, smiles, encourage people to use all their senses, demonstrate cause and effect, focuse on a single individual, invite people to take part, avoid technical vocabulary.

Evaluation - Getting Feedback from Tourists - (effective response - emotional, cognitive, behavioral)

This serves a guide to check if interpretation plan is running, is effective and is achieving the established objectives. Guide needs to collect data through several techniques as following: Direct evaluation by talking with tourists, observation, “Infiltrated” (This means that a person gets infiltrated into the guide's group and accesses comments what the audience probably would not express to the guide directly), Follow-up, questionnaires, interviews, expert groups.

3.2.3. Training of Danube geopark guides in geointerpretation - a learning interaction

In Danube GeoTour application form training for geointerpretation within WP 5 – Geo-interpretation was introduced. On 20th September 2017 joint geo-interpretation training for key Danube Geopark personnel responsible for geoguide service and/or interpretation was organized in the Karavanke/Karawanken UNESCO Global Geopark (Leader of WP 5). The training covered the following 3 topics:

1) familiarizing with most recent developments, methods and best practices - learning from others;
2) exchange of different personal experience and practices in the interpretation of the selected top 8 interpretation challenges. This was implemented in form of a workshop with a goal to learn from each other;
3) modes of communicating complex geological facts in an easy-to-understand language. As part of this topic English vocabulary and all partner language terms commonly used in geointerpretation were prepared. That is part of deliverable 5.2.1 Joint geointerpretation training material developed and training implemented. The

role of Geopark trainees will be to spread this new knowledge to geoguides of other Parks.

During the geo-interpretation training all participants (ERDF LP Idrija Heritage Centre, ERDF PP1 Balaton-felvideki National Park Directorate, Nonrprofit Ltd, ERDF PP2 Styrian Eisenwurzen, ERDF PP3 Public Institution Nature Park Papuk, ERDF PP4 Geopark Karavanks, ERDF PP6 Bakony & Balaton Regional Tourism, ERDF PP7 Bohemian Paradise Geopark non-profit organization, ERDF PP8 University of Bucharest) visited an example of good practice in the Karawanken/Karavanke UNESCO Global Geopark – visitor centre »World of geology« in Bad Eisenkappel with presentation of different kinds of geointerpretation methods and applications – Geopuls System, Geo clock, GeoGames, …This visit provided a very good insight into interpretation of geological heritage through different kinds of methods and technologies – a combination of personal and non-personal interpretation of geological heritage was presented.

The aim of the geointerpretation training was that all participated Geoparks became familirized mainly with the modern methods and new trends in geointerpretation as well as with best practices from all over the world. Within this training all Geoparks presented personal experience and methods which they commonly use in interpretation of geological heritage, especially for the interpetation of their own selected geological challenge. This transnational dimension of training was very useful; each Geopark gained new approaches for geointerpretation through learning from other particpants as well as got new ideas for heritage interpretation.


Figure 9: Geo-interpretation training in the Karavanke/Karawanken UNESCO Global Geopark on 20th of September 2017

4. Outputs 1 - 8 presenting specific methods of Geointerpretation

Within specific methods of GEO-interpretation eight different geological challenges which are typical for Geoparks of the Danube region, were chosen e.g.: tectonics, volcanology, geohazards, geology over time, water in time, metamorphic processes and rocks, geomorphology and dialogue between earth & humans. Each of them represents an individual output 5.1. as foreseen in the Danube GeoTour application. For each of the eight selected geological challenge its definition is given, followed by the geological background of the pilot area, best practices in the field of challenge interpretation (from partners and also abroad), possible methods of interpretation and lessons learned/tips. Table 3 shows summary of best practices for 8 selected geological challenges, which are thoroughly explained in subchapters.

Table 3: The summary of best practices for 8 selected geological challenges

No.	Best practice	Location	Type of interpretation	Topic of geointerpretation / Geological challenge
1	Animation of plate tectonics and formation of Idrija territory	Idrija UNESCO Global Geopark, Slovenia	Animation at the 1511 Anno Domini exhibition	Tectonics
2	3D models, showing the types of faults and movements along different faults	Idrija UNESCO Global Geopark, Slovenia	Animation for the interpretation of Idrija territory formation and Idrija fault	Tectonic
3	Wooden 3D model	Idrija UNESCO Global Geopark, Slovenia	Didactic tool used for presentation of movements along different types of faults	Tectonic
4	Interpretation point TIC Topla	Karavanke UNESCO Global Geopark, Slovenia/Austria	Didactic tools and interpretative boards showing the plate boundaries and geological time-scale	Tectonic/ Geology over time
5	Visitors center Cliffs of Moher	Burren and Cliffs of Moher UNESCO Global Geopark, Ireland	Multimedia exhibition which enables to move in time and see distribution of tectonic plates throughout the Earths' geological history	Tectonic
6	Geological clock	Karavanke UNESCO Global Geopark,	Special animation- clock, where geological time is divided and presented in 12	Tectonic/Geology over time/Water in time

No.	Best practice	Location	Type of interpretation	Topic of geointerpretation / Geological challenge
		Slovenia/Austria	hours	
7	High Definition 3D adventure cinema	Nationalparkzentrum Hohe Tauern in Mittersill, Austria	3D cinema which shows the formation of the Alps and the Hohe Tauern window	Tectonic
8	Visitors center Our Dynamic Earth	Edinburgh, Scotland	Interactive exhibition, experience with erupting volcanoes and lava flow	Volcanology
9	Adventure park VULKANIJA	Grad, Slovenia	Power of volcanoes and their activity is presented through images, text and film, through play and interactive content	Volcanology
10	Vulcania theme park	Saint-Ours, Auvergne, France	Projections, special effects and mapping on the rock walls; exploring volcanoes and the planet Earth with attraction named Abyss explorer.	Volcanology
11	Illustrative tools used by geohike guides	Balaton-felvidéki National Park Directorate, Bakony–Balaton UNESCO Global Geopark, Hungary	Guiding a group of visitors on a field trip or on a geohike	Volcanology
12	Hegyestű Geological Visitor Site	Bakony–Balaton UNESCO Global Geopark, Hungary	Information panel of the evolution of volcanic remnant hills	Volcanology
13	Tapolca Lake Cave Visitor Centre	Bakony–Balaton UNESCO Global Geopark, Hungary	Model of volcanic remnant hills	Volcanology
14	Lavender House Visitor Centre	Bakony–Balaton UNESCO Global Geopark, Hungary	Geyser and thermal spring simulator	Volcanology
15	Lavender House Visitor Centre	Bakony–Balaton UNESCO Global Geopark, Hungary	Model of a volcano	Volcanology
16	Volcano Nature Trail	Bakony–Balaton UNESCO Global Geopark, Hungary	“Stone heaps”: 4 models of the volcano cut into half	Volcanology
17	Volcano Nature Trail	Bakony–Balaton UNESCO Global Geopark, Hungary	“Stone map”: model of Lake Balaton and the volcanoes around it	Volcanology

No.	Best practice	Location	Type of interpretation	Topic of geointerpretation / Geological challenge
18	Volcano Nature Trail	Bakony–Balaton UNESCO Global Geopark, Hungary	"Stone wall": timeline of the volcanic activity in the area	Volcanology
19	Portable volcano model	Nógrád–Novohrad UNESCO Global Geopark, Hungary	Portable volcanoes model	Volcanology
20	Volcano simulator	Pannon Sea Museum, Geology and Natural History Exhibition of Herman Ottó Museum, Hungary	The simulator and the panels	Volcanology
21	Phreatomagmatic eruption simulator	Kemenes Vulcano Park, Celldömölk, Hungary	Simulator showing the process of the phreatomagmatic explosive eruption	Volcanology
22	Models of lava types	Kemenes Vulcano Park, Celldömölk, Hungary	Lifelike imitations of two interesting lava types: aa lava and pahoehoe lava	Volcanology
23	Simulations of volcanic processes	Kemenes Vulcano Park, Celldömölk, Hungary	Touchscreen, modelled videos of volcano lives like magma chamber processes, the movement of the lava flows, simulation (2D, 3D) etc.	Volcanology
24	Models of volcano types	Kemenes Vulcano Park, Celldömölk, Hungary	Six major types of idealized volcanoes are displayed by professionally detailed and accurate relief models on a table	Volcanology
25	The House of Volcanoes	Hateg Country Dinosaurs UNESCO Global Geopark, Romania	An interpretation and education point with main interpretation theme - ancient volcanoes from the Cretaceous	Volcanology
26	Smrekovec – extinct giant	Karavanke UNESCO Global Geopark, Slovenia/Austria	The interpretation point reveals the geological story of Slovenia's only volcanic mountain range.	Volcanology
27	Seismic table simulator	Natural history museum of the Lesvos petrified forest, Lesvos island Geopark	Seismic table which simulates the seismic movement of some of the most destructive earthquakes in recent years.	Geohazards

No.	Best practice	Location	Type of interpretation	Topic of geointerpretation / Geological challenge
28	Earthquake: Life on a Dynamic Planet	California academy of sciences, United States of America	Interactive exhibition with an earthquake simulator	Geohazards
29	Application of Modern Technologies in Popularization of the Czech Volcanic Geoheritage	Czech Republic	3D animation	Geohazards
30	Hiking tour "Hike to the seabed"	Karavanke UNESCO Global Geopark, Slovenia/Austria	Example of people-based/personal interpretation; guided tour where Geology over time is interpreted	Geology over time
31	Lavamünd Geopath	Karavanke UNESCO Global Geopark, Slovenia/Austria	Geopath with detailed explanations, where the history of the Earth from Devon to the Quaternary can be discovered	Geology over time
32	Children's book "Geological treasures of the Geopark Karavanke"	Karavanke UNESCO Global Geopark, Slovenia/Austria	Book which include very interesting and easily understandable geological time scale with illustrations	Geology over time
33	Family Geotime Trail	English Riviera UNESCO Global Geopark, Tourqay	Very interesting and attractive geo trail where visitors can explore history of our planet and its 4.600 million year long history	Geology over time
34	Geology park	St. Martin near Lofer, Austria	Walkable adventure trail	Geology over time
35	»Among rocks and flowers at Hleviše Hill«	Idrija UNESCO Global Geopark, Slovenia	Playground with detailed stratigraphic column and equipment arranged in the circle	Geology over time
36	„Journey through the time“	Slovenian Museum of Natural History (Ljubljana), Slovenia	Interactive publication for children aged 3 and more	Geology over time
37	A journey through time in Geopark Odsherred	Geopark Odsherred (Denmark)	3D technology - 3D graphics and augmented reality	Geology over time
38	Live timeline of	Pannon Sea Museum, Geology	18 meters long timeline made live by 5 round	Geology over time

No.	Best practice	Location	Type of interpretation	Topic of geointerpretation / Geological challenge
	Earth's history	and Natural History Exhibition of Herman Ottó Museum, Miskolc, Hungary	windows in which 4 characteristic paleogeographic environments can be rotated by wheels next to the window	
39	Centro de Interpretatcion de Geologica Nautilus	Basque Coast UNESCO Global Geopark, Mutriku Spain	Special exhibition about fossils and live within water over different time periods	Water in time
40	The OMIC Observatório Microbiano dos Azores	Azores UNESCO Global Geopark, Furnas, Portugal	The exhibition with various interactive stations, showing the changing microbiology in water within changing condition and over various time periods	Water in time
41	Interpretation point Feistritzbach Stream	Karavanke UNESCO Global Geopark, Slovenia/Austria	Interpretation point explains the area's complex water network through animation, educates about water flora and fauna and offers water-play facilities	Water in time
42	Spring Water Museum Wildalpen	Styrische Eisenwurzen UNESCO Global Geopark, Austria	The collection of the Museum comprises many original documents that enable visitors to understand the historical development of the Vienna Water	Water in time
43	Haus der Natur - Exhibition Salzach lifeline	Salzburg, Austria	Exhibition with flight simulator	Water in time
44	Exhibition Gletscher.leben	Visitor Centre Kaiser-Franz-Josefs-Höhe (National Park Hohe Tauern – Salzburg, Carinthia, Tyrol)	Interactive Station of the Pasterze glacier; Glacier.Life exhibition provides a deep insight into the glacier's habitat, its origin and its influence on nature	Water in time
45	Exhibiton "Wasserleben"	Ökopark Hartberg, Styria, Austria	Partly outdoors exhibition with various interactive experiments	Water in time
46	A glance into the Hohe Tauern window	Neukirchen - National Park Hohe Tauern – Salzburg, Carinthia, Tyrol	A thematic trail which shows how water is shaping landscapes	Water in time

No.	Best practice	Location	Type of interpretation	Topic of geointerpretation / Geological challenge
47	Hexenwasser Hochsöll	Tyrol, Austria	A mountain adventure world with games of safe nature watching	Water in time
48	The Natural History Museum	London, United Kingdom	Different kind of panels with text and examples of rocks, describing and showing metamorphic processes and rocks; interactive installation where visitors with button change metamorphic conditions	Metamorphic rocks and processes
49	Knocken Craig outdoor Visitor Centre	North West Highlands Geopark, Scotland	Interpretation panels with examples from real life explaining process of metamorphism; interactive installation with micro and macro rock examples	Metamorphic rocks and processes
50	Assynt Visitor Center	United Kingdom	Rock boulders of metamorphic and other rocks with description and interactive panels	Metamorphic rocks and processes
51	Interpretation panels in Rokua Geopark	Rokua UNESCO Global Geopark, Finland	Interpretation panels in Rokua Geopark describing metamorphic rocks of the area	Metamorphic rocks and processes
52	Interpretation panels in Papuk Geopark	Geopark Papuk, Croatia	Interpretation panels alluding to metamorphic rocks	Metamorphic rocks and processes
53	Itoigawa's GeoStation GeoPal	Itoigawa Global Geopark, Japan	Geopark tourist information center	Geomorphology
54	Serra de Santa Bárbara Interpretation Centre	Azores, Portugal	Interpretation center, explanation of geomorphological process of formation and evolution of the island and its relation to areas of high interest in terms of bio and geo-diversity	Geomorphology
55	Touchable glacier and Pasterze time wheel	Nationalparkzentrum Hohe Tauern, Mittersill, Austria	Information about the glaciers of the Hohe Tauern, about snow, corn snow and glacial ice, about the ice flowing and other peculiarities of the glaciers is given; the highlight is the	Geomorphology

No.	Best practice	Location	Type of interpretation	Topic of geointerpretation / Geological challenge
			real glacier which is placed in the middle of the room	
56	Expo Postojna cave karst	Postojna, Slovenia	The biggest exposition of the Karst and karst caves in the world	Geomorphology
57	Trail guide maps	Rokua UNESCO Global Geopark, Finland	Guides combine detailed explanations of the sites and a map that gives a good overall picture on the terrain and the location of sites of interest	Geomorphology
58	Rokua Geopark 3d Mobile app	Rokua UNESCO Global Geopark, Finland	By mobile application visitors can explore landforms, attractions and tourism services with respect to their own positions in a three dimensional map view	Geomorphology
59	Levels of interpretation in the Geosite “Foz do Enxarrique”	Naturtejo UNESCO Global Geopark, Portugal	Interpretation panels, billboards, different thematic panels	Geomorphology
60	The Promenade Museum	Haute Provence UNESCO Global Geopark, France	Nature, contemporary art and geology which show the history of our planet during the last 300 million years.	Dialoque between Earth and human
61	The Natural History Museum of the Lesvos Petrified Forest	Lesvos UNESCO Global Geopark, Greece	Two permanent exhibitions presented through rare fossils and through impressive models and charts of geological phenomena and processes.	Dialoque between Earth and human
62	Visitor information center for the Messel fossil pit	Bergstraße-Odenwald UNESCO Global Geopark, Germany	Significant monolithic wall panels and various exhibition rooms with effective architectural means such as confinement and expanse, light and dark effects, high and low ceilings.	Dialoque between Earth and human
63	Natural History Education Center Ulm	Geopark Swabian Alb, Germany	The Natural history education center; scientific collections with over 60,000 objects	Dialoque between Earth and human

No.	Best practice	Location	Type of interpretation	Topic of geointerpretation / Geological challenge
64	Exhibition Nature in human hands	Natural History Museum, Graz, Austria	Exhibition about the relationship Human - Nature	Dialoque between Earth and human
65	The Visitor Centre of the Troodos National Forest Park	The Troodos National Forest Park, Cyprus	Collection of rocks and minerals, a maquette of area'a geology, depicting sites of geological importance and interest and information panels	Dialoque between Earth and human
66	Mine of lead and zinc Mežica	Karavanke UNESCO Global Geopark, Slovenia/Austria	Numerous objects exhibited in the mine reveal the everyday work and lives of miners	Dialoque between Earth and human
67	Anthony's shaft – tourist mine in Idrija	Idrija UNESCO Global Geopark, Slovenia	Presentation of the hard daily work routine of miners, the precious cinnabar ore, drops of mercury and the unique and extraordinary underground chapel	Dialoque between Earth and human
68	Thematic tours and activities guided with local know-how and the travelling exhibition "When we went for ore"	Naturtejo UNESCO Global Geopark, Portugal	Travelling exhibition "When we went for Ore" is an open way to knowledge transfer between old miners and geologists that provide training to tour guides and educational monitors	Dialoque between Earth and human
69	Footpath for everyone	Adamello Brenta UNESCO Global Geopark, Italy	Interpreted trail where visitors can learn how to read landscape and environment by using their five senses	Dialoque between Earth and human
70	Intangible cultural heritage	Buzau Land Aspiring Geopark, Romania	Exhibitions, publications and a visiting centre	Dialoque between Earth and human

4.1. Output 1: Geological challenge Tectonics

Prepared by IDRIJA HERITAGE CENTRE (Idrija UNESCO Global Geopark). Edited by Karavanke/Karawanken UNESCO Global Geopark

Definition of specific challenge

The chosen challenge by the Idrija Heritage Centre is TECTONICS which will be interpretated by IHC with the external expert group in the area of Idrija UNESCO Global Geopark. The pilot action will apply creative solutions that are very simple (GEOfor DUMMIES) and will be presented in a form of a Visitor Centre.

The geological background of the pilot area

The Idrija hills in western Slovenia have a complicated geological composition. Due to intense and polyphase tertiary tectonic activity, the majority of contacts between the sequences of different Carboniferous to Eocene rock strata are tectonic.

There have been three major tectonic phases in Idrija area, which have been documented on field as well as in the mine:

a) **Idrija rifting phase in upper Anisian (middle Triassic)**

At the beginning of the Upper Anisian, during Idrija's rifting phase, the area was dissected by normal faults forming horst and graben structures mainly directed in E-W direction. The area at that time belonged to a new paleogeographic unit called the Dinaric Carbonate Platform. This platform was not uniform but composed of different tectonic trenches (aulacogens). In one of that tectonic trenches, i.e. ore deposit trench, the famous Idrija mercury ore deposit was formed during this period. Along the strong normal faults with a vertical displacement component of 600 to 900 m, individual blocks were raised, while others were lowered. Some 750 m of strata were eroded from the raised blocks (Čar, 1990).[23] The Anisian, Early Triassic, Permian and partly also Carboniferous rocks were removed. So in some tectonic blocks Ladinian rocks directly (discordantly) overlie Carboniferous clastites.

The final period of Ladinian tectonic events was accompanied by extensive volcanic activity with outpourings of diabase and keratophyre. At the end of the Ladinian, tectonic activity ended.

Notes: The evidence of the rifting phase is visible and presented at the best in the Idrija Mercury Mine. At the entrance tere is a interpretational board with the cross-section of the Idrija ore deposit, where this phase and the formation of ores is explained personally by the guides. At the entrance also different types of ore are presented to the visitors. Furthermore in the tourist part oft he underground mine, there is possible to see a discordance between Carboniferous and Ladinian rocks and normal faults.

[23] Čar J. (1990): Kotna tektonsko-erozijska diskordanca v rudiščnem delu idrijske srednjetriasne tektonske zgradbe (Angular tectonic-erosional unconformity in the deposits part of the Idrija Middle Triassic tectonic structure).

b) Thrusting phase in late Eocene (Tertiary)

The next stronger tectonic activity in the area then happened in Tertiarry, namely folding and thrusting in the Late Eocene, and continued into the Early and Middle Oligocene. At first a large recumbent fold was formed, which, under ongling compression, was internally thrusted. Thrusting was directed towards the south-west, forming a thrust structure typical of western Slovenia. The lowermost structural unit, representing the basement of the Idrija region is the Hrušica nappe, which is overhtursted by the Kočevnik, Čekovnik and Kanomlja thrust slice. The uppermost structural unit of the area is represented by the Trnovo nappe (Placer, 1973, 1999)[24]. This complex folding and extensive thrusting completely obliterated the primary spatial relation of different strata and created several tectonic phenomena: various tectonic windows and tectonic half-windows, as well as tectonic klippes and half-klippes.

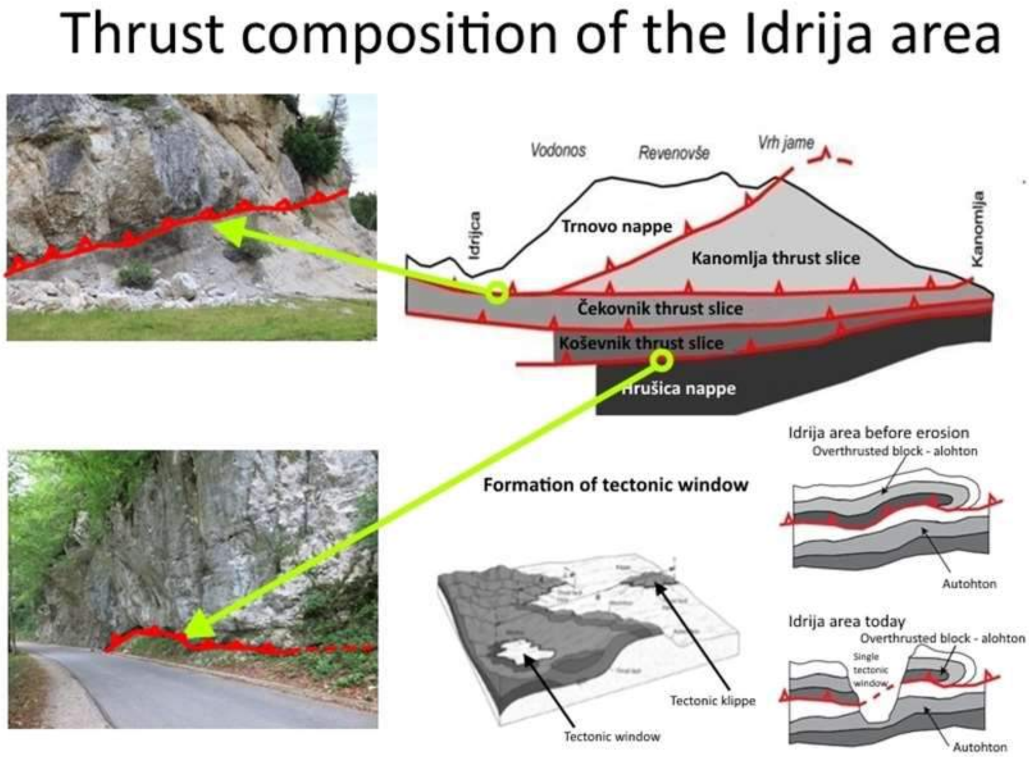


Figure 10: Thrust composition of Idrija area (Illustrations: Rafael Bizjak, Photo: Mojca Gorjup Kavčič

[24] Placer L. (1973): Rekonstrukcija krovne zgradbe Idrijsko Žirovskega ozemlja (Reconstruction of the Nappe Structure of the Idrija – Žiri Region; Reconstruction des Deckenbaus des Idrija-Žiri Gebietes).
Placer L. (1999): Contribution to the macrotectonic subdivision of the border region between Southern Alps and External Dinarides.

c) Strike-slip tectonic activity in Miocen (Neogene)

The last tectonic activity started in the Neogene, precisely at the beginning of Pliocen 6 Ma ago, and is lasting until today. The Neogene to recent geological strucutre of Idrija's terrain was formed by numerous strong normal and then by dextral strike-slip faults which cut and displaced older thrust units (Mlakar, 1969; Čar, 2010)[25]. Of the numerous faults, let us mention only the two larger ones, the Idrija and Zala faults.

Idrija fault is one of the 4 sites of international importance in Idrija UNESCO Global Geopark and thus additionally described:

Idrija fault is one of the most important tectonic elements in Slovenia and one of the strongest in the Southern Alps. The fault begins in Carnia, cuts across the Resia Valley in Italy, crosses the entire territory of Slovenia and ends in the Velebit mountain range in Croatia. It extends across Slovenia over a distance of more than 120 km, striking NW-SE in a so-called Dinaric direction. The recent seismic activity shows that the fault is still active (Gosar 2007, Gosar et al., 2011, Kastelic & Carafa 2012).[26]

Figure 11: A distinctive valley along Idrija fault (Photo: Gregor Kacin)

[25] Mlakar I. (1969): Krovna zgradba idrijsko žirovskega ozemlja (Nappe structure of the Idrija-Žiri region). Geologija 12. Geološki zavod Slovenije, Ljubljana, pp 5-72

Čar, J. (2010): Geološka zgradba idrijsko-cerkljanskega hribovja; Tolmač h Geološki karti idrijsko-cerkljanskega hribovja med Stopnikom in Rovtami 1: 25 000 (Geological structure of the Idrija – Cerkno hills; Explanatory Book to the Geological map of the Idrija – Cerkljansko hills between Stopnik and Rovte) 1: 25000. Geološki zavod Slovenije, Ljubljana. pp127

[26] Gosar, A. 2007. Monitoring of mico-deformations along Idrija and Raša faults in W Slovenia/ Opazovanje mikro-deformacij ob Idrijskem in Raškem prelomu v zahodni Sloveniji

Gosar, A., Šebela, S., Koštak, B., Stemberk, J., 2011. On the state of the TM 71 extensometer monitoring in Slovenia: seven years of micro-tectonic displacement measurements. Acta geodynamica et geomaterialia

Kastelic, V. & Carafa M., M., C., 2012. Fault slip rates for the active External Dinarides thrust-and.fold belt.

