Geological paths – their use for the regional geography teaching

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Abstract: Geological paths (geopaths, geotrails) represent a type of educational paths that connect sites which are interesting from the Earth-sciences point of view. These sites (e.g. outcrops, old quarries, historical buildings built of local stone or viewpoints) often represent the links between geodiversity and other phenomena within a region (which is in accordance with a holistic approach to geotourism). Thus, they can give complex information not only about the abiotic nature but also about biodiversity, history or culture of the region, usually through narrative. Suitable interpretation of geodiversity and its relationships to the biodiversity and cultural heritage allows to identify regional specifics, it helps to find the mutual connections between particular phenomena within the region and it supports the holistic perception of a given region. The contribution presents an example from the Brno city where the urban geopath can be used for teaching regional geography of Brno and its surroundings.

Keywords: geodiversity, geotourism, geoheritage, cultural heritage, Brno

INTRODUCTION: GEOTOURISM AND EDUCATION

In the last decades, the geotourism has shown a considerable growth all over the world and it is appreciated and accepted as a useful tool for promoting natural and cultural heritage and for fostering local and regional economic development (Hose, 2012, Dowling, Newsome, 2018). Originally, the geotourism was defined as "tourism relating to geology and geomorphology and the natural resources of landscape with an emphasis on provision of interpretive and service facilities to enable tourists to acquire knowledge" (Hose, 1995), later, the National Geographic (2005) presented a more complex definition: geotourism as geographical tourism: tourism that sustains or enhances the distinctive geographical character of a place, i.e., its environment, heritage, aesthetics, culture, and the well-being of its residents. This approach is reflected e.g. in Arouca Declaration (2011) and in holistic concepts of geotourism as well, e.g. Dowling (2013) who stresses the ABC concept or Dowling and Newsome (2018) who discuss the mutual relationships between the various concepts (Fig. 1).

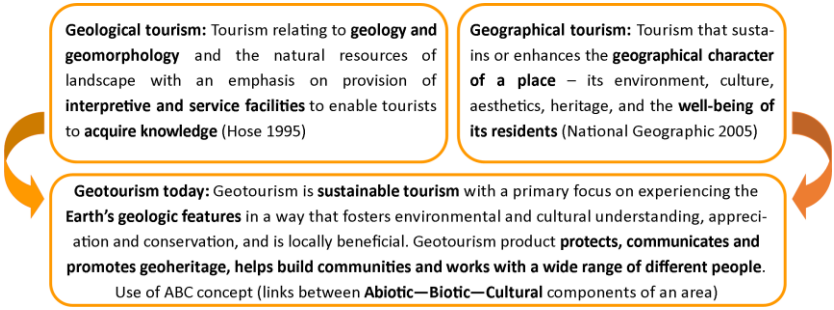

Fig. 1: Definitions and approaches to geotourism

Geotourism and education have been always closely related. Environmental education is one of the pillars of the geotourism and it also plays an important role within nature conservation (Dowling, Newsome, 2010). Since the early 1990s when the concept of geotourism originated, the education and interpretation were emphasized and accepted as an important tool that can raise the awareness of the geodiversity and geoheritage conservation and contribute to the sustainable development of geotourism. The educational aspect is integrated or reflected in numerous definitions and approaches to geotourism, beginning from the early ones up to the present holistic approaches (Dowling, Newsome, 2018).

National Geographic has adopted the term geo-education to describe education about our world; a well-rounded geo-education provides young people with a

fundamental understanding of how the human and natural worlds work at local, regional, and global scales (National Geographic Society, 2018). This approach includes both natural features and anthropogenic impact on them (and vice-versa). Dowling and Newsome (2010) consider the geoeducation a part of the environmental education that is focused especially on Earth sciences and which seeks to create interlinks among geology, pedology and geomorphology within the landscape. The importance of geoeducation and interpretation is also emphasized by Hose (2012) who presents three key interrelated aspects of modern geotourism: geoconservation, geohistory and geo-interpretation. The geoeducation is, of course, an important tool for increasing public geoliteracy (Clary 2018, Vegas Salamanca, Díez Herrero 2018).

Based on the abovementioned, it can be stated that geoeducation has numerous functions, for example: (1) it helps to increase recognition of geodiversity and geoheritage in international, national, regional and local levels which contribute to the geoconservation activities; (2) it makes geodiversity relevant to where the people live and the places they visit; (3) it helps to interpret, utilise and widen understanding of geodiversity and geoheritage for numerous purposes (including geotourism and other forms of sustainable tourism); (4) it helps to create and foster the sense of place and regional identity; (5) it contributes to discover the links between abiotic, biotic and cultural components of the landscape by the public. These selected aspects make the geoeducation really essential not only for geoconservation and geotourism, but also for regional geography teaching.

GEOPATHS: AN EFFECTIVE TOOL FOR EDUCATION

There are numerous geotourist products that have an educative outreach. Geological pedestrian trails (geotrails, geopaths) are one of the ways how to introduce geoheritage to the public. They are usually seen as part of educational activities, as Gray (2013) notes, "the greatest threat to geodiversity is ignorance". Geotrails combine the desire for knowledge (as the main reason for knowledge-based tourism), the experience of an attractive location and the positive feeling of movement. Their appearance can vary greatly depending on the phenomenon they represent, from short walks to and around certain locations (e.g. geotrails in the Mixteca Alta UNESCO Global Geopark; see Palacio Prieto et al., 2019) to long-distance hiking trails (e.g. GeoRoute Ruhr; see Wrede, Mügge-Bartolović, 2012). According to Brilha (2018), the following factors have to be taken into account for the geotrail to be implemented in geosites: (1) the geoheritage has a remarkable aesthetic relevance; (2) the geological/geomorphological significance can be easily understood by visitors with no geoscientific background; (3) there is a low risk of degradation as a result of human activities; (4) there are good facilities and

infrastructures to receives visitors, including those with disabilities. Geotrails can be combined with other kinds of educational activities such as visitor centres, museums, theme parks, disused mines, audio-visual presentations, expert-led programs etc.

Geotrails today are not only a hiking trail lined with interpretation panels; on the contrary, they often use various 3D models, the ability to touch the stone, interact with exhibits or admire the aesthetic side of various works of art. In recent years, modern technology has been widely applied, where, with the help of a smartphone, a visitor can view a virtual 3D model, play a video, or explore the surroundings of his / her habitat using augmented reality, which shows the location in another time period. In addition, if geotrail tells an interesting story, which Drápela and Büchner (2019) consider being a key factor in the acceptance of the educational component of the trail by ordinary tourists, it can be used for thematic teaching at various levels of education. Brilha (2018) describes the suitability of geosites for educational use when: (1) its geoheritage is resistant to the eventual destruction caused by students; (2) it can be easily understood by students of different school levels; (3) it can be easily reached by bus or short and easy trails; (4) it provides safe conditions for students, in particular considering the younger ones. The possibilities of using geotrails for educational purposes are enormous, as geology affects both nature in the locality and many related human activities. They can be used not only in the teaching of biology and geography but also in history, civics, physics, chemistry, art, etc. However, it has the closest connection to teaching the regional geography of the local region.

STUDY AREA

Brno is the second largest city in the Czech Republic (population approximately 380 000 inhabitants) and it is situated in the south-eastern part of the Czech Republic. It lies on the contact of the two different geological units: Bohemian Massif and Carpathian Foredeep. The geology and landscape of the area is very diverse; in the relatively small area of the city, numerous rock types are present: Cadomian Brno massif (metabasalts, diorites and granodiorites), Paleozoic cover (clastic sediments, limestones), Jurassic limestones, Neogene sediments of the Carpathian Foredeep (gravels, calcareous clays) and Quaternary sediments (loess, fluvial sediments, anthropogenic deposits) (Müller, Novák, 2000). The study area belongs to the two different geomorphological provinces: Bohemian Highlands and Western Carpathians (Demek, Mackovčin, 2014) which implicates a variety of landforms. In the northern and central parts, the relief is tectonically influenced (horsts, grabens and tectonically conditioned valleys) and more pronounced, the southern part is rather flat. The uniqueness of the relief of the Brno City lies

in the “chessboard” layout of the ridges and valleys which influenced the situation of the important communications, buildings and urban development in general (Buček, Kirchner, 2011).