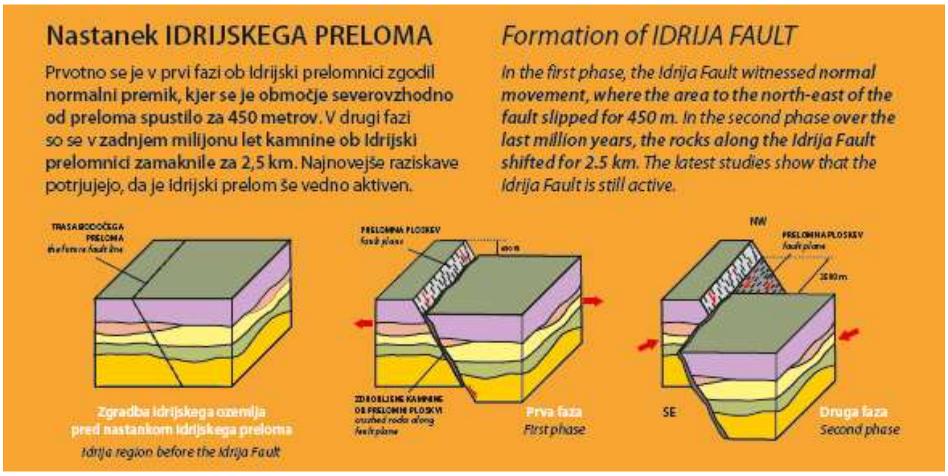


Figure 12: Explanation of formation of the Idrija fault, as part on an interpretation pannel in Idrija UNESCO Global Geopark (Texts: Martina Peljhan, Mojca Gorjup Kavčič, Illustrations: Rafael Bizjak)

<u>Possible methods for geo-interpretation of geological challenge tectonics</u>

Tectonic processes are very complicated and difficult for non-geologists to understand and imagine because:

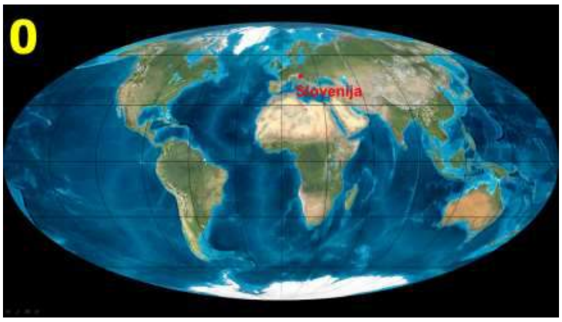
- These processes have been going on inconceivably long time ago, so it is of great importance that we present the time dimensions to the visitors. In our opinion a geological timeline or geological clock or any other tool to interpret a geological time is a good method to present this longlasting tectonic processes and to show the aspect of occurrence human being in this geological time frame
- The dimension of the processes, which can affect the whole regions, as well as dimensions of pressures and energy, which is released in case of tectonic activities. In this aspect it is important to show to the visitors that this processes are still going on today and relate these past tectonic events to the currently tectonically active areas, or relate to near history events in the domestic area, which are still in the minds of people
- Time of the ongoing tectonic activity can be unimaginable long and these are slow movements. In this aspect it is important to link this slow processes to something familiar to people (such as nail growth or hair growth or something else imaginable)
- The 3D dimensions of the tectonic movements and also the spatial distribution of the rocks, which have been moved during the tectonic phases. The good geo-interpretation method would be 3-D models or animations to see the spatial distribution of tectonic movements.
- In action to self-guided interpretation we also recommend guided personal interpretation for visitors, who are interested in that, and expert groups.

It is of extreme importance, if you want to make a quality tectonics interpretation, to put yourself in a position of non-geologist and explain difficult contents in an easy to understand language, supported with illustrative and photo material or any other tools.

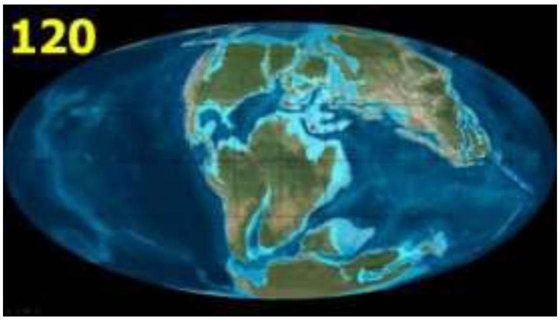
Best practices from partners and abroad

In this chapter we have collected some examples, which in our opinion are good examples of interpretation of complex tectonic processes. It is important to point out that quality of interpretation does not always refer to the amount of money spent on a specific interpretational tool. In some cases a very simple and cheep didactic tool has much bigger effect on visitors than expensive ones.

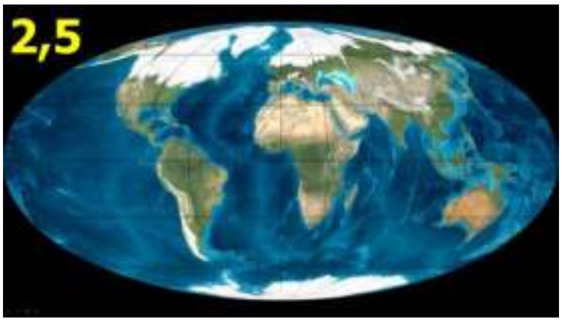
Animation of plate tectonics and formation of Idrija territory at the 1511 Anno Domini exhibition, Author: Rafael Bizjak



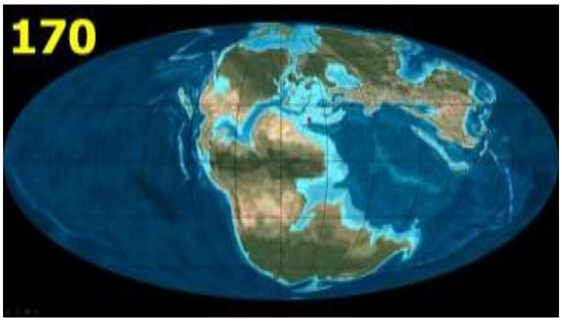
Recent



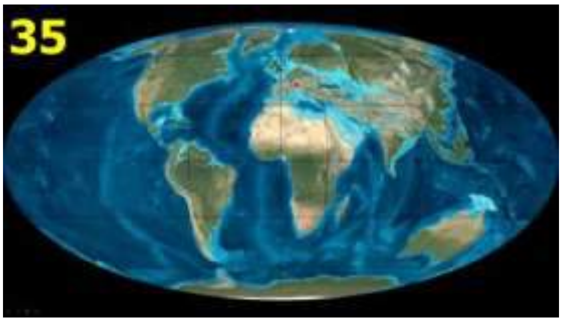
Lower Cretaceous



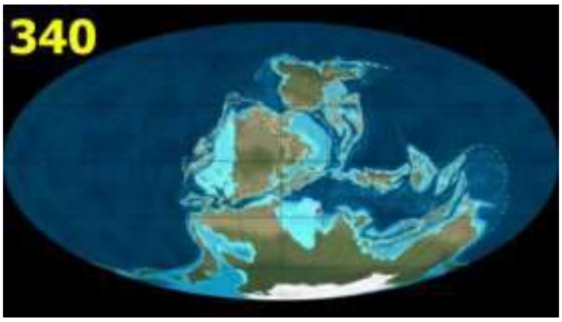
Pleistocene



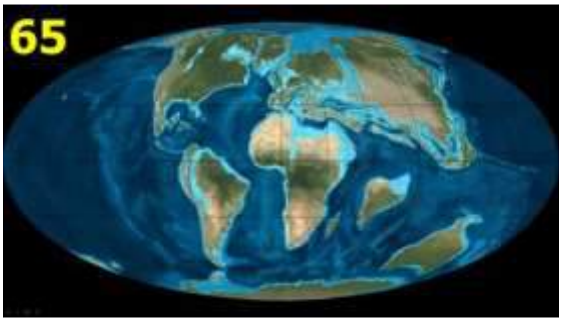
Middle Jurrasic



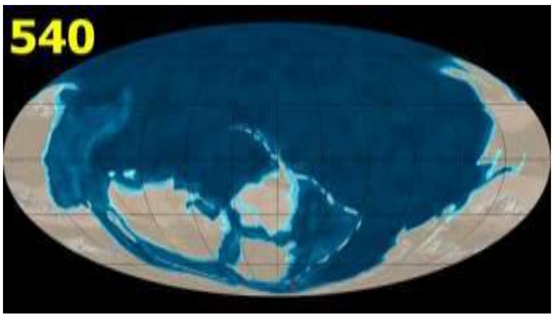
Late Eocene



Carboniferous



K/T Boundary



Cambrian

Figure 13: Animation of plate tectonics and formation of Idrija territory at the 1511 Anno Domini exhibition, Author: Rafael Bizjak, https://www.youtube.com/watch?v=g_iEWvtKcuQ (Author: Scotese)

These photos were part of animation of tectonic plate movements in the geological history 600 million years back. The most interesting part is, of course, the location (red dot) of Slovenia, so visitor can see the long travel “Slovenia“ made in this time. In our opinion this method would be representative for reconstruction of paleoecology and actualisation to a present day environment. In this case visitors could see the environment as well and then link specific rocks from the era. This would then represent a holistic approach of geo-interpretation and show connections which provided a base for today’s life. This aspect and awareness is in general forgotten and it is important to bring this back to people’s life.

Another interesting animation for interpretation of formation of Idrija territory and Idrija fault has been done. The photos below are part of animation, where first normal fault is presented, the next stage are erosion and glaciationan and the third stage is the actual state today and actualisation to the photo of the view on the valley along Idrija fault. In this way people could really imagine what was moved, how it was moved, where Idrija fault is, etc.

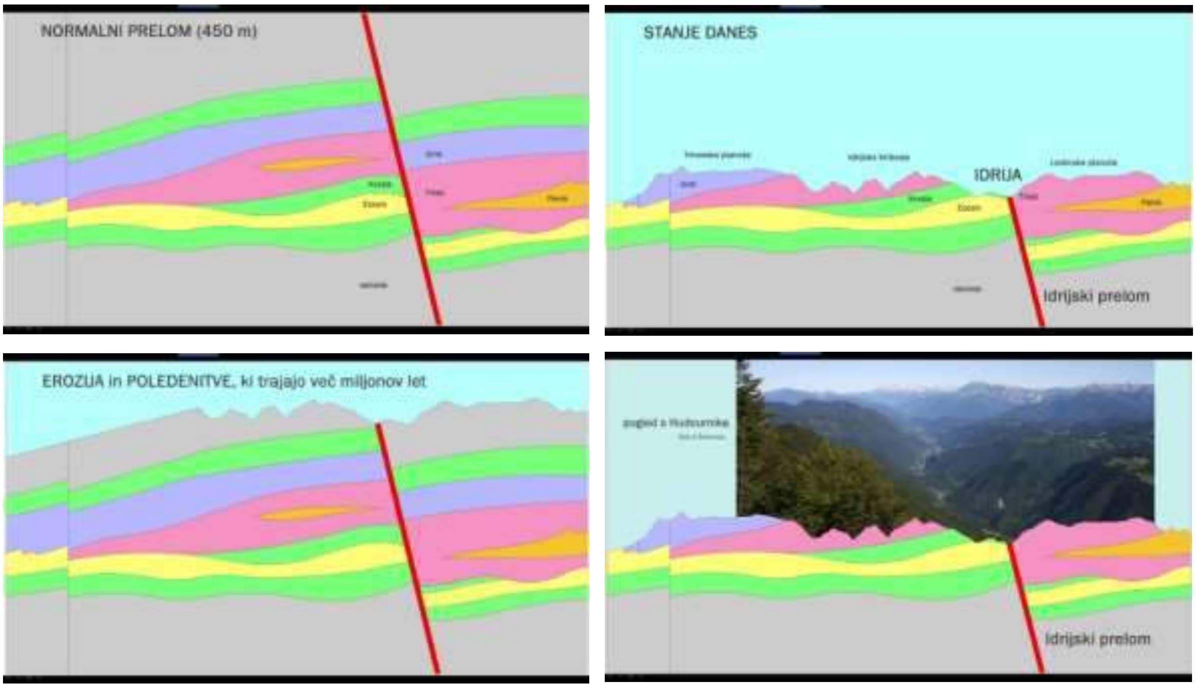


Figure 14: 3D models, showing the types of faults and movements along different faults (Idrija UNESCO Global Geopark)

Furthermore, wooden 3D models are a very representative presentation of movements along different types of faults. The sites of models are coloured as rock strata and thus showing the displacement in 3D. It is possible to move the wooden block with your hands. A representative example that an inexpensive didactical tool can be effective as well.

Figure 15: Wooden 3D models. Source: Exhibition 1511 Anno Domini, CudHg Idrija, Authors: Martina and Silvo Peljhans

Didactic tool, showing the plate boundaries in Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at

An interesting example of interpreting transform plate boundary in an easy to understand language is a didactic tool developed in Karavanke/Karawanken UNESCO Global Geopark. When visitors imagine, that this two boards present two tectonic plates, they can easily understand what kind of movement occurs between these plates at the transform plate boundary.

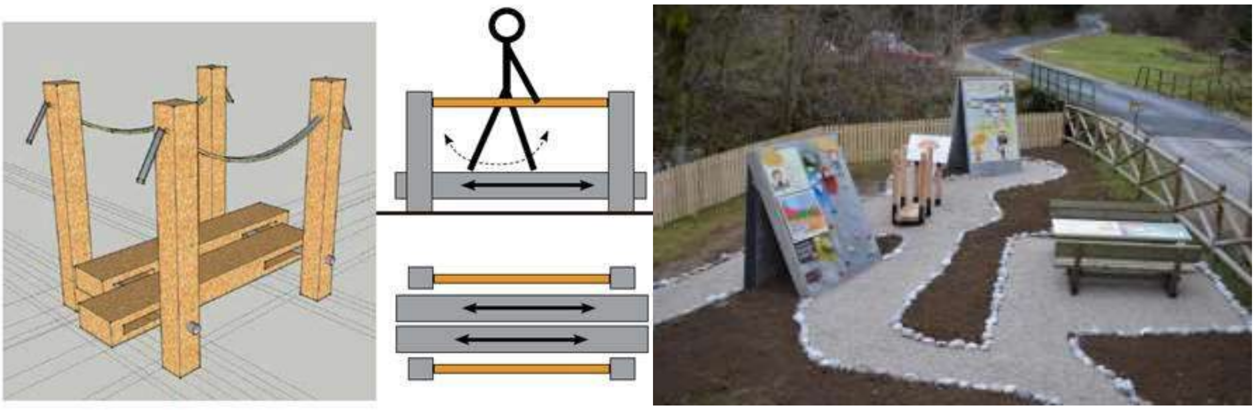


Figure 16: Didactic tool, showing the plate boundaries in Karavanke/Karawanken UNESCO Global Geopark

Interpretative boards, showing the different types of tectonic plate boundaries. On the left side there is a part of board, where you can mechanically move small wooden plates and see the motion between two plates. On the right side there is a game for searching the evidence of plate tectonics.

Figure 17: Didactic tool, showing the plate boundaries in Karavanke/KarawankenUNESCO Global Geopark.

All these examples represent the learning by using approach, which offers the most effective way of learning.

Visitors center Cliffs of Moher in Burren and Cliffs of Moher UNESCO Global Geopark, Ireland

Webpage: http://www.burrengeopark.ie/

A good geo-interpretation of plate tectonics is shown in Visitors centre of Moher Cliffs in Burren and Cliffs of Moher UNESCO Global Geopark. A fully multimedia exhibition enables to move in time and see distribution of tectonic plates throughout the Earths' geological history. Additionally, the rock formation and paleoecology is reconstructed and actualised to today's examples. This exhibition is exclusively multimedia driven, but still offers a visitor a possibility to manage the tools, so one can discover the topic as deep as he/she wishes. This method enables the visitor not just to listen and read, but discover as well.



Figure 18: Visitors center Cliffs of Moher in Burren and Cliffs of Moher UNESCO Global Geopark, Ireland

Application Geological clock, Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at/en/home.html

A very interesting presentation of geological time is shown in Info center of Karavanke/Karawanken UNESCO Global Geopark in Bad Eisenkappel, where geological time is divided and presented in 12 hours. The highlight of the method is, that human appears in last second of 12 hours. In this way visitors can see, what tiny peace human beings present in the Earth history and what impact we have done during this short time.


Figure 19: Geological clock in Karavanke/Karawanken UNESCO Global Geopark.

High Definition 3D adventure cinema, Nationalparkzentrum Hohe Tauern, Mittersill, Austria

Webpage: http://www.nationalparkzentrum.at/

In the cinema visitors can experience time-lapse 3D animation about the formation of the mountains and the origins of the Tauern Window. This 3D cinema experience helps visitors to understand the unimaginable: the formation of the Alps and the Hohe Tauern window when the continental plates smashed one into another – 250 million years of history packed into 15 minutes that will take your breath away!

Figure 20: High definition 3D adventure cinema, Nationalparkzentrum Hohe Tauern, Austria

Lesson learned / tips

While carrying out study tours in 6 visitor centres in Slovenia and also abroad, we made several conclusions, which are presented here as tips:

- Multimedia presentations should be used carefully. In some cases it is the most effective way to interpret a specific content by multimedia tools, but you also have to be aware about several negative aspects. Firstly, technology can easily go out of order and does not work. That is why you have to consider maintenance costs and provision of instant technical support to ensure the constant operation of the tool. Secondly, we noticed that visitors do not spend much time in front of multimedia. It has to be very simple and it should offer well thought and simple messages with strong visual part to attract visitors.
- We suggest more practical solutions of interpretation and classical didactical tools, where visitors can discover or do something on their own, with their hands. This is especially important for children.
- Additionally, some effects can increase impact of interpretation on visitor experience, for example sound, shaking, smell, etc.
- Use power of photography – a good photo tells more than 1000 words. We suggest to put emphasis and also more finances in high quality photography.
- We suggest careful planning of contents presented in visitor centres. The right amount of information is just to provoke visitors and with good visual image we want to encourage people to go out of the centres, into the field and also taste the genuine countryside with the heritage, tradition and culinary offer.
- In general, our suggestion is to apply the saying: Less is more.
- Personal interpretation. In relation to previous tip we suggest to organise guided personal tours in the visitor centres for visitors that are highly interested in the contents or expert groups. In this case there are no limitations in the amount of information, which is communicated to the visitors, except the skills and knowledge level of the guide.
- Be enjoyable and funny, but be aware of the limit, where you become a clown.

Successful interpretation has a strong theme, is easy to follow, matters to the audience and is enjoyable to process (Sam H. Ham).

4.2. Output 2: Geological challenge Volcanology

Prepared by Bakony - Balaton UNESCO Global Geopark, Hungary
Edited by Karavanke/Karawanken UNESCO Global Geopark

Definition of specific challenge

The chosen challenge by the Balaton-Felvidéki National Park Directorate in Bakony–Balaton UNESCO Global Geopark is VOLCANOLOGY, which will be interpreted with the help of external experts. The pilot action will apply creative solutions at the internal exhibition of Hegyestű Geological Visitor Site near Monoszló, to be renewed within the project. The outdoor elements of the pilot action are two nature trails to be renewed and one to be developed, all of them focusing on volcanism.

The pilot action will be implemented in an area of the Geopark, which is one of the densest volcanic fields of Europe. About 50 volcanic remnant hills can be found in this region. Hegyestű Hill itself is a volcanic remnant hill, where a basalt quarry functioned for decades before the area became strictly protected and part of the Balaton-felvidéki National Park. The peak of the hill was almost cut into half in the course of quarrying, thus a nearly 30 m high wall of the one-time quarry shows the internal structure: the basalt (basanite) is characterised by columnar jointing and this is one of the most beautiful and spectacular occurrences in Hungary. The diameter of the vertical columns is 10-45 cm. The top section is of vesicular structure, which indicates a wet environment during the explosion. The volcanic neck of the Hegyestű has been formed from the melt (lava) that had filled up the vent and crater of the strongly eroded volcano. The melt cooled on the surface 7,94 years ago, about 20 thousand years after the first explosions of the intercontinental basalt volcanism in Tihany.

The trails to be renewed and developed lead along volcanic remnant hills (Badacsony Hill, Szent György Hill, Hegyestű Hill, Fekete Hill, Kopasz Hill).

The geological background of the Pilot area: Basaltic Volcanism in the Geopark Area

The Pliocene Epoch was the main phase of the volcanic activities in the area. By the time of the first volcanic eruption, about 8 million years ago, Lake Pannon – which formerly covered a large part of the Carpathian Basin – had almost completely receded from the area, and a flat landscape came into being, dissected by swamps and shallow lakes and slow watercourses. Only the high limestone and dolomite cliffs of Keszthely Hills and Bakony Hills rose above the gently sloping land. Due to the gradual upwarping of the mantle beneath Transdanubia, the molten rock of the mantle suddenly started moving upwards through the fissures of the crust. As the magma (having a temperature of 1000-1200 Celsius) got in contact with water-saturated sediments under the surface, deposited in Lake Pannon, it forced its way to the surface by huge steam-blasts. Due to these explosions, the volcanic ash and rocks created a ring around the crater. After that lava lake formed in it and in the end a scoria cone was often built at the top of the basalt.

The volcanoes in Tihany were the first which were formed by these explosions about 8 million years ago. Due to these eruptions and similar following events, at least 50 maar-type volcanoes were born during the following 6 million years. Today the most crowded volcano field of Europe can be found here, but only their eroded remnants can be seen. The complete denudation of volcanic ash rings is due to wind and water erosion; only rocks of the vents remained, such as the volcanic remnant hills of the Káli Basin and Tapolca Basin that can be seen from Hegyestű Hill.

Tihany Peninsula is another important volcanic site of the Geopark. It is the venue of the first volcanic eruptions in the geopark area, with remnants of caldera rims, various stages of the erosion of basaltic tuff and the hot spring cones, or geyserite cones that are unique post volcanic formations. After the extinction of the volcanoes, the heat of the molten rock (magma) trapped in the depth was still heating the surroundings for thousands of centuries. High temperature gases (carbon dioxide, sulphur dioxide) came from the molten basalt streamed upwards through the rock fractures and mixed with underground waters. These hot waters occluded the gases and thus became aggressive, dissolving calcium, silica, magnesium and iron from sedimentary rocks and depositing them on the surface in the form of hot spring cones. This miscellaneous rock is called geyserite.

Possible methods for geo-interpretation of geological challenge volcanology

During a guided geohike or a geoactivity day (these methods are used in guided hiking tours and during geoeducational outdoor events):

- printed photos of volcanic eruptions, volcanic forms that are similar to the ones in the geopark landscape – showing how a certain type of volcano looked like when it erupted
- gas bubbles growing in the lava – opening a bottle of a mineral water to show how gas bubbles grow in it when pressure becomes lower
- specimens of hard basalt and vesicular basalt, weighing them with hands and guessing the reason for the difference of weight
- specimen of a basalt bomb – to support explanation of their forming and their shape at an exhibition:
- a scale-model of landscape with hard basalt volcanic mini-hills and soft sediments (sand) around them – to understand the process of erosion
- sequence of drawings or multimedia explaining the process of an eruption
- using sound effects to interpret eruption
- using movement to interpret earthquakes
- short games that focus on different aspects of the topic, e.g. to step forward on a panel on the ground where it is possible to choose different itineraries (that feature different conditions) that eventually lead to a certain type of volcanic eruption

Figure 21: Geointerpretation in guided hiking tours and during geoeducational outdoor events, Source: Balaton Bakony UNESCO Global Geopark

Best practice from partners and abroad

In the continuation, we present some good practices in interpretation of geological challenge volcanology provided by Bakony–Balaton UNESCO Global Geopark from their own Geopark.

Our dynamic Earth in Edinburgh, Scotland - Restless Earth

Webpage: http://www.dynamicearth.co.uk/

Figure 22: Our dynamic Earth in Edinburgh (Scotland). Source: http://www.welcometoscotland.com/things-to-do/attractions/family-fun/edinburgh/dynamic-earth-edinburgh

Our Dynamic Earth is a visitor attraction in Edinburgh and also functions as a conference venue. The principal focus of Dynamic Earth is to facilitate a better public understanding of the processes that have shaped the Earth (known as earth science). Feel the ground shudder as a molten lava flow speeds straight towards you and volcanoes throw clouds of ash and gas into the sky. This would be edge-of-the-seat stuff if you weren't standing up, gripping a handrail for balance.

Figure 23: Our dynamic Earth in Edinburgh (Scotland). Source: http://www.welcometoscotland.com/things-to-do/attractions/family-fun/edinburgh/dynamic-earth-edinburgh

Adventure park VULKANIJA, Grad, Slovenia

Webpage: http://vulkanija.si/m/en/vulkanija

Figure 24: Adventure park Vulkanija, Grad Slovenija. Source: http://vulkanija.si/m/en/vulkanija

The Vulkanija Adventure Park presents the forces within the Earth’s core and geological processes that take the place on near the surface. Visitors can learn about the power of volcanoes and their activity through images, text and film, through play and interactive content, all of which will leave a lasting impression and help you overcome your fear of volcanoes. Experience volcanoes and the geological history of Goričko at the Vulkanija Adventure Park.

Figure 25: Adventure park Vulkanija, Grad Slovenija. Source: http://www.obcina-grad.si/objava/59998

Vulcania, Saint-Ours, Auvergne, France

Webpage: http://www.vulcania.com

Vulcania theme park for exploring volcanoes and the planet Earth is a unique place to have fun and discover the secrets of volcanism. They have attraction named **Abyss explorer,** in which you can take part to explore the mysteries of underwater volcanoes. After a perilous and turbulent dive aboard the "Abyss Explorer" bathyscaphe, the expedition leaves you at a depth of 2,500 metres to discover amazing volcanic phenomena and the famous "black smokers". Projections, special effects and mapping on the rock walls immerse you in a strange world. On this dream-like voyage, you discover little known animal species that survive – and thrive – in the glacial and gloomy ocean depths.

Figure 26: Vulcania, Auvergne, France. Source: http://www.vulcania.com/en/animation/abyss-explorer/

Balaton-felvidéki National Park Directorate and its contracted geohike guides. Hungary. Bakony–Balaton UNESCO Global Geopark

Webpage: http://geopark.hu/

Illustrative tools used by geohike guides

Text: György Czibula

When guiding a group of visitors on a field trip or on a geohike, the guide has very little opportunities for illustration. Nevertheless, what's being told can easily be made understood, if the guide previously prepares for the hike with suitable tools. By this we mean to find adequate tools, methods or objects for illustration – evidently only with a size and weight that fits for a backpack. First of all, pictures. Many good quality pictures for aa certain topic can be found on the Internet, in our case volcanism. Moreover, the Balaton-felvidéki National Park Directorate, the geopark organisation, provides material for their contracted geohike guides (Geopark Partners), if required. The expectations are: relevancy, good quality, appropriate size and design (eg. waterproof cover) and mentioning of the source. Secondly, a guide may use rock samples. It is not often that the guide manages to find the necessary type of rock, which bears the characteristics and can be used as a demonstrative object of the subject to be interpreted, out in the field. For this reason the guide should carry well preserved rock samples with him/herself. These samples are ideal for showing different structures of volcanic rocks (eg. vesicular basalt) and consequent difference of density and weight; or the connection between the shape and the evolution of that piece of rock (a volcanic bomb – if not too heavy). Third, the guide may use extraordinary ways or methods of illustration, such as referring to famous pieces of fine arts (paintings, sculptures, etc.), or even use examples from literature (poems, romans, etc.). Reading a few lines from a book written by a famous author gives a colourful scene for the hike and brings the topic closer to the participants. Some internationally known examples: https://www.theguardian.com/artanddesign/gallery/2010/aug/01/art-volcano-warhol-turner. Of course, the national art gives many examples such as poems of the Hungarian poets Ady Endre (Jégpályán) or Székely Szabolcs (Vulkán). The metaphors of volcanoes often express intense feelings and emotions (hot-love, eruption-euphoria). Using body movements or group movement to express a volcanic eruption, the lava flow or of the timely distribution of volcanic eruptions eg. in Balaton Uplands is an entertaining way of involving the audience and create an effective, memorable interpretation method. A future tool could be to make a 'volcanic dance' where members of a group (eg. a class) would express patterns of volcanic activity with dancing and music performance.

Figure 27: Geohike guides in Bakony-Balaton UNESCO Global Geopark. Source: Bakony–Balaton UNESCO Geopark, Hungary. Photos: Barnabás Korbély

Hegyestű Geological Visitor Site, Bakony–Balaton UNESCO Global Geopark. Monoszló, Hungary.

Webpage: http://geopark.hu/

Information panel of the evolution of volcanic remnant hills

Text: György Czibula

The visitor centre was created in a former basalt quarry on Hegyestű Hill, which was closed decades ago. The quarry had cut the basalt volcanic remnant hill into half, which is now damaged landscape in the middle of the Balaton-felvidéki National Park and the Geopark, but at the same time it serves as an excellent opportunity to show the inside of a volcanic vent and the columnar basalt formations there. Moreover, from the clear top of the hill, a breath-taking panorama of the volcanic remnant hills opens. Looking around, almost the whole volcanic area of the Geopark is visible with the characteristic volcanic shapes and forms. Here a bilingual (HUN/ENG) information panel describes the formation of the specific shape of the basalt volcanic remnant hills. The age of different volcanoes and their elevation are shown as well. Looking at the figure referring to Hegyestű, almost the whole mountain has eroded since the first eruption, while others stand in an almost intact state. The figure highlights the direct link between erosion and geological time, moreover, it shows that in this case only the rocks formed in the vent stayed at its original place and that is why the columnar basalt formations are visible. This figure, printed on a waterproof laminated paper, is a great tool for geohike guides as well.

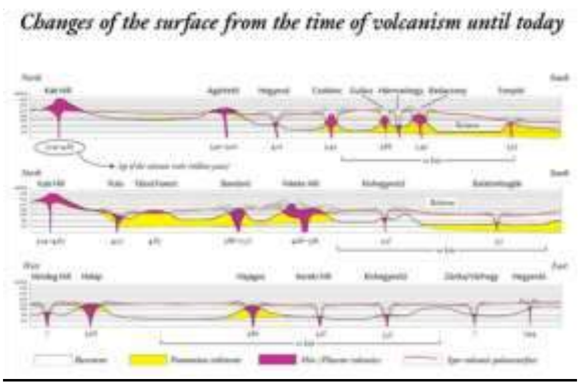


Figure 28: Information panel of the evolution of volcanic remnant hills. Source: Hegyestű Geological Visitor Site, Bakony–Balaton UNESCO Geopark. Monoszló, Hungary. Information panel: Balaton-felvidéki National Park Directorate.

Tapolca Lake Cave Visitor Centre, Bakony–Balaton UNESCO Global Geopark, Tapolca, Hungary.

Webpage: http://www.tavasbarlang.hu/index.php/en/

Model of volcanic remnant hills

Text: György Czibula

The visitor centre focuses mainly on karstic phenomena, though, in the “Geopark Room” there is a model of the evolution of a Pliocene basalt volcanic remnant hill (butte). It demonstrates what can hardly be understood by ordinary people (i.e.: those who have little background knowledge of earth sciences). The first and the second models show the formation of a maar volcano, a lava lake and a hopoka, while the third and the fourth models illustrate the evolution of an extinct volcano into a volcanic remnant hill (butte) by wind and water erosion. On the side of the models one can read information about the nature of the Pliocene basalt volcanic activity in the area in three languages (HUN/ENG/GER). Those, who participate in a geohike led by a Geopark Partner guide in the area (namely: Tapolcai Basin, where volcanic remnant hills dominate the landscape), have the opportunity to visit the visitor centre at a discount price, so the knowledge of volcanic remnant hills can be deepened and repeated. In the “Geopark Room” more information, such as general information on the geopark, timeline with paleogeographical environments, a rock identification game, etc., is available.

s. Directorate/Bakony–Balaton Unesco Geopark, Tapolca Lake Cave Visitor Centre. Tapolca, Hungary. Photos: Barnabás Korbély.

Lavender House Visitor Centre, Bakony–Balaton UNESCO Global Geopark, Tihany, Hungary

Webpage: https://www.bfnp.hu/en/lavender-house-visitor-centre-tihany

The visitor centre serves as the eastern gate of the Geopark and focuses on the volcanism of Tihany Peninsula. The name comes from the lavender cultivated here traditionally.

Text: György Czibula

1. Geyser and thermal spring simulator

In relation to volcanism, geysers are a typical post volcanic phenomena, and hot water springs (thermal springs) are also common for the public. The major differences between the two natural phenomena are described in an interactive way by the simulator. Turning on different functions, light effects show the way of the hot water up to the surface. Next to the figures bilingual (HUN/ENG), very detailed explanatory texts help to understand the functioning of the two natural phenomena. By means of this geointerpretation tool we hope to blow away the age long wrong theory that the characteristic thermal spring cones of Tihany Peninsula used to be geysers.

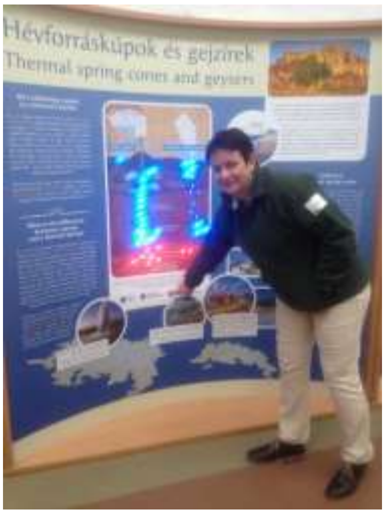


Figure 30: Geyse and thermal spring simulator in Lavander House Visitor Centre, Bakony-Balaton UNESCO Global Geopark, Hungary. Source: Balaton-felvidéki National Park Directorate/Bakony–Balaton Unesco Geopark, Lavender House Visitor Centre. Tihany, Hungary. Photos: Barnabás Korbély, Adél Varga

2. Model of a volcano

We often forget taking note of the fact that among the total number of visitors, young generation implies a significant share. For this reason the Lavender House Visitor Centre is equipped with a very simple and effective illustration tool. There is a relatively big model of a volcano, placed in its original paleogeographycal surroundings. The model is big enough to walk through its interior. Inside sound effects are played and the ground is almost shaking under the visitors' feet (because of the deep sound effects), just like when a real volcano is erupting. This tool attracts many children to the exhibition.

Figure 31: Model of a volcano in Lavander House Visitor Centre, Bakony-Balaton UNESCO Global Geopark, Hungary. Source: Balaton-felvidéki National Park Directorate/Bakony–Balaton Unesco Geopark, Lavender House Visitor Centre. Tihany, Hungary. Photos: Barnabás Korbély, Adél Varga

Volcano Nature Trail, Bakony–Balaton UNESCO Global Geopark, Mencshely, Halom Hill, Hungary.

Webpage: http://www.geopark.hu/en/

The nature trail runs through the former basalt quarry of Halom Hill, which gives an excellent opportunity to see the inside structure of a 4 million years old volcano. Besides the 16 information panels and the free guidebook, this nature trail is unique, because the core messages of it are “set into stone”!

Text: György Czibula

1. “Stone heaps”: 4 models of the volcano cut into half

Walking up to the mountain top, there are four models, which are cut into half to enable the visitors to see the inner structure and the evolution of a basalt volcano. These models show Halom Hill itself and were built up y using local, real rocks, so they are in a way reduced copies of the original mountain. Although visitors can enter the disused quarry, which opens up the interior of the hill, it is still hard to imagine for them how the different volcanic stages produced different types of rocks and different geomorphology during the active life of the volcano. This tool is durable, imaginative and a really efficient way of demonstrating how a volcano’s structure looks like, moreover, it meets the requirements of cost-effectiveness and sustainability, too. Designing this tool, there was a fear that the parts (pieces of rocks) of the installation may be taken away or may be damaged, but fortunately, after two years, they are still in place and the models are intact.

Figure 32: “Stone heaps”: 4 models of the volcano cut into half

2. “Stone map”: model of Lake Balaton and the volcanoes around it

Though on the top of the hill there is viewpoint (tower), this “stone map” interprets how Lake Balaton and the volcanic remnant hills are distributed in the landscape. For building up the volcanoes, the original material, i.e. basalt was used, and the volcanoes were placed next to each other to scale, just like on a real map. It is the visitor’s task to recognise them while looking around up in the viewpoint, seeing the real mountains and then looking down at the ground to the “Stone map” (the “Stone map” is visible on the ground neatly from the tower). To check your knowledge, the volcanoes are named with a label on the model itself, too. This setting can be connected excellently with the “stone wall” timeline, which is discussed below.

Figure 33: “Stone map”: model of Lake Balaton and the volcanoes around it

3. “Stone wall”: timeline of the volcanic activity in the area

This stone timeline is built on a wall to display the age of the 37 volcanoes in the area. These volcanoes were active in the late Miocene and in the Pliocene, so the scale begins 9 Million years ago (Tihany) and ends 2,5 Million years ago (Kopácsi Hill). It is unnecessary for the visitors to give the exact age of a volcano (e.g. 2,51 Million years in the case of the Kopácsi Hill). For this reason the scale of the timeline is 0,5 Million years. The goal of this interpretive tool is rather to give an overview of the volcanic activity of the area and to show how the volcanoes' ages are related to each other. Moreover, in some cases, there is a significant uncertainty due to lack of research in respect of the exact ages of the volcanoes. The “Stone wall” and the “Stone map” are placed next to each other so they may help setting the volcanic activity of the area in space and time. Visiting the place with a guided group, if every visitor choses a volcano on the “Stone map” (sits on it) and the guide reads the volcanoes' name on the “Stone wall”, those, who hear their volcano, may stand up (“erupt”), so the volcanic activity is illustrated by timeliness and by spatiality.

Figure 34: “Stone wall”: timeline of the volcanic activity in the area, Source: Balaton-felvidéki National Park Directorate/Bakony–Balaton Unesco Geopark, Volcano Nature Trail. Mencshely, Hungary. Photo: Melinda Pardi, Julianna Gáborné Sárdy, Zoltán Sipőcz, János Futó

Nógrád–Novohrad UNESCO Global Geopark (NNGP), Hungary

Webpage: http://www.nogradgeopark.eu/

1. Nógrád–Novohrad Geopark Head Office, Eresztvény/portable volcano model

The first demonstrative tools of volcanism were definitely the volcano models. The problem of an average model is that transport is too complicated because of the weight and the size. What if the model is portable? Let's make it little enough (but still make the characteristic features visible), and let's make it light enough (but still keeping the appearance meaningful). Colleagues at NNGP solved this double problem and came out with the result: a model that can be taken almost everywhere at any circumstances. Schools, kindergartens and many events outside the head office welcome this spectacular tool with great satisfaction.

Figure 35: Nógrád–Novohrad Geopark Head Office, Eresztvény/portable volcano model

Pannon Sea Museum, Geology and Natural History Exhibition of Herman Ottó Museum, Miskolc, Hungary

Webpage: http://pannontenger.hu/en/

The museum consists of two exhibitions: Minerals of the Carpathians and On trails of primitive forests. The latter one concentrates on the formation of the Pannonian Basin and the Miocene volcanism in the area.

Volcano simulator of Nagy Kopasz Hill, Tokaj

This tool is much more than a simple scale model of a volcano. The simulator is placed in its original paleogeographic environment in the Miocene epoch. The background of the model is a lifelike painting of 12 Million years ago, when the water body of the Pannon Sea coast girdled a volcanic mountain range, which in some parts are today's North Hungarian Mountains. Above the shallow water, hot volcanoes were towering and the swampy coast was indented by many islands, peninsulas and bays. By turning the simulator on, volcanic activity 12 Million years ago can be revived and the events going on in the magma chamber and in the vent are visible. During the approx. 1 minute long virtual eruption sound effects are being played, recorded at real volcanic eruptions. The magma chamber, the upward movement of the lava in the vent and in the functioning of the adventive craters can be seen by lighting up the different parts of the inner structure. The formation of the volcano, the eruption itself and the description of the layers of the bedded volcano can be read on two a panels next to the simulator. The simulator and the panels are both bilingual (HUN/ENG).

Kemenes Vulcano Park, Celldömölk, Hungary

Webpage: http://www.kemenesvulkanpark.hu/en

Text: György Czibula

The visitor centre is an outstanding collection of interactive tools about volcanism in Hungary. It is placed right next to Ság Hill, where a quarry cut off the upper and the inner part of a 5 million years old basalt volcano. Thanks to this the inner structure of the volcano became visible and gave the idea of such a visitor centre, which is located at the foot of the hill. The visitors can explore the building on its five levels, helped by HUN/ENG/GER labels and explanations.

1. Phreatomagmatic eruption simulator

Turning on the simulator, the process of the phreatomagmatic explosive eruption is visible and the most important features are visible. The eruption itself builds and at the same time destroys the surroundings. The main factor, namely that volcanic ash dispersion builds up layers of volcanic material, can be seen purely. The volcanic ash is substituted by sand in the simulator. Ordinary people often link volcanoes only with effusive eruptions (lava flows, etc.), while on Earth's surface phreatomagmatic explosive eruption materials (tuffs, volcanic ashes and pyroclastic materials) are much more common and can be blown away by the wind thousand kilometres far from the eruption centres. The layers, depending on the power of the eruption and the distance from the crater, may vary from millimetres up to even 100 metres. The impetuosity of the simulator shows this process

Figure 36: Freatomagmatic eruption simulator. Kemenes Vulcano Park, Celldömölk, Hungary, Author: György Czibula

2. Models of lava types

Seeing pictures about the different basalt lava types or talking about them is sometimes misleading and gives false ideas to visitors. For this reason, in one of the rooms, there are lifelike imitations of two interesting lava types: aa lava and pahoehoe lava, each about 1 square metres in size. Even the names (which derive from Hawaiian local language) are bizarre for the first hearing, so as the possibility to touch them! Aa lava (rubbly, rough surface) can only be touched, while visitors are permitted even to step on a piece of pahoehoe lava (soft surface). The full contact of the two very different surfaces give a long lasting memory of the characteristics of the different basalt lava types.

Figure 37: Model of lava types. Kemenes Vulcano Park, Celldömölk, Hungary, Author: György Czibula

3. Simulations of volcanic processes

On a touchscreen visitors are able to start real and modelled videos of volcano lives, like magma chamber processes, the movement of the lava flows, simulation (2D, 3D) and real shots (Mount St. Helens, 1980) of freatomagmatic eruptions, the expansion of the eruption column, erosion of volcanic cones, etc. These processes are difficult or impossible to witness in reality. In this way visitors are given a complete perspective of how a volcano is functioning and at the same time the threats and the unpredictability can be witnessed.

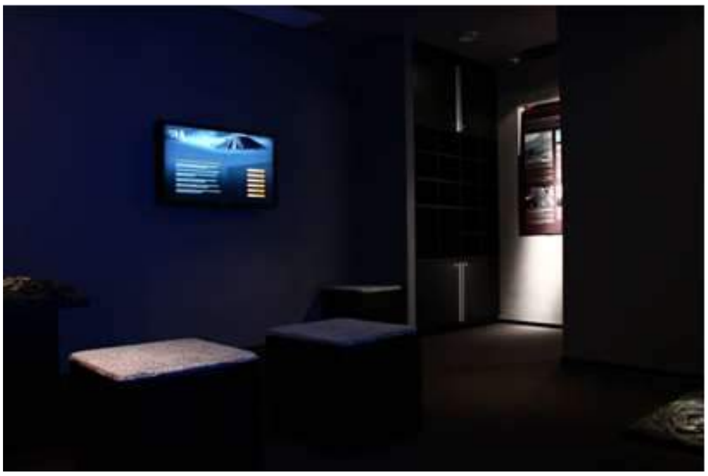


Figure 38: Simulations of volcanic processes. Kemenes Vulcano Park, Celldömölk, Hungary, Author: György Czibula

4. Models of volcano types

Six major types of idealized volcanoes are displayed by professionally detailed and accurate relief models on a table. Six infographic panels are placed above them showing characteristic points (volcanoes) from all over the World. This virtual travel to remote places and breath-taking landscapes brings visitors' notions to life while showing them the diversity of Planet Earth's volcanic areas and its varied surfaces.

1. Cinder cone (Monti Silvestri, Etna)
2. Tuff ring (Diamond Head, Hawaii)
3. Fissure vent (Laki, Iceland)
4. Shield volcano (Mauna Kea, Hawaii)
5. Lava dome row (Mondo Craters, California)
6. Bedded volcano (Mayon, The Philippines)

Figure 39: Models of volcano types. Kemenes Vulcano Park, Celldömölk, Hungary, Author: György Czibula

The House of Volcanoes, Hateg Country Dinosaurs UNESCO Global Geopark, Densus, Romania

Webpage: http://www.hateggeoparc.ro/

The House of Volcanoes is a building made of earth, which tells the story of Earth. It is an interpretation and education point of the Hateg Country Dinosaurs Geopark, UNESCO Global Geopark. Its main interpretation theme is ancient volcanoes from the Cretaceous, because the very hill it stands on is made of volcanic rocks. The secondary themes are Earth's structure, geological time, tectonics and dinosaurs. The interpretation techniques used are interactive, volcanism is shown as an energy transformation from heat to mechanical energy. The visitors experiment this by transforming their own energy into light using a dynamo.

The frame and the box (see figure 40) are two of the educational elements around the House of Volcanoes.

- The frames are spread all around the orchard, it is an art exhibition for the best artist - Earth/Nature, called Image and Imagination. During some of the programs participants are asked to put their own frames somewhere to underline what is behind as art.

- The box is called Young Paleontologist's Box, it has inside fossils, bioglifs and all sorts of ancient traces of life that the visitors have to dig up. They have an educational kit with tools to dig and to measure what they find and then they write the results in their explorers' guide.

The House of Volcanoes was built entirely by the Volunteers of the Geopark in 2014 and have continuously improved it since then. The actual construction is an ecological cob house, made to look like a volcano. Since 2017 educational programs have been available here. This project is an innovative approach because it follows the Geopark's strategy to involve the community at every level of decision. So, the whole project was made by the community: the volunteers, the local school and people from Densus village. I this way the interpretation point is not considered an implant, but something that belongs to the community and that is proudly shown to visitors and friends.

Figure 40: The House of Volcanoes, Hateg Country Dinosaurs UNESCO Global Geopark, Densus, Romania. Source: Hateg Country Dinosaurs UNESCO Global Geopark, Romania text: Hateg Country Dinosaurs UNESCO Global Geopark photos: Hateg Country Dinosaurs UNESCO Global Geopark archive

Interpretation point Smrekovec – extinct giant – Karavanke UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at/en/home.html

The interpretation point Smrekovec reveals the geological story of Slovenia's only volcanic mountain range. It educates about volcanoes in general and aims to awaken respect for nature and the people who used to live here in difficult conditions. It is located in the immediate vicinity of the mountain lodge on Smrekovec. The purpose of the point is to present the peculiarities and features of Smrekovec in a funny and educational way. Here you can clearly see that 23 million years ago a volcano erupted under the sea. This volcanic eruption can be viewed in a short movie. Volcanic rock is omnipresent on the Smrekovec. The colourful rock structure offered special conditions for the emergence of life in this place. At the info point you can test the knowledge about the most different tree species, recognize the difference between spruce and fir and determine the age of the trees. For inquisitive visitors, a touch screen is set up at the info point, which provides numerous and detailed information about the geological origin, structure and history of the area as well as about the life of the locals and about the diverse natural environment. The info point Smrekovec is a polygon where it is possible to find out something new in a playful way. The place also perfect as a nature class or just as a resting place after a hike. There will be something interesting for every visitor! Welcome to the Smrekovec, where the story of the extinct giant can be experienced at first hand!

Figure 41: Interpretation point Smrekovec – extinct giant – Karavanke UNESCO Global Geopark, Austria/Slovenia, Copyright Karavanke UNESCO Global Geopark

Lessons learned/tips

- Gestures, tone of voice and expressive words that describe an eruption, its magnitude and the events that accompanied it, can make the explanation much more interesting, more fun and more memorable for the visitors;
- objects that can be weighed, touched, kept in hand are memorable elements of interpretation: involving as many senses as possible makes the interpretation more effective;
- interpretation has to start with basic, known facts that can be used as a starting points to understand further facts – depending on the audience of a guided tour. Here it is especially important to think about what this basic knowledge is when we interpret for a foreign group or for children;
- length and style of the interpretive texts needs to be less academic, easily understandable (everyday language), relatively short, but still correct, not oversimplifying in content;
- involvement of the audience is very important, either by interactive elements that result in capturing attention and letting the visitor explore the topic, or (e.g. during a hike) by addressing the participants with questions by which they can relate themselves (their everyday life or their individual experience) to the topic, or creating an emotional link between individuals and the topic;
- an attitude of the interpreter that allows questions and implies that not everything is known about the interpreted topic can make the interpretation

more interesting and memorable, because the communication process is more of a dialogue type and not simply providing information on the topic;
- The interpreter's personal experience and his/her positive attitude to the topic shown to the audience largely influences the success of sending the message to the audience;

Exhibitions interpretation possibilities:
- ideally, interpretation is carried out at exhibitions on two levels: for children and for adults, with different approaches;
- one main message, that leads the visitor through the exhibition or the guided tour, helps to keep the messages in unity and helps visitors to go home remembering the most important and main message of the site.