The centre of Brno reflects the lithological and morphological diversity of the wider area (Fig. 2). Two geocultural sites – Špilberk and Petrov Hills are probably the most important landmarks within the Brno City and they represent the inherent part of the city’s image. These elevations are noteworthy both from Earth-sciences and cultural/historical point of view. Geologically, both Špilberk and Petrov Hills are a part of metabazite zone of Brno Massif, they are built of Cadomian basalts which were intensively deformed and metamorphosed into the green slates and they represent one of the oldest rocks in the study area (Müller, Novák, 2000). The pillow lavas on the top of Špilberk Hill represent one of the best examples within the Czech Republic. On the eastern slopes of both elevations are covered by loess. Geomorphologically, both sites are considered tectonic horsts elevated above the flat relief of Dyje-Svratka Valley (Demek, Mackovčin 2014). The original landforms (macroforms) are still visible and distinctive, however, parts of the elevations (including natural outcrops) have been modified by human activities that document the land use and landforms changes in the past.

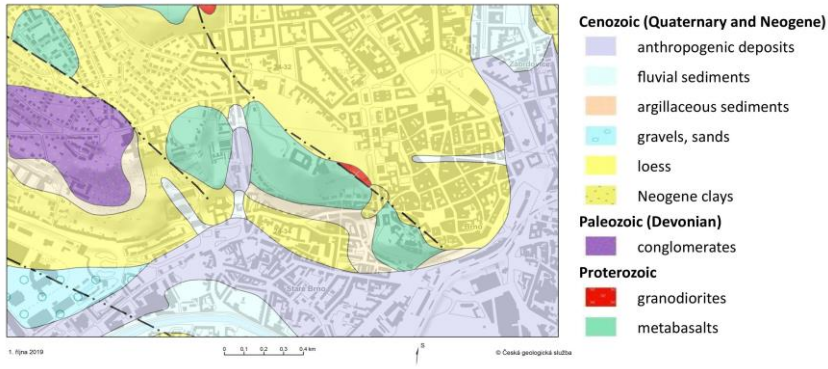

Fig. 2: A geological scheme of the city centre with Špilberk and Petrov Hills which correspond with occurrences of metabasalt outcrops.

GEOPATH THROUGH BRNO CITY CENTRE AND ITS POSSIBLE USE FOR REGIONAL GEOGRAPHY TEACHING

Based on the detailed literature review (Buček, Kirchner 2011, Czech Geological Survey 2019, Müller, Novák, 2000, Mrázek, 1993), an inventory

and assessment of geotourist resources in Brno city was done (Kubalíková et al. 2017, Kubalíková et al. 2019 in prep) and a geopath connecting Petrov and Špilberk Hills was proposed. It includes eight stops which intent to cover all the types of geotourist resources (outcrops, hydrological features, viewpoints, building stone, geomorphology, paleontology, anthropogenic landforms). The supporting information material (Fig. 3) was issued by Tourist Information Centre of Brno, so the geopath can be considered a full value tourist attraction in the city centre. The printed and electronic material (https://ticbrno.cz/informacni-centra/magazin/to-je-geostezka-centrem-brna) includes a brief description of every site comprehensible for a wide public. However, in the future, more education-oriented activities are intended: for every stop, the team of geographers, geologists, historians and teachers wants to propose activities to recognize particular geodiversity features and their relationships to the other phenomena of Brno's region. Primary, the team would like to stress the importance of geodiversity in the city, however, this is going to be done by interpretation of relationships between geodiversity, biodiversity, history and cultural heritage.