Literature[27]

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- Barnabás Korbély, József Vers: Geyser Field (inerpretive board on the Lóczy Nature Trail, Tihany)

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- http://www.heritageinterp.com/whatis.htm

4.3. Output 3: Geological challenge Geohazards

Prepared by Bohemian Paradise UNESCO Global Geopark, Czech Republic
Edited by Karavanke/Karawanken UNESCO Global Geopark

Definition of specific challenge

The term geohazard is used for natural disasters connected with processes taking place in rock environment of the Earth. Up to the present, 45 different geological processes are considered as geohazards. These processes can be divided into several categories:

- (Submarine) Landslides
- Debris flows
- Shallow gas accumulation
- Overpressured zones (including gas and shallow water flows)
- Naturally occurring gas hydrates and their climate-controlled meta-stability
- Mud flows, diapirism and volcanism/volcanoes
- Flood basalt
- Earthquakes and seismicity
- Tsunamis from tectonics and landslides
- Slope instabilities

Because of Bohemian Paradise UGG location (inland, no active volcanism,…) we decided to focus on interpretation of several slope instabilities.

In general, slope instabilities arise by disruption of slope stability caused by gravity, centre of mass in motion performs trajectory down the slope. Slope movements are very diverse geodynamic processes. Their occurrence and development is caused by local natural conditions (slope inclination, geologic and climatic conditions) and sometimes also by human activity (relief change, hydrologic change,…). Result of slope movement (process) is slope deformation (form).

According to movement mechanism and its speed, we identify 4 basic groups of slope movements:

I. creeping
II. sliding
III. flowing
IV. falling

I. Creeping

Creeping is, from geological point of view, long-term, very slow (in millimetres per year), mostly non-accelerating movement of land masses. Movement distance comparing to mass moved is insignificant. In a case this movement accelerates (because of various factors – climatic, anthropogenic), it changes into sliding or flowing. Creeping can become initial phase of sliding, flowing or even falling.

Creeping is hard to observe and determine, but the most distributed kind of slope movement in Czech Republic.

II. Sliding

Sliding is short-term, relatively quick (in centimetres, even metres per day) sliding movement along one or more slip surfaces. Typically, part of the slided mass overlay original terrain in the front.

III. Flowing

Flowing is short-term, very quick (in kilometres per hour) movement of land masses in viscous state. Substantial mass flows from initial area and moves on the surface for very long distances. Flowing masses are strongly separated from intact bedrock. In its terminal phase, flowing can change to creeping. Flowing is connected to extreme rainfalls, combined with suitable geologic and geomorphologic conditions.

IV. Falling

Falling is nearly instant, very quick movement of rock masses in steep slopes. During this movement, falling masses lose their contact with surface for a short time (free fall). Before the falling movement, sliding or creeping can occur. Movement distance comparing to mass moved is significant. This phenomenon is typical in sandstone areas.

The geological background of the Pilot area

The geological structure of Bohemian Paradise is a product of various processes. At first, upper Palaeozoic Variscian (Hercynian) Orogeny uplifted metamorphed sediments from the bottom of the sea. The material from this elevation together with basalt volcanics filled intra-mountainous and piedmont basins. Nowadays, these areas are rich deposits of petrified remnants of fauna and flora, and also of precious stone varieties of quartz and non-iron ores. During the Cretaceous period, lowering of part of the area caused its covering by shallow sea. This process led to creation of several hundred meters thick layer of sediments. Because of gravity, erosion and weathering, these sediments became the basis of famous sandstone rock-towns. Tertiary volcanism created many fascinating elevations with interesting geosities. Last eruption took place approx. 5 Ma.

Possible methods for geo-interpretation of geological challenge geohazards

In general, there are several methods which are used for interpretation of geological heritage and can be divided into 2 basic categories:

I. verbal
II. multi-medial

I. Verbal method of geohazard interpretation

The easiest way to interpret geohazards is to add necessary information to verbal presentations or lectures of geoguides. Although this method does not require any additional tools and is therefore very cheap, it requires very skilled guides who are able to explain complex geological processes by using the words. Nevertheless, it also requires certain level of imagination of audience, which is very hard to influence. As old Romans said, *Verba docent, exempla trahunt*, it is much easier to accompany the "dry" speech with examples, pictures, movies, etc. thus using any of multi-media to help the audience to imagine and understand the explained topic better.

Figure 42: Guided trip, verbal presentation, Copyright Bohemian Paradise UNESCO Global Geopark

II. Multi-media

As stated earlier, it is much more effective to support the lecture with different media. When interpreting geohazards, the easiest way is to use photographs, schematics, cross-sections, etc. to show the audience the course of explained phenomenon. It is sometimes said that one picture is more than a thousand of words, and in a case of interpretation of geohazards, these words are more than true.

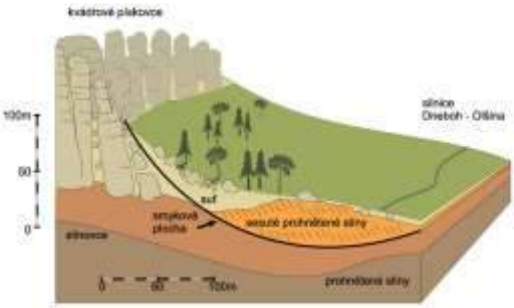


Figure 43: Cross-section explaining a huge landslide from Bohemian Paradise, Dneboh 1926 Copyright Bohemian Paradise UNESCO Global Geopark

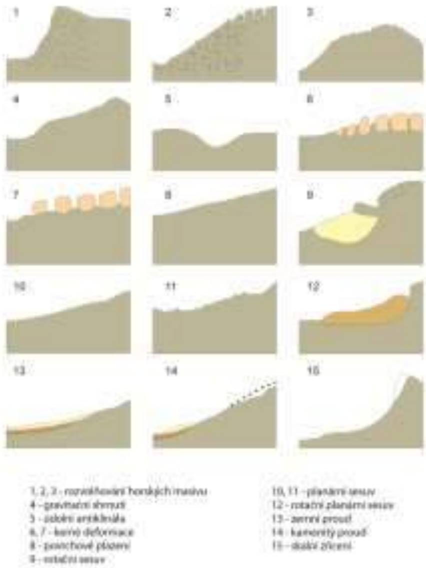


Figure 44: Examples of different slope movements, schematics Copyright Bohemian Paradise UNESCO Global Geopark

To make the speech more interesting for the audience, examples of similar processes from our past can also be added.

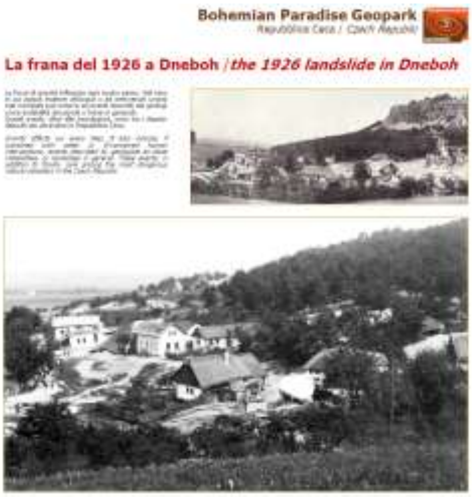


Figure 45: Poster dedicated to Dneboh landslide with photographs of the event results. Copyright Bohemian Paradise UNESCO Global Geopark

In our search of the best method of geohazard interpretation, we try to furher and give the visitors something more than only pictures – the moving pictures, i. e. animations of aforementioned phenomena. We developed set of digital animations showing much more information than single, still pictures. Animation can show the initial state, course of the event and the result in simple, understandable way.

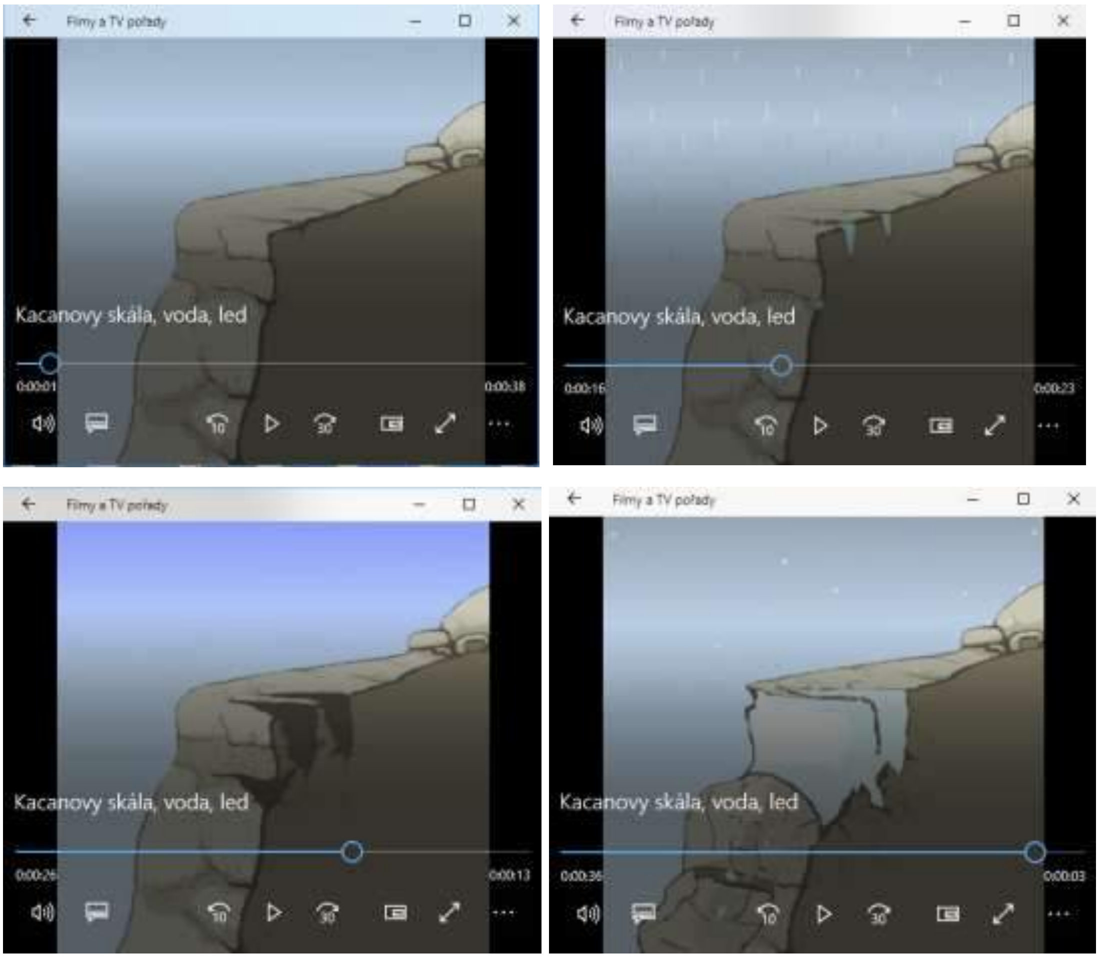


Figure 46: Stills from animation explaining causes of rock falling, Copyright Bohemian Paradise UNESCO Global Geopark

As the time passes, we want to get our way of geohazard interpretation to the next level and use the latest technology for explaining such a difficult topic – the augmented reality. Using the mobile information technologies, augmented reality adds information right into “our” reality. Visitors will be able become a part of the event itself, to see the course of these dramatic phenomena from safe and much easier understand the causes and consequences.

Since the interpretation of geohazards is still relatively new topic world-wide, the examples are very rare or do even not exist. Usage of augmented reality for geointerpretation is in its foundations and as far as we know, nobody has used it for explanation of geohazards until now. From this point of view usage of augmented reality in interpretation of geohazards is truly innovative.

Best practices from partners and abroad

Seismic table simulator - Natural history museum of the Lesvos Petrified forest, Lesvos island UNESCO Global Geopark , Greece

Webpage: http://www.lesvosmuseum.gr/site/home/ws.csp?loc=en_US, http://www.lesvosgeopark.gr/en/lesvos-geopark/

The 2-hour programme, addressed to basic and secondary educational level, includes a presentation on the causes of earthquakes, the ways the seismic waves travel through the Earth and the catastrophic effects they might have. Subsequently, the children visit the Museum's exhibition hall, where they can visualise the movements of the Earth's crust and their link with the generation of earthquakes through interactive models. A real seismometer records the waves they produce on the ground while walking, while screens show the recordings of the seismographs in Sigri and the University of Thessaloniki in real time.

The highlight of the programme, without any doubt, is the seismic table installation of the Museum. The installation, turned into a school-class, can simulate the seismic movement of some of the most destructive earthquakes in the recent years. Children can sit at their desks and feel the tremors the people of Cobe, Japan, felt on 17th January 1995, or of Gujarat, India, on 26th January 2001. This activity aims to the familiarisation of the children with the right behaviour during and right after an earthquake, since they can practise what they learn during the programme in a perfectly safe environment.

Figure 47: Seismic table simulator - Natural history museum of the Lesvos petrified forest, Lesvos island UNESCO Global Geopark, Source: http://www.europeangeoparks.org/?p=2097

Exhibition Earthquake: Life on a Dynamic Planet, California academy of sciences, United States of America

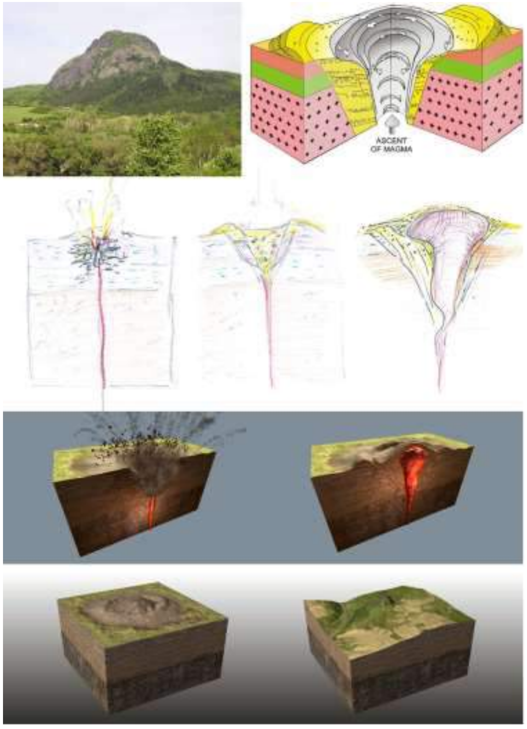
Webpage: https://www.calacademy.org/exhibits/earthquake-life-on-a-dynamic-planet

Visitors can take a kinetic journey through seismic phenomena and explore how they fit into Earth's geologic history. They can also walk through the center of our planet and brave the infamous Shake House. Among large-scale installations are a walk-through model of planet Earth, an earthquake simulator resembling an old Victorian home and an interactive space that teaches earthquake preparedness. In the Shake House visitors can experience the sustained tremors of San Francisco's two biggest quakes—the 6.9-magnitude Loma Prieta earthquake and the 7.9-magnitude Great San Francisco quake of 1906—from inside the dining room of a Victorian-era "Painted Lady" house.

Figure 48: Exhibition Earthquake: Life on a Dynamic Planet, California academy of sciences, United States of America, Source: https://www.calacademy.org/exhibits/earthquake-life-on-a-dynamic-planet

Application of Modern Technologies in Popularization of the Czech Volcanic Geoheritage

Four volcanic geoheritage sites in the Czech Republic were selected to showcase new technologies for communicating the recent results of scientific research to a wider nonprofessional public. The selected volcanic sites are scoria cones with late intrusive plugs, phonolite lava-dome erupted within a maar crater, phonolite laccolith, and a nested group of monogenetic volcanoes of Oligocene to Miocene age. The available scientific results from each volcanic site were summarized and transformed into images (playscreen) used for the 3D animation. The identical sources used for 3D animations were also used for generation of virtual models of augmented reality. The outcomes were tested on school children and the results indicate that the modern methods applied in popularization of volcanic geoheritage are highly attractive for the youngest generation and have a potential to bring more interest in Earth Sciences. Using such techniques makes the communication of geoheritage to the public more effective. Bohemian Paradise UNESCO Global Geopark wants to develop this method or application for further geointerpretation of geohazards.



Processing and shots from the Bořeň volcano animation: a view of Bořeň Hill from the west; b scientific interpretation model of the Bořeň volcano (from Závada et al. 2011); c examples of graphical sketches prepared by scientist for the animator; d–g screen captures of the animation sequence: d phase 1—phreatomagmatic eruption producing a maar crater; e intrusion of phonolitic magma into the diatreme; f surface morphology of the volcano with tuff-ring and phonolitic cryptodome; g present-day morphology of the Bořeň volcano at the end of animation (LiDAR-based digital elevation model combined with airborne photograph). The entire animation can be seen at https://www.youtube.com/watch?v=2aAoBE7uG_g&feature=youtu.be

Figure 49: Application of Modern Technologies in Popularization of the Czech Volcanic Geoheritage, Source: Geoheritage, DOI 10.1007/s12371-016-0208-x

Lessons learned and tips

- Good interpretation plan is a must.
- Illustrative and demonstrative interpretation methods help to understand better and easier.
- Active participation of visitors can not only enhance their experience but also helps them to remember important facts more easily.
- Interpretation of geohazards is still in its beginnings worldwide.
- Usage of modern technologies such as augmented reality in interpretation of geohazards is truly innovative.

4.4. Output 4: Geological challenge Geology over time

Prepared by Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia

Definition of specific challenge

Geologic time is the study and interpretation of Earth‘s past. By looking at a cross-section of land or an outcrop, we can gain evidence about how it was formed. It is like solving a puzzle. By the definition of American Heritage Dictionary geologic time is the period of time covering the physical formation and development of Earth, especially the period prior to human history. By the American Heritage Student Science Dictionary geologic time is the period of time covering the formation and development of the Earth, from about 4.6 billion years ago till today. The geological timescale and the processes that occur over a very long period of time often millions of years. Each geological period describes a particular, major event that is thought to have happened at that time. The Earth is thought to be 4,600 million years old. Life is believed to have become dominant on earth 542 million years ago. The geological periods relate to events which have happened in the Earth's history. For example, during the carboniferous period there were tropical weather conditions in the UK and coal and limestone were formed. The most recent period in geological time is called the quaternary, when the Ice Age occurred. Rocks are formed at different times and are a result of the environment present during that time. For example, chalk is formed in the cretaceous period, as this is when warm tropical seas were present around the shores of the UK.

The geological background of the Pilot area

The Karavanke/Karawanken Mountains (K. Mts) are built up of exceptionally varying sedimentary, igneous and metamorphic rocks from Ordovician to Miocene in age, which were formed during late Caledonian, Variscian and Alpine orogeny cycles in the time span of more than 450 million years. The prevailing area of the GeoPark has been formed by a succession of sediments originating from a carbonate platform of southern margins of the Palaeozoic Palaeo-Tethys Ocean and the successive Mesozoic Neo-Tethys Ocean. Mostly shallow water platform carbonate sediments now belong to the upper part of the Adriatic micro-continental plate, which was in the time of sedimentation still attached to the northern part of a larger African continental plate, but it is now far away.

Possible methods for geo-interpretation of geological challenge geology over time

Since its establishment the Karavanke/Karawanken UNESCO Global Geopark used different kinds of methods in geointerpretation for the geological challenge “Geology over time”. The aim is to use very simple methods of geointerpretation: very simple technologies and presentation tools in visitor centres and simple verbal communication in thematic hiking tours. To summarize – the following interpretation methods are used in Karavanke/Karawanken UNESCO Global:

People-based/personal interpretation

• Guided tours;

• workshops for children;

• story telling - performances.

Non-personal /design-based interpretation

• Brochures & pamphlets;

• booklets & books;

• audio-visual equipment;

• panels & signage;

• informations and visitor centres;

• info points.

Best practices from partners and abroad

First, some best practices examples in interpreting Geolgical time within Karavanke/Karawanken UNESCO Global Geopark are presented. Furtheron, best practices from partner geoparks and also otuside the partnership are described.

Hiking tour "Hike to the seabed", Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at/en/home.html

Example of people-based/personal interpretation is **hiking tour "Hike to the seabed"**, where the Geology over time is interpreted. Together with participants we explore, how old are rocks were formed and when they were formed. We explore different rock layers. We also play different games and experiments to the Geotime theme. Games and experiments are adapted to different target groups.

Figure 50: Hiking tour in the Karavanke/Karawanken UNESCO Global Geopark - "Hike to the seabed", Copyright Geopark Karavanke

Lavamünd Geopath, Karavanke UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at/en/hiking-and-trekking/geopaths/the-lavamnd-geopath.html

Furthermore along the **Lavamünd Geopath (Austrian side)**, the history of the Earth from Devon to the Quaternary can be discovered. Visitors can learn about the rocks of former mountain ranges, about deposits of the first Alpine layers, as well as about the shaping of the landscape that is visible now. Detailed explanations on what can be seen in the local rocks over the landscape of Carinthia in earlier geological eras are available. Visitors travel together with our guide through 500 million years of geology, flora and fauna, from the Earth formation to its first people. For the explanation the special equipment such as clock is used, where one hour presents approx. 400 millions years. Guides also encourage visitors to participate and to think with him/her. First story telling is used, later on various questions such as what visitors think about the age of different stones and about the events in individual geological periods. The panels in the last station provide an overview of the developments in the Alps after their folding and rising.

Figure 51: Lavamünd Geopath in the Karavanke/Karawanken UNESCO Global Geopark, Copyright Geopark Karavanke

Interpretation point TIC Topla, Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at/en/information-centres-and-museums/information-points/the-topla-info-point-are-you-in-africa-or-in-europe.html

Geology over time is also presented at the **Interpretation point TIC Topla (Slovenian side),** where different interpretation tables can be found. The geological periods are presented on panels, made out of concrete. Here Geopark also offers workshops for children groups, schools and kindergartens.

Figure 52: Interpretation point TIC Topla in the Karavanke/Karawanken UNESCO Global Geopark, Copyright Geoprk Karavanke

Children's book "Geological treasures of the Geopark Karavanke"

Webpage: http://www.geopark-karawanken.at/en/home.html

We also published the book for children titled "Geological treasures of the Geopark Karavanke". It includes very interesting and easy to understand geological time scale with illustrations.

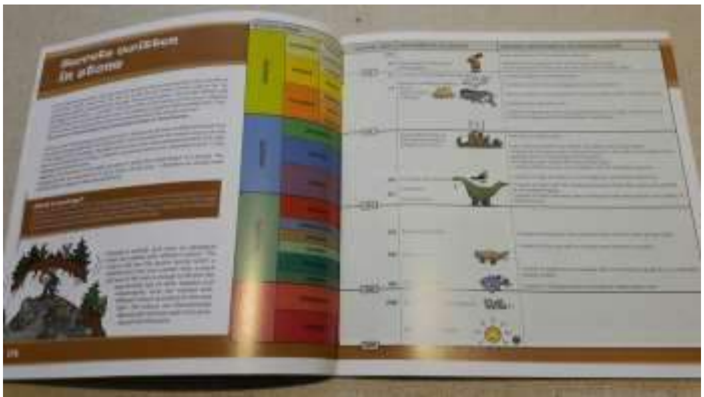


Figure 53: "Geological treasures of the Geopark Karavanke" book, Copyright Geopark Karavanke

Visitor centre World of geology, Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at/en/information-centres-and-museums/information-centres/the-geopark-karavanke-information-centre-world-of-geology-in-bad-eisenkappel.html

The highlight for the interpretation of geology over time is the Karavanke/Karawanken UNESCO Global Geopark visitor centre “World of geology” and its interpretation tool Geoclock. It shows the entire creation and evolution of the planet Earth through animation. The entire Geopark Information Centre is particularly suitable for school groups and groups of children. These can experience a special children’s tour, as well as use different playful applications for a better understanding of the Geopark Karavanke and its treasures. For adults we use more detailed explanation and for children easy to understand language. We also encourage visitors to participate and to “think with us”.

Figure 54: Geological clock in the Karavanke/Karawanken UNESCO Global Geopark, Copyright Geopark Karavanke

Here we want to present some good practices for interpretation of geological challenge “Geology over time” from partners in Danube GeoTour project, other Geoparks in European Geopark Network and abroad.

Family Geotime Trail, English Riviera UNESCO Global Geopark, Tourqay

Webpage: http://www.englishrivierageopark.org.uk/

A very interesting and attractive geo trail. The visitor can explore history of our planet and its 4.600 million year long history. The Geopark did a map with periods of geological time and instructions for family geotime trail. The visitors use the map to find the markers fixed on the outside of buildings through the town. There are 12 to find and they all show a different creature, one for each period of geological time. The fun starts at the geoplay park (photo below) and the first marker is on the building located closest to the Geology park.

Figure 55: Family Geotime Trail, English Riviera UNESCO Global Geopark, Tourqay. Source: http://www.englishrivierageopark.org.uk/, http://www.severnstudios.co.uk/english-riviera-geopark-trails/

Geology park in St. Martin near Lofer, Austria

Webpage: https://www.lofer.com/en/things-to-do-in-summer/hiking/adventure-paths/

In the geology park in St.Martin near Lofer, parents and children travel back in time through millions of years of geological history. On the all-year walkable adventure trail you will find traces of the ancient seas, interesting facts about mountain formation and information on the violence of the glaciers of the last ice age.

At the three stations you will learn more about the ice age, find a boulder with large fossilized shells, so-called "megalodons", and the atmosphere of the stand, which was a completely different one over 250 million years ago. These 3 stations are equipped with information panels, which represent a good example of info panels, because there are a lot of pictures. One also conatins a steering wheel for better imagination of the theme “traveling into the past”.

Figure 56: Geology park in St. Martin near Lofer, Austria. Copyright salzburger-saalachtal.com/sommerurlaub/erlebniswanderwege/geologiepark

Playground »Among rocks and flowers at Hleviše Hill«, Idrija UNESCO Global Geopark

Webpage: http://www.geopark-idrija.si/si/

At the playground »Among rocks and flowers at Hleviše Hill« one can find almost all rocks of »Idrijsko« area. Playground equipment is arranged in the circle - carboniferous rocks are built in the rock garden, middle and upper Permian rocks form labyrinth, lower and middle Triassic rocks are foot stepping stones, upper Triassic rocks are a part of »ristanc« or »tančula« game (Hopscotch), the solar clock is made out of Jurassic rocks, cretaceous and Flysch rocks built »little man« figures.

Detailed stratigraphic column of »Idrijsko« is represented on the panel, together with »Idrijsko« rocks through the geological time and timeline back to the »Big bang« event.

One circle of the playground represent the time since the carboniferous, i.e. approx. 340 million years; if somenone wants to go back to the beginning (back to the »Big bang«), he has to circle 38-times around the playground!

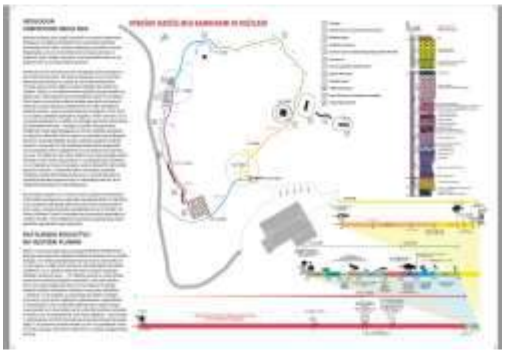



Figure 57: Playground »Among rocks and flowers at Hleviše Hill«, Idrija UNESCO Global Geopark, Copyright Idrija UNESCO Global Geopark

Game „JOURNEY THROUGH THE TIME“- Slovenian Museum of Natural History (Ljubljana), Slovenia

Webpage: http://www.pms-lj.si/si/izdelek/potovanje-skozi-cas?id=495

Journey through the time is an interactive publication for children aged 3 and more. The leaflet is more than 3.5 meters long and represents the history of life on planet Earth in the last 600 million years. Some unusual creatures are presented, as well as some of the most important events in our planet history. The story is explained by Professor Florjan Umek, who is a mascot of the children's programs in Slovenian Museum of Natural History (Ljubljana).

Description of the story: After many years of research and several unsuccessful attempts, the professor finally invented a time machine and went on a journey to the past. On this journey he observed the changing of our planet - he saw the continental movements, felt the climatic changes, and experienced all terrible catastrophes that devastated the life on Earth. He was a witness of life development - from tiny single-celled organisms to more complex animals and plants. He met very unusual creatures; some of them were small as a grain of bean, some of them were long as three buses. He saw terrible predators, tame herbivores and admired the development of plants. He ran away from the predatory dinosaurs and sometimes he sat under the high tree-ferns. When he returned back to the present, he wrote down all his findings and interesting facts in the travel diary. This travel diary is published on the other side of the timeline. Players can read about these interesting facts also along the timeline.

The interactive publication Journey through the time also includes playing cards so that players of all ages can test their knowledge and play along the timeline.

Figure 58: Game „JOURNEY THROUGH THE TIME“- Slovenian Museum of Natural History (Ljubljana), Slovenia. Copyright http://www.pms-lj.si/si/izdelek/potovanje-skozi-cas?id=495 Photo: Danijela Modrej

Odsherred UNESCO Global Geopark, Denmark

Webpage: http://www.geoparkodsherred.dk/odsherred/rejs-i-tiden-med-vores-app; https://www.youtube.com/watch?v=E2bF7jRC9h4

Text: Frantisek Janke

Make a journey through time in Geopark Odsherred. The view from the highest point in Geopark Odsherred has been reconstructed as four "hits" over a period of 25,000 years with the help of magnificent 3D graphics and augmented reality. Technology supplements reality by combining the physical setting with a 3D universe.

You can make the journey through time anywhere you like, even at home in your sofa, as long as you are able turn your device through 360 degrees. You'll get the best experience, though, from the Bronze Age burial mounds Vejrhøj, 121 metres above sea level, GPS: N55°47'35.49", E11°23'45.76" and Esterhøj, 89 metres above sea level, GPS: N55°50'10", E11°29'3". From here you can compare the landscape as you see it today with the view through thousands of years:

- 25,000 years ago – This is what the place looked like when the Vejrhøj Arch was formed
- 17,000 years ago – The Ice Age reigns in Odsherred
- 7,000 years ago – Odsherred is an island realm
- 100 years ago – Man makes his mark on the landscape

Infospots within the four 3D universes provide answers to questions you might have about various periods.

The app also features a map with the addresses and GPS coordinates you need to find your way in the landscape on your hunt for exciting locations of geological interest, which are often places of the greatest scenic beauty. The map shows car parks with Geopark information signs, great places to set off on a walk or bike ride in Geopark Odsherred. The more you know about the landscapes, the richer your experience of the countryside will be.

Figure 59: 3D technology in Odsherred UNESCO Global Geopark, Source: University of Presov

Pannon Sea Museum, Geology and Natural History Exhibition of Herman Ottó Museum, Miskolc, Hungary

Webpage: http://pannontenger.hu/en/

Live timeline of Earth's history

Text: György Czibula

The timeline is 18 metres long. It is made live by the 5 round windows in which 4 characteristic paleogeographic environments can be rotated by the wheels next to the window. The five windows are placed at five specific moments in Earth's history. In some of the windows the information refers to the mass extinctions which are caused or assumed to be caused by powerful volcanic activity: 1. end of the Cretaceous 2. Permian/Triassic boundary 3. beginning of the Lower Ordovician. Above the windows, on the timeline itself, Earth's climate is shown as well. Where the powerful volcanic activities are on the timeline, climate changed radically in a short time, showing that this is the reason why mass extinctions occurred. This timeline is a good tool for showing how life on Earth changed by volcanism in the past 4.600 Million years. The timeline is bilingual (HUN/ENG).

Figure 60: Live timeline of Earth's history. Pannon Sea Museum, Geology and Natural History Exhibition of Herman Ottó Museum, Miskolc, Hungary, Photo: György Czibula

Lessons learned / tips

- Making personal links is much more important for visitors than labels with complex descriptions which most of them will not even read;
- It is very important that the visitors participate actively in guided tours, workshops, events etc., because visitors will remember 90 % of what they make on their own;
- less is more – we have to give visitors less rather than more information about complex geological phenomena and this must be very simplified, clear and interesting;
- personal interpretation has an important role and priority in geointerpretation but it is recommended to be mixed also with non-personal methods of interpretation such as different kinds of technologies, publicitations, apps, etc.;
- geopark staff must be trained as geoguides and interprets to assure high quality guiding and programmes. A good guide can encourage excitement and curiosity, link interpretation to personal experiences from everyday life, provides disclosure of new insights and wider sense, using as different and effective communication tools as possible, with all senses involved;
- for excellent interpretation of geological heritage interpretative planning is very important– we need answers to the following questions: Why are we doing this? Who is it for? What will we interpret/promote? How will we do it for? How will it be managed? How will monitor and evaluate it?
- non-personal interpretation through visitor centres, booklets, interpretative points, etc. shall add rich interpretation and educational contents as well as new presentations for visitors by providing experiences and educational information.

4.5. Output 5: Geological challenge Water in time

Prepared by Styrian Eisenwurzen UNESCO Global Geopark, Austria
Edited by Karavanke/Karawanken UNESCO Global Geopark

Definition of specific challenge

The chosen challenge by the Styrian Eisenwurzen Geopark is Water in time, which will be interpreted by PP2 with the external expert company in Nature and Geopark villages Wildalpen, Gams and ST. Gallen. The pilot action will apply creative solutions that are very simple (GEO for DUMMIES) and will be presented in a form of village interpretation points as part of Danube GeoTour Visitor Infrastructure Network.

The geological background of the pilot area:

The Eisenwurzen and its geological structure in the Alps from HEINZ KOLLMANN (Excerpt from the book UNESCO Geoparks in Austria, Natur- und Kulturerlebnisführer der Universität Salzburg, p.129-165)

The Nature and Geopark Styrian Eisenwurzen is located entirely within the region of the Northern Limestone Alps. The rocks in this region are mainly from the Mesozoic Era. The rocks of the Limestone Alps formed at the edge of a wide bay on the large continent. The oldest time period of the Mesozoic Era is the Triassic period. At the start of the Triassic, rivers deposited green and red clay and sand from the large deserts in the inner continent. These deposits were accumulated at the kilometre-long beaches at the edge of this bay. The sea frequently flooded large, shallow lagoons. The sea water evaporated in this hot and dry climate. Its mineral substances formed rock salt and gypsum.

Hornstone, hard as glass

240 million years ago, the sea flooded the beach and lagoon landscape. This started the sedimentation process of limestone and dolomite, the predominant rocks of the Limestone Alps. One of the oldest rocks of this kind is the Reifling limestone, named after Großreifling in the Nature and Geopark. It is dark grey and consists of thin banks.

Limestone and dolomite: the backbone of the Limestone Alps

Dolomite rock is the most frequently occurring rock in the Geopark. It is comparatively brittle and crumbles to small, angular fragments. Dolomite rock was deposited in marine environments that were almost completely cut off from the open sea. As a result, the water’s oxygen level was low. The evaporation of water further led to a high concentration of minerals, primarily rock salt. Consequently, only a few animals lived in this part of the sea, but a large number of algae which emitted limestone lived there. The influence of bacteria transformed the sometimes several hundred metre thick sediments that were composed of the algae limestone shells to dolomite. The Dachstein limestone was deposited in a maritime environment which was always connected to the open sea. Like all types of limestone of maritime origin,

it consists of fragments of organisms like algae, corals, calcareous sponges and bivalves which the force of the waves has ground into more or less small fragments.
The connection to the open sea was interrupted roughly every 1,000 years. For a certain time span, a few centimetres of dolomite or no dolomite at all were deposited when the connection to the open sea was also interrupted. These short periods are marked by the borders between the limestone banks.

250 million years ago, in the Jurassic, the supercontinent began to break apart. The distance between the continents was still increasing due to the expansion of the oceans, a process that is still ongoing nowadays. Further, several smaller continents formed at that time. On one of them, the rocks of the latter Limestone Alps could be found. Having been part of the continental shelf, this micro-continent was still covered by the sea and further rocks deposited there. The big events in the geological history have also left their footprints. Since the water depth varied considerably between deep and shallow water levels, Jurassic rocks also look very different. In the Nothklamm Gorge in Gams, above the Dachstein limestone, red limestone with numerous remnants of crinoids have been deposited. Crinoids are related to sea stars and sea urchins. Their long stems were firmly grown onto the seabed. The stems had been degraded and their remaining parts are clearly visible in the red limestone.

Nowadays, crinoids live in water depths of several hundred meters. We also have to consider this fact for the formation of red limestone in the Nothklamm Gorge. Hornstone-rich limestone was deposited in deep depths again. The water depth has to have changed almost abruptly towards the end of Jurassic. The subsequent white and yellow limestone that formed the mountain chain between Gams and the Salza valley were deposited at this time. This limestone consists of the remnants of organisms that, even today, only live in shallow waters, such as corals and algae. This type of limestone was once produced as so-called Wildalpen Marble (Wildalpener Marmor). The bright, shiny-polished high altar of the parish church in St. Gallen is made out of this beautiful stone.

Sand and clay

The next period in earth’s history started 135 million years ago, the Cretaceous. During this period, the Alps were uplifted above the sea level. 90 million years ago an island landscape formed south of the Limestone Alps. The Limestone Alps were still sliding northwards at this time. Some parts were uplifted while others lowered slowly. This development is comparable with a snow blanket that slowly starts to slide down a roof. Sand and clay accumulated in the sinking parts of the mountains.
One of these accumulation basins is the basin in Gams. Findings of fossil corals, snail shells and sea shells prove that the water level in the western part of the Gams basin was continuously at low depths. The situation in the eastern part of the Gams basin is totally different however. Clay rock and sandstone that can be found here have been deposited at the end of the Cretaceous in water depths around 1,000 metres. This depth did not change in the following Paleogene period.

Ice Age

Starting approximately 800 million years ago, the Ice Age had a fundamental influence on the landscape. The period was however not solely characterised by great coldness. Only during the four glacial periods, large parts of the Alps were covered by glaciers. The glacier tongue eventually melted and rivers and streams sprung. They swept away enormous quantities of rock formations which were released by the melting ice. These fragments were deposited as gravel at those places where the current was less strong. The gravel filled the valley in its entirety. Limestone sediments solidified the gravel into a rather compact form of conglomerate. The Ice Age ended approximately 12,000 years ago. Since then, the rivers have cut their beds deeply into the conglomerate rock. The remnants are called terraces. They are flat on top and plunge down steeply to the rivers. In the Enns valley, the terrace of the last glaciations spreads from Hieflau to Großraming in Upper Austria. In the Salza valley, the terrace spreads from Fachwerk to the estuary of the Enns.

Possible methods for geo-interpretation of geological challenge water in time

Overall concerning the geological description above the **Styrian Eisenwurzen UNESCO Global Geopark,** would highlight at every village interpretation point the most important facts of "Water in time" at every location. This means at the end we have three different interpretation points focusing on the topics water and geology (Landl, Wildalpen, St. Gallen). Based on a uniform concept dealing with the geological effects of water, differing content-related key aspects will be presented fitting the location of the respective interpretation point. The basic concept envisages each interpretation point to be constructed in the way of an information board with interactive turning elements, primarily focusing on the comprehensible preparation of the subject areas geology and water. Therefore, each of the interpretation points will consist of:

- Information and map of the Geopark and its visitor attractions
- Illustrated explanation of the geological history of the region and the occurring geological phenomena (with special emphasis on the influence of water) such as the ice age, karst springs, caves, gorges,…
- Interactive element consisting of rotating pentagons linking the geological phenomena of the region with its present visitor attractions

By actively exploring the regions phenomena and their linked attractions of the present Geopark, the visitors will understand the geological history of the region and their current characteristics, ready to experience in all the Geopark Eisenwurzen.

In detail, the topic "Water in time" can be presented with various active elements. At every point the information and map as well as the illustrated explanation of the geological history of the region is the same. The interactive elements have various information, but can be highlighted in different ways. The following examples show how this is possible (these information panels are not in particular related with the topic water and/or geology):

Best practices from partners and abroad

Here you can find some examples of best practice for interpretation points from partners and abroad and/or as well about the topic “Water in time”. At the end of this chapter we also added some positive and negative examples of interpretation panels and info points.

Geopark information centre World of geology, Bad Eisenkappel/ Železna Kapla (Karavanke/Karawanken UNESCO Global Geopark – AUT/SLO) – Information panels about Water in time and Geology

Webpage: http://www.geopark-karawanken.at/en/home.html

These panels in the Geopark Infocentre are giving the visitor a very good overview of the Geology and Water topic. The signs include quite the right amount of facts and scientific input. The interactive screens for more GeoInterpretation are also very good. Visitors also have the possibility to see various Geology and stones as some examples are highlighted in the exhibition as well. In conclusion, it is a good combination of different interpretation methods.


Figure 61: Geopark information centre World of geology, Bad Eisenkappel/ Železna Kapla (Karavanke/Karawanken UNESCO Global Geopark – AUT/SLO) – Information panels about Water in time and Geology. Copyright Nature and Geopark Styrian Eisenwurzen

Centro de Interpretatcion de Geologica Nautilus, Basque Coast UNESCO Global Geopark, Mutriku Spain – Special exhibition about fossils and the live within water over different time periods

Webpage: https://geoparkea.com/en/

Again, this is a fine example concerning the combination of various GeoInterpretation methods. The visitors have the possibility to see fossil exhibits in detail. The centre includes a small laboratory. This is also an interactive way, especially for groups, to show the visitor more about the fossils of the area. It is also a good mix of original troves and enlarged copies of the exhibits.

Figure 62: Centro de Interpretatcion de Geologica Nautilus, Basque Coast UNESCO Global Geopark, Mutriku Spain – Special exhibition about fossils and the live within water over different time periods. Copyright Nature and Geopark Styrian Eisenwurzen.

The OMIC Observatório Microbiano dos Azores, Azores UNESCO Global Geopark, Furnas, Portugal

Webpage: https://www.azoresgeopark.com/?lang=EN

The OMIC Observatório Microbiano dos Azores shows the changing microbiology in water within changing condition and over various time periods.

Figure 63: The OMIC Observatório Microbiano dos Azores, Azores UNESCO Global Geopark, Furnas, Portugal. Copyright Nature and Geopark Styrian Eisenwurzen.

The centre shows a very specific scientific topic in a very good way as the staff tries to involve the people already at the entrance. The exhibition has various interactive stations and the information is not too informative. Finally, a lot of pictures and infographics are giving a very good overview.

Interpretation point Feistritzbach Stream, Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at/en/information-centres-and-museums/information-points/the-feistritzbach-stream-info-point.html

At interpretation point Feistritz explains the area‘s complex water network through animation, educates about water flora and fauna and offers water-play facilities. The site demonstrates the importance of water resources through varied interpretative approaches. Starting from the global distribution in the most diverse aggregate states, the water cycle, the cleaning, the way the water takes in the pile of Mount Peca, up to each human being, which consists largely of water, it is illustrated by numerous interactive stations, how valuable and worthy of protection it is and how good it is for all of us. Both children and adults have the opportunity to playfully learn a lot about the blue gold. Furthermore, the Feistritzbach invites you to linger, marvel and refresh your feet in the summer.


Figure 64: Interpretation point Feistritzbach Stream, Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia. Copyright Geopark Karavanke

Spring Water Museum Wildalpen, Styrische Eisenwurzen UNESCO Global Geopark, Austria

Webpage: https://www.wien.gv.at/english/environment/watersupply/wildalpen/

The collection of the Museum comprises many original documents that enable visitors to understand the historical development of the Vienna Water. Large-format photographs provide an overview of the work conducted in the spring zone of the Second Vienna Spring Water Main. This information is complemented by interesting facts about related topics such as geology, hydrology and water resource protection. The Spring is one of Europe's richest drinking water springs. In winter months, the yield of the spring is small. But in spring, with the thawing of the snow, a staggering 10,000 litres of water per second gush from the mountain, equalling 860 million litres per day. The Kläffer Spring provides a glimpse behind the scenes of drinking water supply. You must look out for funny Molecools (Tim and Trixi waterdrops indicate information of special interest for children) during your visit of the Museum! The Molecool indicate information of special interest to children. The Museum has a very modern technology – visitors can watch 3D film "The Journey of the water", which presents an impressive array of interesting facts, ranging from the global water situation to Vienna`s water supply by the two Mountain spring lines. Fahrerhof Building upper Storey provides a creative interpretation of various elements of Vienna's water supply. Very interesting is also interactive media library – two interactive stations enable interested visitors to access information individually. There are many different themes to select, ranging from the global water cycle to Vienna's water supply. Moreover, numerous videos for younger and older visitors can be watched as well. The rooms of the Mountain Spring Water Museum (Rooms 1 to 9) as well as the Water & Forest exhibition are also accessible for persons with restricted mobility.

Figure 65: Spring Water Museum Wildalpen, Styrische Eisenwurzen UNESCO Global Geopark, Austria, Source: https://www.wien.gv.at/english/environment/watersupply/wildalpen/

Haus der Natur - Exhibition Salzach lifeline, Salzburg

Webpage: https://www.hausdernatur.at/en/salzach-lifeline.html

From its origin around 2300 meters above sea level to its mouth in the Inn River at about 340 meters above sea level, the Salzach River flows over 226 kilometers. In this exhibit, you can follow its course in a very short time – from the glacier-covered summits of the High Tauern to the lowlands of the Alpine foothills. From the source to the mouth, the river is continually changing its appearance, features, and living environment: from a torrential mountain stream with its cold, oxygen-rich water, to the meandering Schotterfluss River in the wider valley and the warm and nutrient-rich floodplain waters in the lowlands. Follow along as the Salzach winds its course! Travel through time with the flight simulator and discover the Salzach valley in our present era, the ice age, and 12 million years ago at the time the Alps first rose up. Explore the caves and ravines formed by this water.

Figure 66: Haus der Natur - Exhibition Salzach lifeline, Source: https://www.hausdernatur.at/en/salzach-lifeline.html

Exhibition Gletscher.leben at the Visitor Centre Kaiser-Franz-Josefs-Höhe (National Park Hohe Tauern – Salzburg, Carinthia, Tyrol) – Interactive Station of the Pasterze glacier

Webpage: https://www.grossglockner.at/gg/en/index

Nothing is forever – not even the eternal ice. Because one thing keeps showing up over the millennia: the fact that the glacier is a living thing. It grows, it recedes – due to natural climate fluctuations and more recently also due to mankind and its actions. Glacier.Life, the new exhibition provides a deep insight into the glacier habitat, its origins and its influence on nature. The Pasterze and the sensational discovery found in its retreating masses – a stone pine more than 6000 years old – are presented as two lovers that are never allowed to meet in the exhibition rooms of the visitor centre on Kaiser-Franz-Josefs-Höhe: the powerful ice giants and their hidden treasures buried underneath.

Source:

http://www.moertschach.gv.at/_Resources/Persistent/cf5b5a69236e7069cd0172e8fe59d7f12790b0af/Infoblatt-Ausstellung-GletscherLeben-2017.pdf

https://www.grossglockner.at/gg/de/hochalpenstrasse/ausstellungen

Figure 67: Exhibition Gletscher.leben at the Visitor Centre Kaiser-Franz-Josefs-Höhe, National Park Hohe Tauern, Source: Copyright E.C.O. – Institut of Ecology

Exhibiton “Wasserleben” – Ökopark Hartberg, Styria

Webpage: http://www.oekopark.at/de/erlebnis/ausstellungen/wasserleben.html

Within the exhibition of the Ökopark Hartberg, visitors are able to play with the element water. Various interactive experiments are making the visit an adventure, especially for children. Partly outdoors everybody can learn more about the strength of water molecules or about other physical phenomena. Learning by doing: create a thunderstorm or have a look how a coloured drop merges with water. All these are only a few interactive stations visitors are able to explore. Learn more about water - shaping landscapes and societies.

Figure 68: Exhibiton “Wasserleben” – Ökopark Hartberg, Styria, Copyright oekopark.at

A glance into the Hohe Tauern window – thematic trail (Neukirchen - National Park Hohe Tauern – Salzburg, Carinthia, Tyrol)

Webpage: https://www.nationalpark.at/en/attraktionen/lehrwege/geolehrweg-blick-ins-tauernfenster/

The thematic trail shows the visitor how water is shaping landscapes. Along the Untersulzbach waterfall, all the way to the historical copper mining site of Hochfeld, various stations illustrate the culture-historical development of ore and mineral mining as well as the diversity of the vegetation and landscape.

Figure 69: A glance into the Hohe Tauern window – thematic trail, Neukirchen - National Park Hohe Tauern, Copyright E.C.O. – Institut of Ecology

Hexenwasser Hochsöll, Tyrol, Austria

Webpage: https://www.wilderkaiser.info/en/summer-holiday/destination-tyrol/hexenwasser-soell.html

The mountain adventure world of Hexenwasser in Söll in Tyrol has been delighting adults and children alike for more than ten years with games of safe nature watching. Back to the roots is the common theme of all six of the mountain adventure worlds in the Wilder Kaiser region.

So off we go on Austria's longest barefoot path in Hexenwasser Hochsöll over grass, bark mulch, massaging stones and bubbling water to 60 interactive stations, where all the senses will be newly aroused. Clever witches and crafty wizards give advice at each point about what to do, whether in the Hexenwerkstatt (witches' workshop), fire place or a jumping water.

There is lots to experience: the feeling of wading knee-deep through bog, building channels, sticking your head into the humming stone or getting a note out of the stone harp.

Figure 70: Hexenwasser Hochsöll, Tyrol, Austria, Source: https://www.wilderkaiser.info/en/summer-holiday/destination-tyrol/hexenwasser-soell.html

Positive examples of panels and information points:

a.) The following picture is showing a very interactive and innovative information point with the right amount of details. Very interesting are the various panels where you can listen to some facts about the theme.

Figure 71: Positive example of information point - example a). Copyright E.C.O. – www.e-c-o.at

b.) This information panel has an interactive opportunity which can be interesting for adults or children. With a rotary item, you have the possibility to change the specific topics which the visitor is interested in.

Figure 72: Positive example of information point - example b). Copyright E.C.O. – www.e-c-o.at

c.) This information point is quite the same as mentioned before. But in this case, the design is even better and fits more to the landscape and specific theme. Furthermore, the rotary items are just various elements related to the topic. The elements help to imagine and learn even better about the theme figuratively.

Figure 73: Positive example of information point - example c). Copyright E.C.O. – www.e-c-o.at

d.) It is also extraordinary, in a positive way, that this information board compares the cultural landscape from the past with the actual one. So, this means you have an interactive rotary item. The visitor can put down the image from the past and roll up this image to compare it with the actual landscape.

Figure 74: Positive example of information point - example d). Copyright E.C.O. – www.e-c-o.at

e.) An extremely interactive station, which represents a combination of climbing elements and rotating information elements and is designed especially for children, can be seen on below photo. The visitors learn more about the topic and the landscape in the area. The figurative and interactive presentation is one of the best. Inbparticularly, if you involve the children, you are also involving the adults.