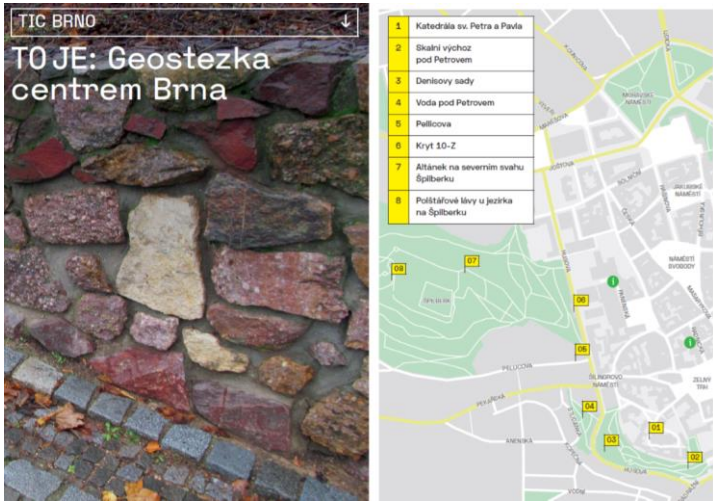

Fig. 3: Printed material of the Geopath through Brno city centre

Below, there are several examples of how originally geologically and geomorphologically important sites can be used for regional geography teaching.

Stop 1: St. Peter and Paul's Cathedral

The cathedral is built on a distinctive metabasalt elevation (such elevations were usually used for placing important buildings), the building stones for the

cathedral came from quarries in Brno or nearby, e.g. white limestone from Stránská skála, purple conglomerate from Červený kopec, and dark metabasalt probably from small quarries in the Brno centre.

Topics for regional geography:

- Influence of the landforms on the position of important buildings and city development
- Mining history, diversity of materials, extraction of the building stone
- Religious history

Stop 2: Metabasalt outcrop on Petrov

In Precambrian (some authors say over 700 Ma ago), Brno lay on a mid-ocean ridge from which lava spewed. Later, under great pressure and heat, it underwent metamorphic processes so that rocks we call metabasalt appeared. The outcrops are now protected as Important Landscape Element.

Topics for regional geography

- Geology, volcanism, tectonics
- Geomorphology (resistance of the rocks)
- Nature conservation and management of protected sites

Stop 3: Denis Gardens

From the lookout in Denis Gardens, it is possible to observe the difference between two European-scale geologic provinces: Bohemian Massif and Western Carpathians (Fig. 4). The obelisk is built of coral marble from Šumbera and it is possible to find some fossils here.

Fig. 4 A view from Denis Gardens: the difference between two main geological units of the Czech Republic can be observed here: pronounced relief of Bohemian Massif (old and resistant rocks, e.g. metabasalts, granodiorites or

limestone) and flat relief of Western Carpathians (soft and younger sediments as sands or clays)

Topics for regional geography

- geological and geomorphological settings of Brno and its surroundings, its influence on agriculture and landuse in the past
- influence of landforms on the position of important buildings or communications
- geography of the industry (importance of natural resources and landforms for industrial development)
- paleontology

Stop 4: Water under the Petrov Hill

The spring in Studánka Park is one of several fracture springs under Petrov. In the Middle Ages, it was an important water resource, but at the end of the 19th century, the water was contaminated by typhoid-causing bacteria. There are some legends about underground lakes under Petrov that are based on the existence of underground wells which sometimes overflow due to the high pressure.

Topics for regional geography

- hydrography, hydrology, hydrogeology
- use of water resources, water management, contamination
- underground anthropogenic landforms

Stop 5: Pellicova Street (use of local building stone)

The walls are composed mostly of red conglomerate mined on Červený kopec, which is one of the materials typically used in Brno. There also appear grey limestone, red-grey granodiorite, and dark metabasalt, so on a simple wall, it is possible to study the diversity of building material from Brno and its close surroundings.