Figure 75: Positive example of information point - example e). Copyright E.C.O. – www.e-c-o.at

Negative examples of panels and information points:

a.) The first example shows a thematic trail with the focus on flowers, but as you can see, there are too many signs with too much information in a very close area.

Figure 76: Negative example of information point - example a). Copyright E.C.O. – www.e-c-o.at

b.) The second panel shows information about Geology as well as mountain springs and water. With a closer look, the viewer gets overloaded with too much information and details are too scientific and not easy to understand.

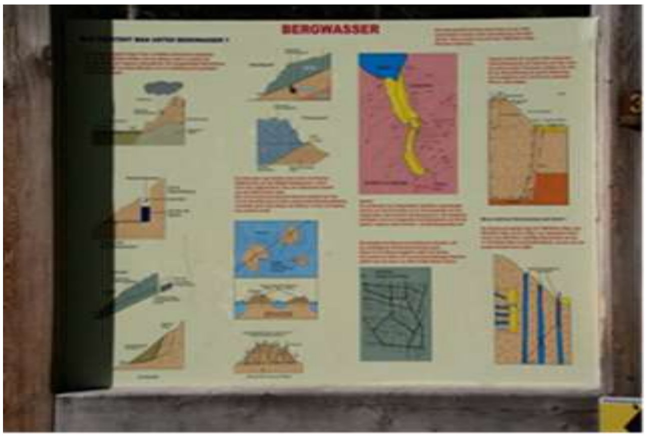


Figure 77: Negative example of information point - example b). Copyright E.C.O. – www.e-c-o.at

c) The third example shows a typical alpine bog and wetland area, but for the interested visitor, you find too much information on the panel. Normally the viewer is getting lost after reading this amount of information.

Figure 78: Negative example of information point - example c). Copyright E.C.O. – www.e-c-o.at

Lessons learned/tips

In cooperation with our external consultants we got a good overview about visitor information points related to the topic ‘water in time’ in Austria and abroad. Here are some lessons learnt about installing of outdoor information points:

- Do not use too much information and facts on the panels. Visitors are not reading a lot when they are on a thematic trail.
- A mix of maps, graphics and pictures with a good short information text is the best way. Since you have to motivate all senses of the visitor, use minimum one interactive tool. If people interact, they get involved, understand and learn more about the topic.
- Multimedia is not necessary at the panels. It always depends on the topic and on the location. The costs and the maintenance are another issue in this case.
- Keep the interactive tool simple. A very complex element, which takes a lot of time to solve, is not very interesting for the visitor.
- Choose the locations of the information panels in a proper manner: visibility, distance to the next point and if it is there something to see or add to the related topic.
- QR-Codes can be interesting for some themes as they offer the possibility to get more information and facts. But not many people are using them. So, if you would like to generate some application for the visitor’s smartphone, nowadays the most common tool is a specific app. This is an additional tool to provide more information for the visitors, including maps and track of the thematic trail as well as more information and sights about the area.
- Keep it simple on the panels. Not every visitor is a scientist!
- If you have a thematic trail, use one larger sign with a map and a general information about the trail and the area.
- If you have just one visitor information point, for example, in one village or at one site, add always a small part with general information (including where we are, website etc.) and if possible, add a small map about the region.
- Involve children and you will automatically involve adults.

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4.6. Output 6: Geological challenge Metamorphic rocks and processes

Prepared by Papuk UNESCO Global Geopark, Croatia
Edited by Karavanke/Karawanken UNESCO Global Geopark

Definition of specific challenge

Geochallange for Papuk Geopark is metamorphic rocks and processes. This geochallange will also be a subject of interpretation at Geological interpretation point Zvečevo, an outdoor interpretation point.

Metamorphic means that a 'change takes place'. Metamorphic rocks are rocks that have been changed from its original form by heat, pressure and fluid activity into a new rock. Metamorphic rocks were originally igneous or sedimentary rocks.

There are three types of metamorphism:
CONTACT (THERMAL) caused by igneous activity
DYNAMIC associated with faults and earthquake zone
REGIONAL caused by tremendous pressure associated with plate tectonic activity

Type of metamorphic rocks and processes:

1. FOLIATED metamorphic rocks are formed within the Earth's interior under extremely high pressures that are unequal, occurring when the pressure is greater in one direction than in the others (directed pressure). This causes the minerals in the original rock to reorient themselves with the long and flat minerals aligning perpendicular to the greatest pressure direction. This reduces the overall pressure on the rock and gives it a stripped look.
Examples of foliated rocks are gneiss, phyllite, schist, slate**....**

2. NONFOLIATED METAMORPHIC ROCKS are formed around igneous intrusions where the temperatures are high but the pressures are relatively low and equal in all directions (confining pressure). The original minerals within the rock recrystallize into larger sizes and the atoms become more tightly packed together, increasing the density of the rock. Examples of non-foliated rocks are marble, quartzite ….

3. NEOMETAMORPHISM is a metamorphic process, where mineral crystals completely rearrange to form completely new minerals that are more stable under increased pressure and/or temperatures.
This is the most often observe with the sedimentary rock shale which is composed of fine grained quartz, feldspar and other clay minerals that under metamorphic process change to muscovite mica and garnet.

4. RECRYSTALLIZATION is a metamorphic process that occurs under situations of intense temperature and pressure where grains, atoms or molecules of a rock or mineral are packed closer together, creating a new crystal structure. Example: limestone can recrystallize to marble. Recrystallization is the most common process in the formation of metamorphic rocks.

Many metamorphic rocks are used for various purposes, for example marble are used for statuary (Michelangelo David) and building stone (the Pantheon, Taj Mahal), talc for powders, graphite for pencils, slate for roofing and flooring and so on.

The geological background of the Pilot area

The Papuk Geopark is located in the eastern part of Croatia-Slavonia. Lowland area of Slavonia is mostly flat agriculture landscape. Fairly distinctive feature in such landscape are Slavonian Mountains. Papuk is one of the Slavonian mountains which are up to 1000 m high. Mt. Papuk is generally spreading out in East – West direction and abounds with springs and streams. Geological, Papuk is situated in the most southern part of the tectonic unit Tisija, representing a part of the Preneogene crystal base of the Pannonian basin. Papuk is generally built of metamorphic and igneous rocks, and it is presumed that the shoots of the Tisian rock units found on Papuk are the best examples on the wider area of the Pannonian basin. Crystalline basement comprises the following tectonic and metamorphic units: (1) the Psunj metamorphic complex (also named as the Kutjevo metamorphic series) originated from a progressive metamorphism during the Baikalian orogeny, later overprinted and retrogressed by younger metamorphic events; (2) the Papuk metamorphic complex (also named as the Jankovac metamorphic series) originated from progressive metamorphism and migmatitization during the Caledonian orogeny, and (3) the Radlovac metamorphic complex originated from a very low-grade metamorphism during the Variscan orogeny.

Possible methods for geo-interpretation of geological challenge metamorphic rocks and processes

Big challenge is how to explain to visitors very complex theme such as metamorphic rocks and processes, especially to children. The most important element of metamorphic rocks and processes is change. Metamorphic rocks are rocks that have been changed from its original form by heat, pressure and fluid activity into a new rock. Metamorphic rocks were originally igneous or sedimentary rocks.

In terms of concrete point in Zvečevo, outdoor location is anoter factor which determines an interpretation approach.

Current interpretation of metamorphic rocks in Papuk is based on traditional interpretation panels. To improve interpretation in Papuk on this theme we decided to use also other interpretation methods.

Possible methods applicable for geo-interpretation of metamorphic rocks and processes in Papuk Geopark are:

People-based/personal interpretation

1. Guided tours
2. Workshop with children on the theme of metamorphic rocks and processes

Non-personal

1. Educational trail with interpretation panels and other tools
3. Exhibition of metamorphic rocks (rock boulders) near panels
2. Educative interactive installation (e.g. metamorphic machine/meta-machine)

Best practices from partners and abroad

The Natural History Museum, London, United Kingdom

Webpage: http://www.nhm.ac.uk/

In Natural History Museum in London, metamorphic rocks are interpreted through different kind of panels with text and examples of rocks, describing and showing metamorphic processes and rocks. Other way of interpretation is interactive installation where visitor can by touching a button change metamorphic conditions and see what is happening with rock, how is changing (see Figure 80).

Figure 79: The Natural History Museum in London. Archive Geopark Papuk

North West Highlands Geopark, Scotland

Webpage: http://www.nwhgeopark.com/

Interesting interpretation panels with examples from real life explaining process of metamorphism, interactive installation with micro and macro rock examples situated in Knocken Craig outdoor Visitor Centre. (Figure 81)

Figure 80: Knocken Craig Visitor Centre (Archive Geopark Papuk)

Assynt Visitor Center, United Kingdom

Webpage: http://www.discoverassynt.co.uk/visitor-centre.php

Rock boulders of metamorphic and other rocks with description and interactive panels can be seen in Assynt Visitor Center. (Figure 82).

Figure 81: Assynt Visitor Centre (Archive Geopark Papuk)

Rokua UNESCO Global Geopark, Finland

Webpage: http://www.rokuageopark.fi/fi/koe

Interpretation panels in Rokua UNESCO Global Geopark describing metamorphic rocks of the area. (Figure 83).

Figure 82: Interpretation panels Rokua Geopark (Archive Geopark Papuk)

In Geopark Papuk we also have some interpretation panels regarding to metamorphic rocks (Figure 84).


Figure 83: Geopark Papuk. Archive Geopark Papuk.

Lessons learned / tips

Geological interpretation point Zvečevo is an outdoor interpretation point. Since we are limited in interpretation (no electricity, no multimedia), we made some conclusions how to approach when interpreting methamorphic processes:

- Mixed personal and nonpersonal methods of interpretation is always good when you want to present difficult theme such as metamorphic processes;

- Personal interpretation: visitor can be educated by geopark staff through educational workshop (mostly for children) and guided tours. Educator’s role is to provide an interesting, entertaining and fun experience for visitors. When you want to explain to the visitor some complex theme, such as metamorphic rocks and processes, it is important to connect/compare information with some familiar facts/events in real life. In workshops and guided tours visitors can actively participate, “do something” and that is the best way to learn.

- Educational trails with interpretation panels are still important and useful method/tool of interpretation but with carefully planning of contented: what to put on panels and how much text (“less is more”), how to provide simplified information, what pictures and schemes to choose, how big they should be.

- Interactive installation give visitors an opportunity to see, touch/do and read something. In our case, educative interactive installation will be “meta machine” (machine that make metamorphic rocks) which will consist of real rock examples and will present simplified process of metamorphism - how one rock transformed into another rock.

- Exhibition of real rock example with description on panels is a good way of interpretation, when we are talking about outdoor interpretation points.

An old Chinese proverb says:

I hear, I forget.

I see and hear, I remember.

I see, hear, and do, I understand.

4.7. Output 7: Geological challenge Geomorphology

Prepared by National park Djerdap, Serbia
Edited by Karavanke/Karawanken UNESCO Global Geopark

Definition of specific challenge

The chosen interpretation challenge of National Park Djerdap is Geomorphology. This challenge will be addressed within Danube GeoTourproject WP 5 by development of geo interpretation center for Djerdap geomorphology. This center will be developed in village Tekija, close to most important geological features of Djerdap area – Djerdap Gorge (Djerdapska Klisura – Iron Gates) with its Kazan Gorge.

NP Djerdap intends to set up an innovative interpretation site at Danube River bank location in Tekija village close to the Djerdap gorge. The Djerdap gorge (100 km) is a compound river valley made up of four gorges that are separated from each other by ravines. In Gospođin vir, one of the greatest river depths in the world has been measured (82 m). The cliffs of the canyon in Kazan are about 300 meters high. Therefore, as part of the Danube GeoTour, interpretation point Tekija will focus its attention on geomorphology. At the moment, there is no adequate presentation of the gorge although some old infrastructure exists (trails, a hut). It is foreseen that the interpretation point will be placed in the area of the existing premises of NP Djerdap in Tekija. The main interpretation topics will cover the formation of gorges and geomorphology processes of the Danube river basin.

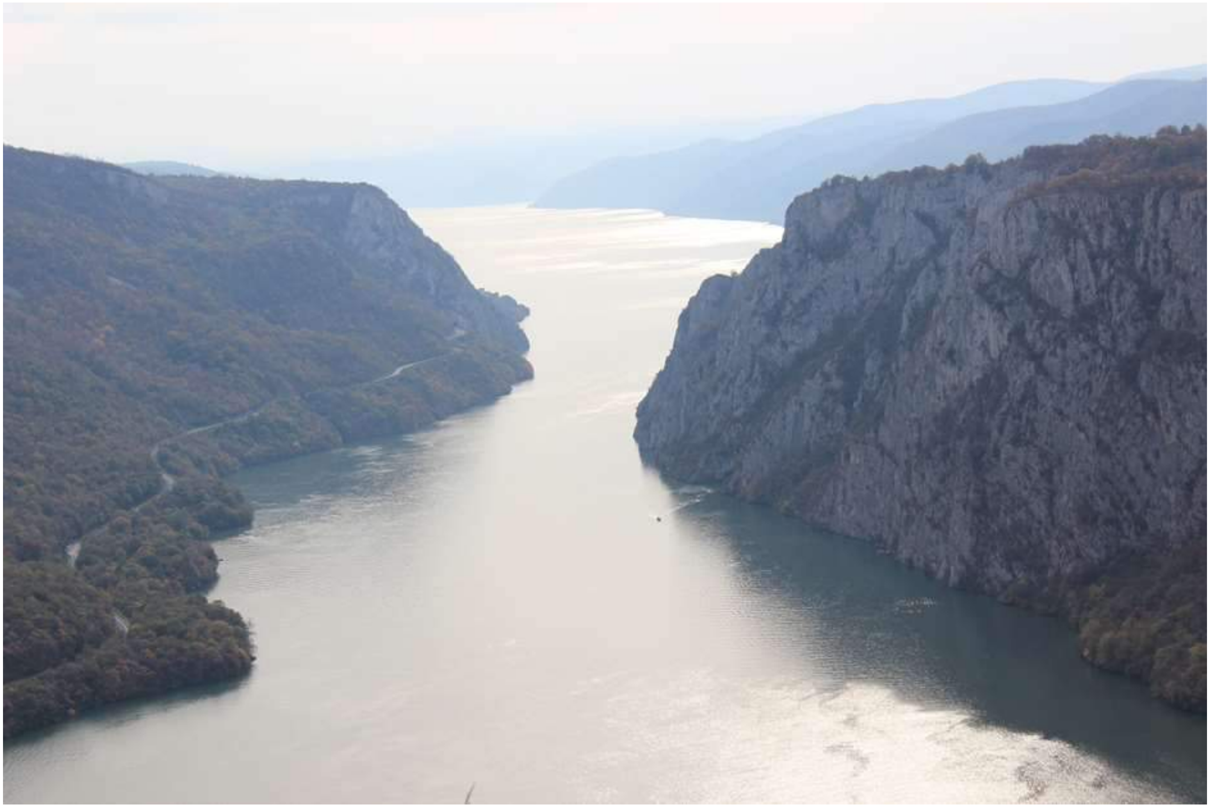


Figure 84: Djerdap gorge, Photo: Ivan Svetozarević

The geological background of the Pilot area

Aspiring Geopark Djerdap encompasses the southern part of the Djerdap Gorge in the Middle Basin of the Danube. In the downstream part of the Middle Basin, the Danube is cut in the mountain range of the Southern Carpathians, between two large tectonic basins – Pannonian on the west and Dacian on the east. The Danube Gorge is a composite gorge, consisting of four shorter gorges (Gornja Klisura, Gospodjin Vir, Kazan and Sipska Klisura), and three wider parts – basins (Ljupkova, Donji Milanovac and Orsova). The most upstream and the most downstream parts of the Gorge are characterised by lowland, mildly hilly terrain of the rims of Pannonian and Dacian Plain, respectively. The main orographic units are Golubačke Planine, Šomrda, Liškovac, Veliki Greben and Miroč. Within the mountainous area of the gorge, there are deep river valleys cut by the tributaries of the Danube, except in the limestone areas, which are characterized by dry karstic plateaus (e.g. Štrpsko Korito on Mt. Miroč).

The area has undergone substantial change during the 1970s, when the hydroenergetic system Djerdap was built, damming the Danube River in the Sipska Klisura Gorge, thus forming a throughflow lake. Although the lake caused certain environmental changes in its surroundings, it is by now completely integrated into the landscape, giving it a new dimension and aesthetic value.

The geomorphological axis of the whole Djerdap area is the Djerdap gorge, formed along the Danube through the Southern Carpathians, between the Pannonian plain on the west and the Dacian plain on the east. With a length of over 100 km, this is the longest through gorge in Europe. The southern side belongs to Serbia, and the northern side to Romania. The gorge stretches from the rock Babakai, which protrudes from the Danube opposite to the Golubac medieval fortress, to the village Gura Văii in Romania. It actually consists of four gorge sectors and three basin-like wider parts, in this order: Gornja Klisura (Upper Gorge, Golubac Gorge), Ljupkovska Kotlina (Liubcova basin), Gospodjin Vir Gorge, Donjomilanovačka Kotlina (Donji Milanovac basin), Kazan Gorge, Oršavska Kotlina (Orşova basin), and Sipska Klisura (Sip Gorge). The name Djerdap was formerly related only to Sipska Klisura, but later on started to be used for the whole gorge. In the diverse geological composition, the rocks that dominate are schists, limestones and sandstones.

Possible methods for geo-interpretation of geological challenge geomorphology

During a guided geohike day:

- printed photos of Djerdap gorge geomorphology profile
- viewpoints explanation of the mountains and Danube River dividing two river banks

At an exhibition:

- “travel to the past” presentation
- model presentation of formation of Djerdap Gorge

- using sound effects, lights, simple games for kids

<u>Best practices from partners and abroad</u>

Tourist Information centre, Itoigawa UNESCO Global Geopark, Japan

Webpage: http://www.geo-itoigawa.com/eng/

Figure 85: Tourist information centre Itoigawa's GeoStation GeoPal, Source: http://www.nihon-kankou.or.jp.e.wp.hp.transer.com/detail/15216cb3542097259

The Itoigawa UNESCO Global Geopark is situated in the westernmost end of Niigata Prefecture, Japan, near Toyama and Nagano. The area is crisscrossed by rock strata from different ages ranging from jade-bearing strata formed 500 million years ago to metamorphic rock strata from 3000 years ago. With elevations ranging from 0 to 2,766 meters above the sea level, the rugged terrain is home to a wide variety of plants and animals. The Itoigawa Geopark boasts the world's oldest jade culture as well as a salt trail that runs along a fault line. Signs of Earth's early history as well as the bounty of Mother Nature can be seen everywhere throughout the geopark and are also closely bound up with the lives of the local people.

Itoigawa's GeoStation GeoPal is Itoigawa's new Tourist Information Center. It's divided into 3 sections, the **"Itoigawa Geopark Tourist Information Center,"** the **"Kiha 52 Waiting Room,"** and the **"Model Railroad & Diorama Gallery."** Visitors can enjoy interactive displays, play equipment and more while learning more about the Itoigawa UNESCO Global Geopark.

About the Name GeoPal:

The name "GeoPal," a combination of the "Geo" of "Geopark" and the English word "pal," was chosen from a number of submissions by the local community. The name reflects the new facility's goal to connect people together through their interest in the Itoigawa Geopark and the new Hokuriku Shinkansen.

Geopark Tourist Information Center

The space of Tourist Information Center is divided into five zones.

Entrance zone – The doors feature a map of the Japanese Islands, with Itoigawa highlighted in the middle. The pillar in the entrance features panels about Geoparks around Japan and the world.

Experience zone I – visitors can learn about the different activities to enjoy in Itoigawa's mountains and sea.

Experience zone II –Visitors can slide down to Mt. Myojo Slide on a realistic replica of Mt. Myojo limestone face. Kids can try bouldering at authentic kid's climbing wall.

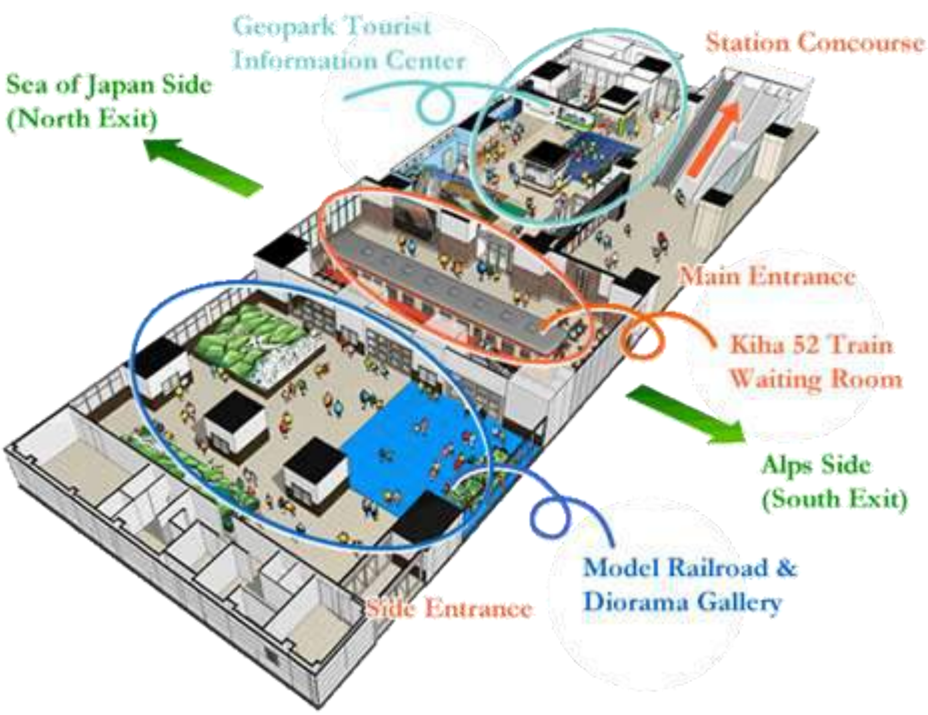
Guidance zone – Visitors can learn about the possibilities of experience of Itoigawa Geopark, including bird's-eye view of Itigawa area.

Tourist information – visitors can get latest information and printed materials. One of the interpretation tool which could act as best practice is Photobook, introduced at Tourist information zone. It is an on-line tool allowing visitors of Geopark to record the visit. From the web-page of Geopark Tourist Information Center it is possible to download already prepared photo books for 24 locations of interest. All 24 photo books have initial information about the location (why is it important) but also well-developed design with some basic photos and the space for inserting own impressions. Visitors can choose the photo book of the location they visited and put inside own photos and impressions. Photo book should be printed afterwards, which will stay as a memory and reminder of Itoigawa Geopark.

Source:

http://www.geo-itoigawa.com/eng/enjoying/geopal.html

http://www.ysnp.gov.tw/css_en/page.aspx?path=868



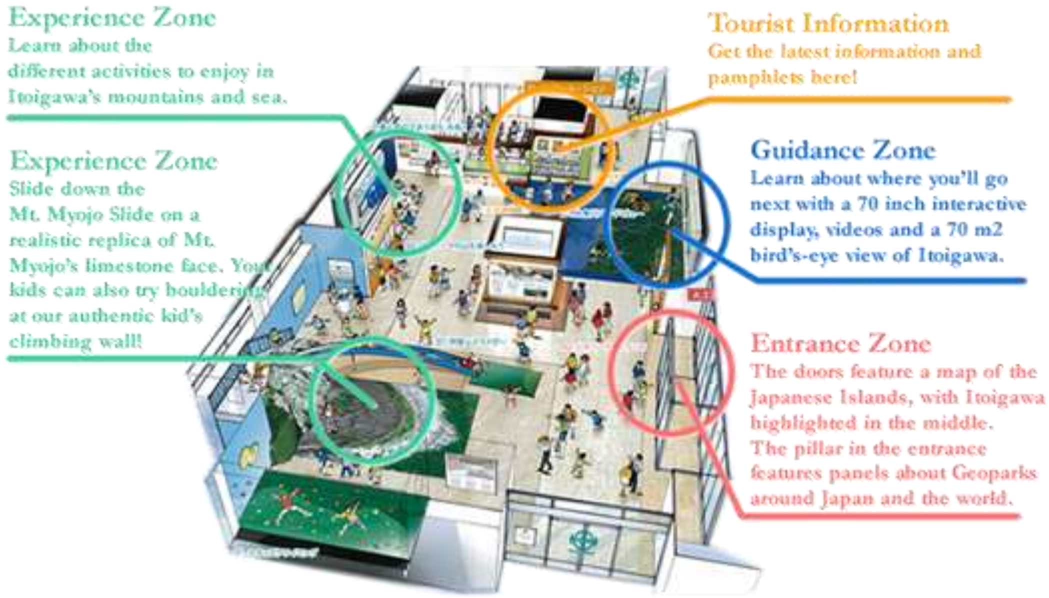


Figure 86: Tourist Information centre, Itoigawa Global Geopark, Japan

Serra de Santa Bárbara Interpretation Centre, Azores, Portugal

Webpage: http://parquesnaturais.azores.gov.pt/en/terceira-eng/what-visit/environmental-centres/serra-de-santa-barbara-interpretation-centre

The Serra de Santa Bárbara Interpretation Centre (CISSB) aims to be the starting point for the understanding of the natural heritage of Terceira Natural Park. Here visitors will experience the geomorphological process of formation and evolution of the island and its relation to areas of high interest in terms of bio and geo-diversity. Visitors also have the opportunity to "travel" to the past to understand the influence of the human interaction with the environment, with emphasis on the use of the areas that currently are part of the Park. It also provides support information to visit and discover the Natural Park.

Figure 87: Serra de Santa Bárbara Interpretation Centre, Source: https://www.exploreterceira.com/en/centros-interpretacao/centro-de-interpretacao-da-serra-de-santa-barbara/

Nationalparkzentrum Hohe Tauern, Mittersill, Austria

Webpage: http://www.nationalparkzentrum.at/1.0.html?L=1

This is a modern visitor centre of National Park Hohe Taueren in Mitersill in Austria. The idea of visitor centre is transformation of the landscape: water, rocks and glaciers. The base zone of the visitor center is a discovery area. The tectonic is described by 3D cinema experience which helps visitors to understand the formation of the Alps and the Hohe Tauern window when the continental plates smashed into one another.

Touchable glacier and Pasterze time wheel

Information about the glaciers of the Hohe Tauern, about snow, corn snow and glacial ice, about the ice flowing and other peculiarities of the glaciers is given. The highlight is the real glacier placed in the middle of the room. Here you can really touch the icy beauty of the glacier. On the Pasterze time wheel you take a trip through time and see how the biggest Tauern glacier has changed from the ice age to the present and even catch a glimpse into the future. Selected photos and facts provide interesting information about the glacier world and also climate change.


Figure 88: Touchable glacier and Pasterze time wheel, Nationalparkzentrum Hohe Tauern, Mittersill, Austria, Source: Danijela Modrej

Expo Postojna cave karst, Slovenia

Webpage: https://www.postojnska-jama.eu/en/come-and-visit-us/expo-postojna-cave-karst/?RemeberLocale=1

Expo Postojnska jama kras is the most recent exhibition, which is rich in audio and visual aids and other exhibit pieces. It is the biggest exposition of the karst and karst caves in the world. The exhibition focuses on the karst, karstic features and rocks in the area. Here, the consequences of human activity and endeavour on the karst underground are clearly depicted. The beginnings and the history of cave exploration as well as the development of tourism in the most renowned tourist cave in the world are shown in an interactive presentation. A 3D scale-model presentation, which projects various aspects of the cave, is the most interesting component of the documentation presented and provides plenty of detailed information. Special attention is paid to young visitors, who are led through the exhibition by a ‘proteus salamander’ and a ‘Leptodirus hochenwartii cave beetle’, and there are plenty of helpful and engaging animations. Children can even try driving a real cave train. Extensive use of various modern technologies and interpretive approaches make this a truly rich and extensive exhibition (Bajec, Rupnik, 2017)[29].

Figure 89: Expo Postojna cave karst, Slovenia, Source: https://www.postojnska-jama.eu/en/come-and-visit-us/expo-postojna-cave-karst/

Rokua UNESCO Global Geopark, Finland

Webpage: http://www.rokuageopark.fi/en/experience

Text: Vessa Krökki

1. New trail guide maps

Rokua Geopark published four totally new Trail Guide maps in 2017. Trail guide maps have been prepared of the most popular visiting sites and trails in the Geopark. The guides combine detailed explanations of the sites and a map that gives a good overall picture on the terrain and the location of sites of interest. The trail guide maps make the planning of a trip easier and more interesting for the visitors.

The guides were prepared together with the local communities. In the preparation meetings the representatives of the communities pondered the best local attractions

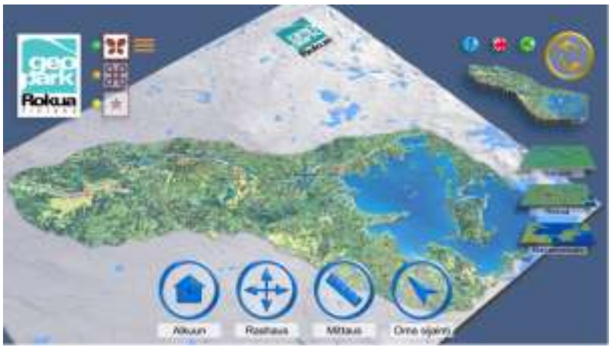
[29] Bajec, Rupnik (2017). Examples of best interpretation practices in geological, natural and cultural heritage in visitor centres and museums in Slovenia

and services to be published in the guides. They also gathered old stories and legends from the nearby region. Thanks for the locals the completed guides share multidimensional information beginning from the geological facts of the region and ending up to cultural legends and myths surrounding the paths and geosites. The locals-including preparation process both revealed wider and deeper contents for the guides and got the locals to feel prouder of their home region. The guides have become very popular not only among the visitors, but also among the locals.

Figure 90: New trail guide maps, Rokua UNESCO Global Geopark, Photo: Vessa Krökki

2. Rokua Geopark 3d Mobile app

Rokua Geopark published a Rokua Geopark 3d Mobile app in May 2017. The mobile app with interactive 3D models explains Rokua Geopark in modern way, and makes it easier to give up to date information to the visitors and residents on the services and sites. In the mobile application visitors can explore landforms, attractions and tourism services with respect to their own positions in a three dimensional map view. The application presenting the Geopark and its sites can be uploaded from Google Play and App Store. By October 2017 the application had been uploaded to mobile devices more than 3300 times.



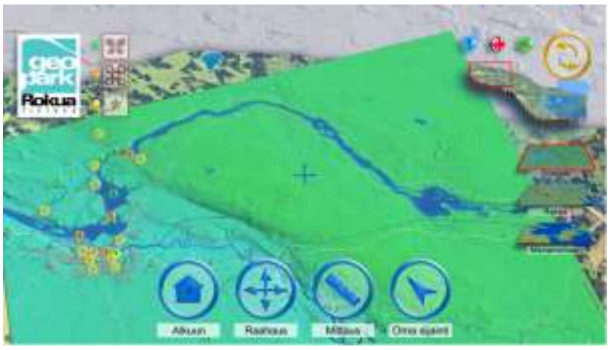


Figure 91: Rokua Geopark 3d Mobile app, Rokua UNESCO Global Geopark, Photo: Vessa Krökki

Levels of interpretation in the Geosite "Foz do Enxarrique", Naturtejo UNESCO Global Geopark, Portugal

Webpage: https://www.naturtejo.com/en/

Text: Carlos Neto De Carvalho

The geosite of Foz do Enxarrique is included in the Portas de Ródão Natural Monument. Some of the last European elephants and Neanderthal men thrived here before extinction during the last Glacial. The palaeontological and archaeological site is an excavation pit in the alluvial terrace of Tagus river. This geosite shows now a belvedere that is also an amphitheatre for nature classes and a protective roof for an excavation site included in an archeological school. Here we find different levels of interpretation for different kinds of visitors that may come 24/7. A large billboard at the entrance introduces the visitors to the importance of the site. From the belvedere a large panel developed between an archaeologist and a professional illustrator expresses in a visual and appealing way the ecology of the area of the most impressive landform in the region as it is interpreted from the fossil record of the site without use any text besides a title. More information about the geological setting, fauna and flora, as well as archaeological findings can be found in different thematic panels that provide a more comprehensive view of the site to those looking for more information or for educational activities. Finaly free wifi in the place provide the possibility to explore in loco further information about the site.

Figure 92: Artistic representation of Portas de Ródão Natural Monument's landscape 30,000 years ago, Source: Carlos Neto De Carvalho.

Figure 93: Geomorphological interpretation of Portas de Ródão Natural Monument, shorts texts bilingual and a large geological map with appealing 3D presentation, Source: Carlos Neto De Carvalho.

Lessons learned/tips

Further to analysis of best practices and exchange of information with other PP Djerdap national Park key lessons learnt important for geointerpretation of geomorphology processes are:

- Publications for children presenting, on one side nicely designed geomorphology features, and on another geomorphological process in Djerdap gorge.
- Traditional games, such as carving in some material simulating the breakthrough of Danube River into the Carpathians, are still interesting for visitors; moreover.
- Geo hiking tours are appreciated, but should be well planned in advance.
- Presentation has to be “easy to understand”, avoiding the overloading visitors with many scientific data in short period of time.
- Organization of the interpretation space should have its “flow”, either historical or with other relevances.

4.8. Output 8: Geological challenge Dialoque between Earth and human

Prepared by Hateg UNESCO Global Geopark, University of Bucharest

Edited by Karavanke/Karawanken UNESCO Global geopark

Definition of specific challenge

In the context of this challenge Earth is represented mainly by two of its components: geodiversity and biodiversity. Geodiversity is the variety of earth materials, forms and processes that constitute and shape the Earth at the global and local level. Geodiversity components are variable in time as a result of former processes or ongoing ones being continuously transformed and even complete removed.

Biodiversity generally referring to the variety and variability of life on Earth was strongly influenced and controlled by geodiversity. Human society development is based on the direct use of different components of geodiversity and biodiversity. Socio-economic evolution in human history was continuously influenced by the search and exploitation of natural resources like silex, salt, copper, iron, raw materials, gold, silver, uranium, mercury, coal, oil, silica, water. In the same time each local community evolved in a specific natural environment, geodiversity playing an important role in shaping different components of local heritage like geologic heritage, natural heritage and cultural heritage.

The role of a geopark is to explore and celebrate the links between geological heritage and all other aspects of the area's natural, cultural and intangible heritages. In fact is to reconnect human society at all levels to the planet we all call Home and to enhance awareness of key issues facing society, such as resources sustainably, climate changes and strengthen of local identity.

In our approach to answer the challenge is to identify and interpret local geological heritage in connection with cultural and natural heritage. Geological heritage is a part of geodiversity identified as being important from the cultural, scientific, educational and touristic point of view and worthing to be preserved. Geological heritage has two interrelated components: a tangible one based on the existence of geologic material or process and an intangible one generated by our interpretation for cultural, educational or economic use. For example, large bodies of basalts with typical columnar joints are spectacular volcanic rocks, in many cases exploited as raw materials, but also have generated a whole mythology becoming iconic geologic sites as part of local, national or international geologic heritage (e.g. Devil`s Tower, in USA or Giant Causeway, in Northern Ireland). The tangible part of the geological heritage are the rock bodies exploitable for different reasons and peculiar landforms generated by geologic process which create a specific natural framework for human settlements. In the same time the landforms are unique cultural landscape for humans and generate narratives, myths, became a touristic attraction, requires a scientific explanation, and, in case of raw materials exploitation, a know-how is developed in time. This is the intangible part of geological heritage.

Connections between geologic heritage and natural and cultural heritages, as an expression of the dialogue between Earth and human, could be approached for interpretation in different ways, some of them being presented below.

1. **Identifying the stone made objects** local communities have developed during centuries using local Earth materials. The stone made objects are a part of local cultural heritage, both tangible and intangible. Identifying as many as possible objects we can define a part of local identity generated by the ability and imagination of successive generations to transform rocks in objects for daily needs or special use. This dialog between Man and Earth we intend to interpret in Hateg Global Geopark as one of the answers for the geological challenge. A detailed description of our approach could be found bellow.

2. **Developing education and visiting centers** is a common approach of all geoparks in order to present to local public, tourists and students Earth history, local geology and the ways local communities used natural resources. Some examples were selected: Promenade Museum (Haute Provence Global Geopark, France), Natural History Museum of the Lesvos Petrified Forest (Lesvos Global Geopark, Greece), Natural History Education Center Ulm (Swabian Alb Global Geopark, Germany), Exhibition Nature in human hands, Natural History Museum (Graz, Austria), and Visitor Information Center for the Messel Fossil Pit (Bergstrase Odenwald UNESCO Global Geopark, Germany).

3. **Adapting former industrial exploitations** for tourism and education as tools to illustrate the importance of earth materials in local socio-economic history and development. Examples selected are from Mine of Lead and Zinc Mežica - Slovenia, Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia and Anthony’s shaft – tourist mine in Idrija, Idrija UNESCO Global Geopark, Slovenia.

4. **Developing integrated educational and touristic geo-trails** which connect geological sites, cultural sites and natural sites and could present geologic evolutions of the territory and the way local people used geologic and natural resources including present pressures on ecosystems and future environmental problems. This kind of geotrails are developed in all European Global Geoparks and we selected as a case study the thematic tours and activities guided with local know-how and the travelling exhibition “When we went for ore” from Naturtejo UNESCO Global Geopark and “Footpath for everyone” from Adamello Brenta UNESCO Global Geopark, Italy.

5. **Identifying intangible cultural heritage** generated by geological rock bodies and geologic phenomena. In this case we can identify the dialogue by analyzing local mythology, geographic names and mental perceptions of landforms. The case study we selected is coming from Buzau Land Aspiring Geopark, Romania.

The geological background of the pilot area

The geopark area is a mountain basin part of the South Carpathian orogenic chain. It has an interesting geological story covering more than 250 million years, starting in Late Permian till Quaternary, if we consider only the sedimentary rocks. If we take into consideration the igneous (Retezat type granitoid) and the metamorphic rocks, the geologic history spans more than 500 million years. Sedimentary rocks are represented by sandstone, reef limestone, clay, tuffs and marlstone and been accumulated in marine and continental paleoenvironments related to the evolution of the Tethys Sea.

The geopark region is world famous for its dwarf dinosaurs, also known as the “dwarf dinosaurs of Transylvania”, from the end of Cretaceous, 72 million years ago. Of particular interest, dinosaur eggs and hatch-lings were also discovered. Other associated fossils within the same deposits, like flying reptiles, birds, mammals, lizards, snakes, frogs, crocodiles and turtles offer a bigger picture about dinosaur’s world and their aftermaths.The most spectacular is a huge pterosaur, or a flying reptile, that was named *Hatzegopteryx* after the region and the town. Also well documented at the Geopark are the volcanic rocks-tuffs, lavas and craters that mark eruptions that took place during the age of the dinosaurs.

Picturesque landscapes and glacial mountain lakes provide the setting for a long human history that stretches from the Paleolithic to the Roman Antiquity and into the Middle Ages and today, enough time for a real dialogue between local communities and Earth to be established. One way to express this dialogue is to identify and tell the stories of stone made objects. Millions or hundreds of millions years have passed since the formations of the raw material until the moment when the Man turned it into objects. Either valuable or ordinary items, most of the objects surrounding us are made from materials of the earth crust: rocks, minerals, metals. The relationship between the material and the object has actually been the materialization of the Man-Earth relationship. This relationship is telling two stories. The first one is the geological story about how natural processes have generated specific rocks or minerals. The second one is related to the ‘Earth custom’ / local custom that makes us think about something specific and particular for a territory. It`s the way local communities used geological resources to create objects. This is an anthropological story.

Possible methods for geo-interpretation of geological challenge Dialogue between Earth and human

This challenge will be interpreted within WP5 by four activities: 1) set up of an itinerant exhibition called “The Dialogue between Man and Earth”; 2) an on-line booklet to accompanies the exhibition, called “The stone made objects”; 3) development of the House of Science and Art as a geo-interpretation centre; 4) incorporating the raw materials stories in existing visiting centers: the House of Geopark and the House of Traditions.

Hateg Global Geopark will develop an exhibition of 10 stone made objects. These are traditional objects and raw materials used in local communities during centuries.

The objects are incorporating a tangible and intangible heritage related to their production, use and significance. The 10 stone made objects are:

1. The sharpening stone (cutie) – used to sharpen the tools in hay production in traditional farming. Nowadays is replaced by industrial sharpening stones. Usually in Hateg area people used siltstones formed during Upper Cretaceous in marine environments
2. Lime – Lime kilns (var / cuptor de var) - the process by which limestone (calcium carbonate) is converted to quicklime by heating, then to slaked lime by hydration. The lime was used in constructions (cement, concrete, mortar) and to paint houses. Locally was produced from Upper Jurassic – Lower Cretaceous reef limestone outcropping in several spots. Lime kilns are still preserved in small villages and the artisanal production stopped less than 15 years ago;
3. Bricks (cărămizi) – a building material used since Roman time for houses, walls and pavements. The local bricks were made of Middle Miocene clay – siltstone rocks outcropping in several areas. Extraction in small pits are still visible and manufacturing and burning process is still in the memory of local people.
4. Potery (ceramică) – local ceramic tradition based on local clay extraction then transformed into objects of a required shape and heating them to high temperatures in a kiln. A specific local ceramic was produced one century ago in Baru Mare village, where 22 potter wheels were registered in the area.
5. Dry stone walls – are walls made by granite and gneiss boulders without concrete.They are a traditional construction generating a specific cultural landscape. The age of rocks is Proterozoic – Paleozoic.
6. Mal – Traditionally people used a specific volcanic ash to clean wood made objects for Christmas or Easter.There are two different volcanic ash outcrops in the area, an Upper Cretaceous one and a Middle Miocene. In fact the volcanic ash contains zeolites which is an active substance for cleaning and formed naturally with the help of volcanic rocks and ash mixed with alkaline underground water;
7. Fire making (cremene & amnar) - Fire making, fire lighting or fire craft is the process of starting a fire artificially using a flint, fire striker, charred cloths, a piece of mushroom.It was the traditional way of fire making before the industrial era. The flint is usually Proterozoic quartzite.
8. Grindstone (tocilă) – a round sharpening stone used for grinding / sharpening ferrous tools. Grindstones were produced only in one village (Băiești). The specific type of sandstone is outcroping. The sandstone is Upper Cretaceous and was formed in a marine paeloenvironment. A small local industry developed in order to extract the sandstone and to produce: grindstones, millstones, tomb crosses.
9. Ore minerals (minereu) - Hydrothermal epigenetic deposits of copper-led-zinc (Paleozoic) were exploited in a small mine in Boița village. The mine was closed twenty years ago. Memories of these activity are still present and ruins of the exploitation are still visible;
10. Raw materials – marble, pebbles, and andesite – local veins of Paleozoic marble, andesite and pebbles were used by Romans during the construction

of Ulpia Traiana Sarmizegetusa, former capital of Dacia Province, in the 2nd Century B.C. These materials were reused by locals to build stone made churches, castles and houses.

The stone made object will be used also to present the impact of industrialization, the challenges of overexploitation of natural resources and the impact on climate change and possible future resource crisis.

- Each selected stone made object will be documented and explained from the geological and anthropological point of view with the help of specialists. Representative objects will be collected and prepared to be exposed.
- An artist/architect will prepare the design of the exhibition and related images, stories, reconstructions, drawings will be created. Specific panels will present the geologic and anthropologic stories for each object.
- Drawings and artistic reconstructions presenting the Geologic Time, Earth history, local geography, information related to the Danube Geo-Tour project will be produced,
- Development of an on-line booklet to better explain the exhibition.
- The exhibition will be organized in a visiting center called the House of Science and Art located in Berthelot, a former school now in the process of renovation. The main idea of the centre is to present different scientific methods to study the Earth and its processes and materials and the way humans used or are using the Earth Resources. The 10 stone made objects will be incorporated and will be a way to explain the dialogue.
- Hateg Global Geopark has a network of visiting centers each dedicated to one subject: the House of Dwarf Dinosaurs, the House of Volcanoes, the Geopark House, The House of Rocks, the House of Traditions. In some of these centers stories about the use of Earth materials by local people and the impact of this use will be presented
- The interpretation idea could be adapted for other geopark, each territory having specific geodiversity and local communities used Earth materials to produce stone made objects. In order to have a good correlation between local geodiversity and human activities as much as possible stone made objects have to be identified, collected and interpreted.

Best practices from partners and abroad

Interpretation of geological heritage is an important part of a geopark management and one of the key requirements in evaluation and revalidation process. Every global geopark has developed specific activities and infrastructure in order to interpret the dialogue between Earth and human. As we mentioned before analyzing different experiences allowed us to identify at least five types of approaches and for each of them some examples and comments to be presented below.

1. Stone made objects: As we know there are no similar approaches in other territories. In some geoparks (eg Bergstraße-Odenwald, Arouca, Haute Provence, Massive de Bauges, Burren and Cliffs of Moher, Naturtejo) raw materials are presented in guided tours for tourists or educational activities for kids in relation to local architecture. Several years ago Hateg Geopark, Astrobleme Geopark and Haute Provence Geopark initiated a project dedicated to stone made objects. Each of the three lands made use of the same types of artifacts and designed three different exhibitions, each of them with their own approach according to the local culture and the scenographer's design. The objects, each with its own geological tale, depicted a part of our planet as a whole. The exhibitions were: Telluriques : Du terroir à la Terre, analysis on the local specificity of Châtaigneraie Limousine; Util Y Terre for Haute Provence and Memory for Hateg Geopark.

2. Education and visitors centers

The Promenade Museum, Haute Provence UNESCO Global Geopark, France

Webpage: https://www.dignelesbains-tourisme.com/en/patrimoine-naturel/the-haute-provence-unesco-geopark-digne-les-bains/

The Promenade Museum of the Haute Provence Global Geopark, Digne-les-Bains, is a unique museum that combines nature, contemporary art and geology. Through the waterfall of the Park you discover contemporary art by visiting the Scuptures Park, the Cairn Gallery, the path of the butterflies and the Maison des Remparts. The rooms of the Museum show the history of our planet during the last 300 million years. Art products and other geo-products could be found in the local shop.


Figure 94: Promenade Museum shop and Cairn in Promenade Museum, Source: http://www.bontourism.com/en/content/promenade-museum-of-digne-les-bains

The Natural History Museum of the Lesvos Petrified Forest, Lesvos island UNESCO Global Geopark, Greece

Webpage: http://www.petrifiedforest.gr/the-museum/?lang=en

The Natural History Museum of the Lesvos Petrified Forest is a part of the visiting and educational infrastructure of Lesvos Global Geopark and includes two permanent exhibition halls. The first is dedicated to the Petrified Forest and the evolution of plants on Earth, which is presented through rare fossils, from the first single-celled organisms appeared on Earth until the appearance of grown plants and the creation of the Petrified Forest. In the second hall the "Evolution of the Aegean" presents through impressive models and charts geological phenomena and processes associated with the creation of the Petrified Forest and the geological history of the Aegean's basin in the last 20 million years. The visitors can watch the recording of earthquakes in real time by the Seismological Station of Sigri and an earthquake simulator provides a realistic experience of earthquakes to the Museum's visitors, in order to understand the phenomenon and to have a proper training on how to encounter seismic risk.

Figure 95: Natural Museum and Open air museum of petrified forest, Source: http://www.petrifiedforest.gr/the-museum/?lang=en

Visitor information center for the Messel fossil pit, Bergstraße-Odenwald UNESCO Global Geopark, Germany

Webpage: http://www.geo-naturpark.net/en/

Visitor information center for the Messel fossil pit, listed as a UNESCO World Natural Heritage site, is paying intense consideration of the turbulent history of the place, of both the scientific origin and the changing history of the site itself. The center is part of the visiting structure of UNESCO Global Geopark Bergstrase Odenwald. The stratification of the oil shale, exploited in a local pit for more than one hundred years, as genius loci forms the basic graphical idea of the building design. Like an earthen clod, the building breaks loose of the existing angular retaining walls and, with its significant monolithic wall panels, is oriented towards the pit – the actual highlight of the place. The various exhibition rooms in their overall appearance prepare the visitor for the subject matter that they deal with. This is achieved by simple but effective architectural means such as confinement and expanse, light and dark effects, high and low ceilings.

Figure 96: Architecture of Meesel Pit visiting center Messel Pit visiting centre. Entrance, Source: http://www.archello.com/en/project/unesco-world-natural-heritage-%C4%B1-messel-pit-visitor-information-center

Natural History Education Center Ulm, Geopark Swabian Alb – Discover secrets going back millions of years, Germany

Webpage: http://www.naturkunde-museum.ulm.de/

Natural History Education Center Ulm in Swabian Alb UNESCO Global Geopark is a 'living museum in Ulm'. The scientific collections include over 60,000 objects. They are the original documents of the geological periods and recent animal and plant world. This makes the facility to a natural history documentation center and an in-depth learning center at the same time. Numerous models and exempted exhibits are integrated to touch the exhibits. The ecological aspect and the relationship between man and nature play a special role in the exhibitions, including examples of the use of different natural materials in modern world industries. Special exhibitions and environmental education related events deepen the themes of the permanent exhibition

Figure 97: Natural History Education Center Ulm, Geopark Swabian Alb – Discover secrets going back millions of years, Source: http://www.naturkunde-museum.ulm.de

Exhibition Nature in human hands, Natural History Museum, Graz, Austria

Webpage: https://www.museum-joanneum.at/naturkundemuseum/ausstellungen/ausstellungen/events/event/4341/natur-in-menschenhand-1

Do we hold nature in our hands? Does nature hold us in its hands? Is mankind something better due to his power of reason? Do we act in a self-destructive way? How do we want to shape the future? Can we change our perspective? Are humans worth more than animals? Are we able to think unconventionally? Can we be enchanted? Is our curiosity aroused by the unknown? What do we really need? Do we have the capacity to question what is familiar to us? We can form nature, use it, despise it, admire it, investigate it, hurt it … By building a relationship with nature, recognising its treasure, seeing it as a part of us, we can better understand the need to take care of it. The fact we are so embedded in 'network nature' surely leads to active and responsible actions that will ensure life on earth into the future. This exhibition shows how and where this relationship can develop; it shows the sheer variety of species in Austria today and the opportunities that nature offers us. It also reveals how easily we can be thrown off balance. It shows us what we can learn from others involved in nature conservation, emboldening us to reflect on our own actions, letting us discover through play the consequences that follow certain decisions. It encourages us to take nature in our hands – to protect it. For example in room 4 the paths are created to walk on them to figure out how nature-friendly are you? Every day we make decisions that impact nature and nature conservation, whether directly or indirectly. These decisions differ greatly depending on whether they concern our job, education, social background etc. Current research findings confirm that close contact with nature as a child fosters understanding and involvement in protecting nature later on. How about you? In various roles – as a consumer, politician, tourist, farmer or conservationist – you can walk along the paths depicted on the floor, and it's for you to decide which way to go when you reach a fork.