Topics for regional geography

- geological history of the Brno surroundings
- typical rocks for buildings, mining history
- engineering geology, use of natural resources

Stop 6: Bunker 10-Z

Thanks to its good engineering geologic conditions, the Špilberk massif was suitable for the constructing of the war shelter and other underground constructions. The Bunker 10-Z (a typical military anthropogenic landform) was built during World War II, today it is a museum.

Topics for regional geography

- anthropogenic landforms
- history, historical geography, military history
- engineering geology

Stop 7: A view on the northern pavilion

From this lookout, it is possible to observe the landforms of the northern part of Brno. The terrain is varied due to the diversity of the bedrock: in addition to the mentioned pre-Paleozoic metabasalt, the area also has Paleozoic granodiorite, limestone, and sandstone; Mesozoic limestone; Cenozoic sand and clay; and Quaternary loess. Hardier rocks forming ridges and hills were broken, and rivers (Svratka and Ponávka Rivers) found their way along these breaks and over many thousands to millions of years created deep valleys.

Topics for regional geography

- geomorphology, influence of geology on landforms
- influence of geodiversity on the position of important buildings and communication
- mining history (quarries)

Stop 8: Pillow lavas on Špilberk Hill

The small outcrops of dark metabasalt that can been found on Špilberk are often incorporated into the castle walls. The most interesting is the outcrop in front of the main castle entrance, especially because it include pillow lava – rock that formed from lava extruding under water and that prove that Brno lay at the bottom of a Precambrian ocean on a mid-ocean ridge.

Topics for regional geography

- geological history, volcanism
- geoheritage issues and geoconservation
- recultivation, revitalisation
- incorporation of the outcrops into the historical buildings

CONCLUSIONS

Geology and geomorphology (or geodiversity) have strong relations to other components of the landscape and influence human activities (position of the cities themselves, the suitability of landforms for industrial development, managing natural resources, influence on cultural identity, landforms as typical features of a city‘s panorama).

Geopaths can be seen as a tool for promoting geoheritage that can be used for teaching regional geography, biology or history. Interpretation of the relationships between geodiversity and cultural heritage allows specifying regional peculiarities or typical characteristics of a given region (e.g. use of typical building material that contributes to the typical appearance of the buildings in a given area). Particular stops on the geopath can be used as excursion localities with a considerable number of possibilities of how to teach regional geography.

Further activities will be focused on the proposals of geoeducational activities on every stop of the geopath (educational materials focused on geodiversity importance in the city) with an outreach to the regional geography teaching. Another activity can be represented by guided walks for the students of local schools and general public. This can support the holistic perception of the region (or city) and views from a different perspective.

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Shrnutí

Geostezky jsou typ naučných stezek spojující místa zajímavá z hlediska věd o Zemi. V současné době jsou velice populární v geoparcích nebo ve zvláště chráněných územích, kde slouží jako efektivní způsob propagace geodiverzity a dědictví neživé přírody. Postupně se objevují i ve městech, kde mohou být považovány za alternativu k tradičním turistickým destinacím přístupným velkému množství návštěvníků. Dílčí zastávky na geostezce (např. skalní výchozy, staré lomy, budovy, kde je využitý místní materiál, výhledová místa) často představují vzájemné vztahy mezi geodiverzitou a dalšími fenomény v rámci určitého regionu (což je v souladu s aktuálním holistickým pojetím geoturismu). Geostezky tak podávají informaci nejen o neživé přírodě regionu, ale i o jeho biodiverzitě, kultuře nebo historii, většinou prostřednictvím příběhu. Vhodná interpretace geodiverzity a jejích vztahů k živé přírodě a kulturnímu dědictví může přispět k identifikaci regionálních specifik, napomáhá při hledání vztahů mezi dílčími fenomény v rámci regionu a přispívá ke komplexnímu vnímání konkrétního regionu. Příspěvek představuje geostezku centrem Brna a ukazuje, jak můžou být jednotlivá místa na geologické stezce využita při výuce regionální geografie Brna a jeho blízkého okolí.