Figure 98: Exhibition Nature in human hands, Natural History Museum, (Photo: J.J. Kucek), Source: Universalmuseum Joanneum Graz

The Visitor Centre of the Troodos National Forest Park, Cyprus

Webpage: http://www.troodos-geo.org/cgibin/hweb?-A=196&-V=troodos

The Visitor Centre of the Troodos National Forest Park has an impressive collection of rocks and minerals, a maquette of the geology of the area, depicting sites of geological importance and interest (faults, mines, geo-trails, etc.), informational panels and a conference room. The center is part of the Troodos Global Geopark visiting infrastructure and hosts exhibits of the abandoned Asbestos and Chromite mines, representations of an ancient pyro-metallurgical furnace for the production of copper and a gallery of the last century for the exploitation of sulphate deposits and handcrafted art products and other geo-products, made by raw materials encountered in the Troodos area.

3. Former industrial exploitations adapted for tourism and education

Mine of lead and zinc Mežica - Slovenia, Karavanke/Karawanken UNESCO Global Geopark, Austria/Slovenia

Webpage: http://www.geopark-karawanken.at/en/caves-and-mines/the-meica-mine.html, http://www.podzemljepece.com/?lang=en

The lead ore deposits between Peca and Uršlja gora reach back to the Roman age while the first written records about the lead ore exploitation date from the year 1665. This year is considered to be the actual beginning of lead mining in Koroška region. Long years of mining and the expansion of the lead mine put a great impact on the area and the life of the inhabitants. The total amount of the of lead and zinc ore dug out in more than 800 km long tunnels in over three centuries was about 19 million. 1994 is the year when the production of lead and zinc ore was permanently stopped. Three years later the mine was opened for visitors.

Visitors use authentic mining train to go into the heart of the mine, so called the Moring district. Driving through the 3.5 km long Glančnik tunnel lasts about 15 minutes and can truly be described as a unique experience. Visitors step out at the station, 600 m below the surface of Veliki vrh. Accompanied by an experienced guide, they find out more about the history of mining. Numerous exhibited objects reveal the everyday work and lives of miners. Upon request, visitors can get a real miner's lunch or breakfast. At the end of the tour, visitors hop back on the train and return from the mine. The entire tour lasts from 1 hour 45 minutes to 2 hours. In the mine different types of mining equipment and tools used in different historical periods from the early beginnings over 350 years ago until the last days of mining in the past century are presented.

Mežica mine can also be discovered by bike and kayak. Led by a guide and equipped with helmets and flashlights visitors can safely ride from one valley to another on a more than 5 kilometers long underground path. In 1994, when the excavation of ore in Mežica mines was stopped, water was no longer drained from the mine so its lower parts were completely flooded all the way to the water shaft where the water flows out. Guides lead visitors along a small underground river until they reach the magical underground lakes almost 700 m below the surface. Visitors can now enjoy the peaceful and pristine water and explore the underground labyrinth, submerged tunnels and excavation sites.

Various mining-related collections are also exhibited in the museum, for example ethnological collection “The presentation of the dwelling culture of the miners in our valley”, the collection of ores, minerals and fossils, the room with measuring equipment and the collection of photos made by Maks Kunc, a naturalist and a photographer.

Figure 99: Mine tour with kayak, (Author: T. Jeseničnik), Source: archive ARGE Geopark Karawanken

Figure 100: Museum of Mežica mine, Source: archive ARGE Geopark Karawanken

Figure 101: Mine tour with authentic mine train, Source: www.podzemljepece.com

Anthony's shaft – tourist mine in Idrija, Idrija UNESCO Global Geopark, Slovenia

Webpage: http://www.geopark-idrija.si/en/, http://www.visit-idrija.si/en/object/613/anthony-s-shaft/, https://www.culture.si/en/Idrija_Mine_Museum

Visiting the second largest mercury mine in the world in Idrija (Slovenia) surely is a unique and pleasant experience. The history of mining in Idrija dates back to 1490. In 1986 the decision was made to close the mine for commercial, geological, and ecological reasons. It finally closed in 1995 but some of its shafts and facilities have remained open for tourists.

Anthony's Shaft was first opened in the year 1500, soon after mercury was first discovered and is known to be one of the oldest still preserved entrances into mines in Europe. It is also the oldest part of the mine in Idrija, named after Anthony of Padua, a patron saint of miners and protector from mine accidents.

Anthony's Shaft presents the hard daily work routine of miners, the precious cinnabar ore, drops of mercury and the unique and extraordinary underground chapel. Visitors can see presentations of old working processes in the mine, from manual ore excavation, loading ore in carts, transporting the full carts etc. All presentations include original tools, old tool copies and dummies. The museum tour is 1,300 m long in an authentically preserved mine. It starts in the 18th century Šelštev House, mighty building, where miners used to take the equipment early in the morning before entering the mine. Here visitors to the mine watch a multivision show in the former call-in room, than professional guides take them through shafts and illuminated galleries with life-size mannequins which illustrate the various mining jobs to the unique underground Chapel of the Holy Trinity, dating from the mid-18th century, the time of the greatest prosperity for the Idrija mine. The shaft was opened for the public in 1994. At the entrance, visitors are given raincoats to wear during the tour and are greeted with the typical miner's greeting srečno ("good luck"), which gets its true meaning when entering the shaft.

Figure 102: Anthony´s shaft (Author: J: Peternelj), Source: Archive Anthony´s shaft

4. Integrated educational and touristic geo-trails

Thematic tours and activities guided with local know-how and the travelling exhibition “When we went for ore”, Naturtejo UNESCO Global Geopark

Webpage: https://www.naturtejo.com/en/

Text: Carlos Neto De Carvalho

At Naturtejo UNESCO Global Geopark we often develop community based, bottom up approaches when we develop thematic tours and activities. Local know-how is usually actively engaged to work as guides or to master subjects related with the interpretation of local landscape or old mining. A tourist product related with panning for gold, that is now offered by different tour companies, was developed based on the know-how transfer of the last gold panners during one of such activities called “There is Gold at Foz!” and brought much attention from media to the territory. The travelling exhibition “When we went for Ore” is an open way to knowledge transfer between old miners and our geologists that provide training to tour guides and educational monitors. The exhibition travelled to several villages where mining activity was once important to create a dialogue that promotes the geomining heritage and also enabled to save intangible heritage that is now available for scientific, cultural, educational and tourist activities.

Figure 103: Activity “There is gold at Foz!”, Source: Carlos Neto De Carvalho

Figure 104: Guided tour to the Salvaterra Gorge, Source: Carlos Neto De Carvalho

Figure 105: Explaining the use of tools at the travelling exhibition "When we went for Ore", Source: Carlos Neto De Carvalho

Footpath for everyone, Adamello Brenta UNESCO Global Geopark, Italy

Webpage: http://www.pnab.it/en.html

The Adamello Brenta UNESCO Global Geopark recently adopted the concept of "Nature Accessible to Everybody and, as a consequence, is rethinking the infrastructure of its nature and culture trails together with its public services and activities. In this context, the Geopark launched on the 3rd of June 2015 the new interpreted trail named "A Footpath for Everybody. It starts at the gateway to the geosite n.18 "Val di Fumo", an extraordinary example of a glacial valley with a typical u-shaped profile. The "Nudole" footpath has been created thanks to the European Regional Development Fund and funding from Chiese BIM. It can be used by any visitor, including blind and disabled people and there are several view-points based on the natural features encountered along the path. At these points, visitors can learn how to read the landscape and the environment using their five senses. Visitors are encouraged to touch the rocks and feel the roughness of the Tonalite, the magmatic intrusive rock of the Adamello Massif; they are encouraged to smell the scent of the aromatic plants such as thymus; they are motivated to listen to the sound of the river crossing the glacial plain of Nudole and are even invited to walk barefoot while crossing the river. In this way anyone can enjoy the experience of the beauty of the Adamello Brenta Geopark. The footpath was launched with a special guided tour. Children of the 4th-5th grades in the local primary school accompanied blind people, the mayor and local residents along the path, invite them to use their five senses to experience this special corner of the Geopark. From the moment when humans discovered stone tools and salt, they have been extracting and using materials from the Earth. Mining is the extraction of metallic or nonmetallic materials from the Earth. Some former mines have been converted into tourist attractions and today visitors can learn a lot about the history of the region or of mining in general by taking a guided tour.

5. **Intangible cultural heritage** generated by geological rock bodies and geologic phenomena.

Buzau Land Aspiring Geopark, Romania

Webpage: http://tinutulbuzaului.org/muzeul-7-locuri-de-poveste/

Buzau Land Aspiring Geopark is located in the Carpathian Band, SE Romania, a place where hills and mountains converge. In the course of geologic evolution of the area spectacular phenomena occurred with great impact on local cultural heritage. The Buzau Land is rich in narratives and legends about good or evil places, names of rivers, valleys or hills all inspired by local geodiversity as a result of a continuous dialogue between Earth and humans. Exhibitions, publications and a visiting centre were developed based on the intangible heritage generated by seven iconic geologic assets: mud volcanoes, salt, oil and gas seepages, amber, strange sand concretions, volcanic ash, vertical beds of fossiliferous limestone called “the giants wall”.

Figure 106: Eternal fire and Artistic view of the Eternal Fire Dragon, Source: http://tinutulbuzaului.org/muzeul-7-locuri-de-poveste/

Lessons learned/tips

- The artistic approach of the exhibition is very important. The exhibition needs to interpret the subject not to offer dry information about the geological processes or local communities;
- The on-line or traditional booklet shall support the exhibition and offer a broader context to understand the specificity of geopark area and also the tangible and intangible heritage of related items to each object;
- An itinerant exhibition may contribute to dissemination and promotions;
- The visiting centre could connect scientific experiments which help us to understand how Earth is working and artistic approach in interpretation of our geoheritage;
- The Earth surface is not seen as a frontier, but as a space where the worlds of animals, plants and minerals meet. The geo-exhibition shall catch the viewer's eye gradually, beyond the surface, making him discover the earth's guts
- The interpretation has to have a cinematographic approach whose key points shall lead to the relationship object – raw material, connected by the time line, common to the earth's and man's history.
- The exhibition shall try to highlight the shapes and aesthetics of the objects, and the geological history to be sketched in an introduction into the natural and cultural environment of the region. The items to be grouped according to the role they played in the traditional economy, from utilitarian to artistic.
- Games or a quiz are still interesting for visitors and could be developed to provide "learning by doing" methods.
- The visitor centre should be related with real life by developing visiting trails where raw materials or human artefacts / constructions are still visible and could be explained and experienced.
- Explanations shall be "easy to understand", avoiding the overloading visitors with many scientific data in short period of time.
- Organization of the exhibition and visitor centre shall have its logic either historical, territorial, geological or with other relevance.

5. Conclusions and recommendations

5.1. Conclusions

The goal of the output was to improve the knowledge-base and exchange practices on quality geoheritage interpretation in participating Geoparks with special focus on 8 selected geological challenges: tectonics, volcanology, geohazards, geology over time, water in time, metamorphic rocks and processes, geomorphology and dialoque between earth and human. Participating partners identified contemporary interpretation methods and technologies and also best practice examples of geointerpretation in their geoparks and abroad. Although there is ample scientific information available, the quality of interpretation among some of participating Danube Geoparks still lags behind more advanced Geoparks such as our associated strategic partners, Rokua UNESCO Global Geopark and Naturtejo UNESCO global Geopark. There is obvious lack of interpretation skills and experiences among Geopark- staff. For some specific geo-processes and phenomena it is hard to find good examples of geointerpretation in the Danube region which would serve as a benchmark (e.g. metamorphic rocks ..). On the other hand, as observed in this research, there exists extensive know-how and variety of best practices and methods for interpretation of geological challenges such as volcanology, tectonics, geological time and water in time.

With this reason, we searched for different methods and new technologies used in geointerpretation all over the world, also in countries outside of Danube GeoTour project partnership. Most recent best practices, new trends, technologies, visitor centres and interpretation methods were screened.

During geointerpretation training hold on 20th September 2017 in Karavanke/Karawanken UNESCO Global Geopark (Municipality of Zell/Sele), project partners shared concrete practical examples from other parks and learnt new interpretation and communication methods. Together with other project partners of the Danube GeoTour Project Karavanke/Karawanken UNESCO Global Geopark visited several visitor centres in Austria, which are also examples of best practice in geointerpretation. Furthermore, the lead partner, Idrija Heritage Centre carried out study tours to 6 newly established visitor centres in Slovenia and abroad.

The field visits provided a deep insight to the current developments in interpretation of nature phenomena in other protected areas and better position the presentations of Geoparks within the Danube programme area.

All of these helped us to draw out lessons learnt and several recommendations that will be useful also for project partners as well as geoparks, nature protected areas as well as other sites outside the project partnership designing an interpretation point or centre. The findings of the output documents will also use for planning and implementation of pilot actions for each partner for their selected geological challenge in the frame of Danube GeoTour and most important all partners of the Danube GeoTour Project achived new competences and learned new methods for interpretation of geological heritage, which can be transfered forward to other geoparks and geopark staff and of course to the geopark guides which are mostly involved into geointerpretation. Through research and training implementation, Geopark guides achieved knowledge about different methods used for geointerpretation, observed successful combination of personal and non-personal interpretation methods, became familiar with different approaches of interpretation – interpretation for kids and interpretation for adults, observe effective personal interpretation, found out how geointerpretation can be more effective with the use of interactive, constructive learning and discovered how to explain complex topics and ideas connected to a site's main themes in simple words and images that are easily accessible for non-expert audiences.

5.2. Recommendations

In the frame of geointerpretation research and learning interactions, the Danube GeoTour project partners concluded that the following basic skills shall be improved and principles followed when interpreting geological or any other heritage in more efficient and quality manner:

- In the first place **geointerpretative planning** is very important – take time for content, visual, audio and multimedia design; only with the proper planning geointerpretation will be successful and will reach and attract visitors;

- **Geointerpretation has to start with basics,** known facts to understand better the further complex geological facts and processes; geointerpretation shall involve as many senses as appropriate and stimulate active participation of the target group to make interpretation more effective;

- **Combine personal and non-personal interpretation**; according to partners practice and experience, personal interpretation has very important role and also priority in geointerpretation, but it is recommended to be combined with non-personal methods such as mobile applications, digital interpretation tools, illustrative tools, etc. For example combination of personal and non-personal interpretation can be already observed in Karavanke/Karawanken Geopark, in info centre World of geology, where the personal interpretation is combined with different digital tools (Geo clock, geogames and geopuls) as well as in Bakony-Balaton Geopark guided hiking tours are supported with non-personal interpretation, such as illustrative material. Also other participating Geopark make us of the before mentioned combination. The facts and information about complex geological phenomena have to be given in simplified and interesting way, in easy understandable language and can be also supported with illustrative materials, other interpretative tools and technologies – our visitors are not scientists;

- **Personal contact** in geointerpretation is more important for visitors than the exhibiton with labels and complex descriptions that most of the visitors will not read;

- **Involvement of the audience** is very important; the geointerpretation has to be suitable for everyone, for children and adults. The geointerpretation addressed to children shall not be a dilution of the presentation to adults, but it should follow a fundamentally different approach;

- **Geointerpretation has to be accessible for everyone** – for the people with special needs, for families with buggies, …

- **Very important are active training programs of Geopark staff and geotour guides** to reach high-quality geointerpretation on guided tours. Geotour guides have to be encouraged to update and upgrade their knowledge and constantly improve their skills. In order to reach this aim, regular education, training and qualification programmes including wider information on geology, geomorphology, geography and local life are necessary. Exchange of geointerpretation experience and practical solutions initiated during the Danube GeoTour project proved to be an efficient learning experience for guides and staff of participating geoparks. Similar practices, including placements of staff in other parks would be beneficial.

- The comprehensive geointerpretation of an individual geopark requires also appropriate supportive infrastructure, such as visitor centers, interpretation points, learning path, etc. It is expensive to set up and properly maintain support infrastructure, thus it is important to consider its cost and benefits well in advance. The project partners have pointed out that the geopark visitor infrastructure shall be developed gradually along with the geopark maturity, staring with the simple geointerpretation point and paths and highly supported with personal interpretation.

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7. Annexes

7.1. Output Factsheet (separate file)

7.2. Questionnaire about geointerpretation

1. How does your Geopark interpretates its geological heritage? Please answer with YES or NO!

a.	Personal Interpretation (different guided tours, schools and kindergardens education, Workshops...)	YES	NO
b.	Non personal Interpretation (Audio-visual equipment, info-Points, panels ...)	YES	NO

2. Which of selected geological processes/challenges are described in your personal or non-personal geo-interpretation? (1- the least preferential and 5 – the most preferential).

a. Tectonics
1 (the least preferential) 2 3 4 5 (the most preferential)

b. Metamorphic processes and rocks
1 (the least preferential) 2 3 4 5 (the most preferential)

c. Geology over time
1 (the least preferential) 2 3 4 5 (the most preferential)

d. Water in time
1 (the least preferential) 2 3 4 5 (the most preferential)

e. geomorphology
1 (the least preferential) 2 3 4 5 (the most preferential)

f. Volcanology
1 (the least preferential) 2 3 4 5 (the most preferential)

g. Sediments
1 (the least preferential) 2 3 4 5 (the most preferential)

h. Dialogue between earth & humans
1 (the least preferential) 2 3 4 5 (the most preferential)

i. Geological hazards
1 (the least preferential) 2 3 4 5 (the most preferential)

3. Which kinds of <u>personal geo-interpretation</u> are used in your Geopark? Please answer with YES or NO!

a.	Guided tours on hiking trails (for visitors, children, children-groups, scientists, ...)	YES	NO
b.	Guided tours on geotrails (for visitors, children, children-groups, scientists, ...)	YES	NO
c.	Guided tours on geopaths (for visitors, children, children-groups, scientists, ...)	YES	NO

d.	Guided tours in your information centres	YES	NO
e.	Educational seminars/programms for schools, kindergartens and other educational institutions	YES	NO
f.	Trainings for guides/rangers/interpreters	YES	NO
g.	Workshops for childrens	YES	NO
h.	Other (please clarify):	YES	NO

4. Which kinds of <u>non-personal geo-interpretation</u> are used in your Geopark? Please answer with YES or NO!

EQUIPMENT			
a.	Booklets	YES	NO
b.	Books	YES	NO
c.	Audio-visual equipment	YES	NO
d.	On-line and Off-line applications	YES	NO
INVESTMENTS			
e.	Info-Points	YES	NO
f.	Informations and visitors centres	YES	NO
g.	Museums	YES	NO
h.	Panels	YES	NO
i.	Other (please clarify):	YES	NO

5. PERSONAL INTERPRETATION – We want to receive some detailed informations about different kinds of personal geo-interpretation used in your Geopark. Please answer to questions, given beneath!

GUIDED TOURS IN DIFFERENT TRAILS AND PATHS				
1. How you scale the quality of geo-interpretation on yours guided tours?				
5 (very good)	4 (good)	3 (acceptable)	2 (poor)	1 (very poor)
2. Please scale how are your guides qualified in geo-interpretation?				
5 (very good)	4 (good)	3 (acceptable)	2 (poor)	1 (very poor)
3. Do your guides use a story-telling tool for a better quality of geo-interpretation in guided tours?				
5 (always)	4 (very often)	3 (sometimes)	2 (rarely)	1 (never)
4. Are your trails and paths equipped with different panels and information boards which includes informations about geological heritage and process, etc.				
□ YES □ NO				

TRAININGS FOR GUIDES/RANGERS/INTERPRETERS		
1. Do you train your guides/rangers/interpreters?		
□ YES □ NO		
2. How often are your guides/rangers/interpreters trained during year?		
□ more than 2 times	□ 2 times	□ 1 time

3. How many guides/rangers/interpreters does your Geopark have?		
□ more than 10	□ 6 - 10	□ 1 - 5

4. What kind of topics do you transfer in your Trainings?
□ NATURAL and CULTURAL HERITAGE □ FOSSILS □ ROCKS AND MINERALS (Metamorphic processes and rocks and sediments,...) □ VOLCANISM □ WATER □ MINING, HUMAN & EARTH □ TECTONICS, GEOMORPHOLOGY, GEOLOGY OVER TIME □ GEOLOGICAL HAZARDS □ OTHER:________________________
5. In which languages are the materials for guides/rangers/interpreters printed?
□ ENGLISH □ GERMAN □ ITALIAN □ FRENCH □ OTHER: ________________________________

EDUCATIONAL SEMINARS FOR EDUCATIONAL INSTITUTIONS			
1. Does your Geopark offer educational seminars and programmes for different educational institution?			
□ YES □ NO			
2. Where do the seminars take place?			
□ indoor	□ outdoor	□ both	
3. Which tools do you use within the seminars?			
□ Audio equipment	□ different games and Apps	□ creative methods (handicraft,...)	□ Other__________
4. What kind of topics do you transfer in your seminars?			
□ NATURAL and CULTURAL HERITAGE □ FOSSILS □ ROCKS AND MINERALS (Metamorphic processes and rocks and sediments,...) □ VOLCANISM □ WATER □ MINING, HUMAN & EARTH □ TECTONICS, GEOMORPHOLOGY, GEOLOGY OVER TIME □ GEOLOGICAL HAZARDS □ OTHER:________________________			
5. In which languages are the materials for educational seminars printed?			
□ ENGLISH □ GERMAN □ ITALIAN □ FRENCH			

□ OTHER: ______________________________

WORKSHOPS FOR CHILDREN				
1. Does your Geopark offer workshops for children?				
□ YES □ NO				
2. Where do the workshops take place?				
□ indoor	□ outdoor	□ both		
3. Which methods do you use within the workshops?				
□ Audio equipment	□ different games and Apps	□ creative methods (handicraft, ...)	□ Other__________	
4. Which of following learning and teaching accessories/materials on the topic of geology do you provide for teachers?				
□ handbooks	□ lectures	□ presentations	□ geo news	□ Other_____
5. What kind of topics do you transfer in your workshops?				
□ NATURAL and CULTURAL HERITAGE □ FOSSILS □ ROCKS AND MINERALS (Metamorphic processes and rocks and sediments,...) □ VOLCANISM □ WATER □ MINING, HUMAN & EARTH □ TECTONICS, GEOMORPHOLOGY, GEOLOGY OVER TIME □ GEOLOGICAL HAZARDS □ OTHER:______________________				

6. NON-PERSONAL GEO-INTERPRETATION – We want to receive some informations about different kinds of non-personal geo-interpretation used in your Geopark. Please answer to questions, given beneath!

BOOKLETS/BOOKS
1. In which languages are the booklets/books printed?
□ ENGLISH □ GERMAN □ ITALIAN □ FRENCH □ OTHER: ______________________________
2. Where are the booklets/books sold?
□ MUNICIPALITIES □ BOOK STORES □ INFORMATION DESKS □ TOURIST - INFORMATION POINTS □ OTHER: ______________________________
3. Do you have special information materials for children?
□ YES □ NO

If the answer is yes, please clarify what kind of materials do you have: ______________________________

INFORMATION PANELS
1. In which languages the information panels are displayed?
□ ENGLISH □ GERMAN □ ITALIAN □ FRENCH □ OTHER: ______________________________
2. Do the information panels include facts about geological heritage or geological processes?
□ YES □ NO

AUDIO-VISUAL EQUIPMENT
1. What kind of audio-visual equipment do you use for geo-interpretations?
□ TABLETS □ PRESENTATION SCREENS □ OTHER: ______________________________
2. Does your audio-visual equipment present the geological heritage, processes and challenges which are typical for your Geopark?
□ YES □ NO
3. Are the geological facts described in easy understandable language?
□ YES □ NO
4. Is the audio-visual equipment suitable for children and adults?
□ YES □ NO

INFO-POINTS		
1. How many Info–points do you have in your Geopark?		
□ more than 10	□ 6 - 10	□ 0 - 5
2. In which languages the informations are available?		
□ ENGLISH □ GERMAN □ ITALIAN □ FRENCH □ Other:______________________________		
3. Are the informations suitable for children and adults?		
□ YES □ NO		

INFO-CENTRES		
1. How many Info centres do you have in your Geopark?		
□ more than 3	□ 1 - 3	□ none
2. Do you have guided tours in Info centres?		
□ YES	□ NO	□ PARTLY
3. In which languages the informations are available?		
□ ENGLISH □ GERMAN □ ITALIAN □ FRENCH □ Other:______________________________		
4. Please describe what kind of audio-visual equipment is used in your Infocentres?		

7. Does your GP has any other geo-interpretation methods, which are not included into this questionnaire. Please describe!
