

## Application of GNSS and GIS in mining tourism

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*The present brings the intensive development of various technologies that support the collection and processing of spatial information. In all areas of social life, human activities directly relate to the position defined by the space around us. In the mining tourism, the spatial localization of all objects is important in several respects. The importance of spatial information in mining tourism stimulates mainly the fact that at present the focus is to improve the visibility of mining heritage. The article presents possibilities of GNSS and GIS for data collection and post processing of spatial information to support the activities of mining tourism.*

**Key words:** mining tourism, GNSS, GIS

### Introduction

Information in the tourism sector has a naturally spatial character. When we are talking about “classic tourism”, most people have a clear image of it, often including accommodation, tourist trails, and a nice view of the countryside (Štrba, Kurtová, 2013). Geographical factor is an integral part of many objects and phenomena, which describes mining tourism. Mining tourism is focused on exploring disclosed workings of museum-related exposures approaching technology of extraction of minerals, miners living in the past and so on (Lukáč, Molokáč, 2007). Mining tourism presents the area of former mining towns and villages that are currently sufficiently close association mining unions and guilds in Slovakia (Association mining unions and guilds in Slovakia). Introducing the concept of mining tourism is to focus attention on objects that are related to mining and mineral processing. Heritage tourism is tourism at sites with history as their main theme or attraction (Light 1989, Edwards, Llurdé, 1996). The object of interest is directed to approximation mining - historical heritage. Development of mining tourism could be an effective tool for mitigating the impact of the continuing economic crisis in the mining industry (Weiss, 2013). Spatial information necessary for the application uses in mining tourism is necessary to obtain appropriate methods designed for collecting spatial data. This opens up the field of geodesy, which implements the latest methods and procedures for collecting spatial information in its surveying practice. At present, only marginal attention is given to the issue of the use of global navigation satellite systems (GNSS) and geographical information systems (GIS) in mining tourism. GNSS receivers are already longer an integral part of obtaining spatial information not only for surveying. Their application has been intensified especially through a network of reference stations. The aim of this paper is the presentation of GNSS options in the process of collecting spatial information and subsequent processing through GIS tools in relation to particular objects after mining activities within a defined micro region. This form can contribute to increasing the visibility of the regions in which the mining tourism directly affects them.

### Geographical information, definition of administrative areas covered in connection with the mining activities

The Hnilčík micro region is situated in the north-western part of the Kosice region, in the territory of the historically significant region - Spiš. The area is a part of the holiday territorial unit Slovak Paradise with ties to Spiš cultural-historical complex of international importance. Its territorial area is ranked eighth in the district Spišská Nová Ves (Information of community Hnilčík).

Settlement of the present Hnilčík incurred independently in different spheres of power interests. The nature of Hnilčík settlement was changed over the centuries: populated parts „move“ according to the position of prosperous or merging mines (Minerals and rocks of Slovakia). At present, the village Hnilčík is known by hiking trail that brings technical monuments in the mining town, famous centuries-old mining and metallurgical processing of copper ore from the mid-19th century and iron ore. The intention

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draws a demarcation of four educational trails and installation of information boards, covering remarkable places of famous sites Roztoky, Bindt a Grétla-Cechy (Educational trail history of mining in Hnilčik).



Fig. 1. Location and overview of the Hnilčik micro region  
Source: <http://www.zbsc.eu/download/tabula1vacsia.png>

### Methods of collection and data sources for the needs of planimetric survey of mining tourism objects

Collection of spatial information for the purpose of planimetric survey is one of the most demanding tasks in terms of time and finances. There are many different sources of geospatial data and many ways for their collection. In practice, two main methods of data collection are applied (direct – measuring tapes, indirect – ETS, TLS, GNSS).

Choice of data collection methods depends on the application and use of types and nature of objects whose data is to be obtained. Geodetic basis for detailed planimetric and altimetric survey is the use of GNSS technology (Sabolová, 2012), which has significantly increased its accuracy in recent decades, giving a prerequisite for their use in mining tourism.

The advantage of using GNSS technology consists mainly of independence from direct visibility between the points providing the possibility of realisation of measurement with high accuracy, because it is not necessary to perform breaks through dense vegetation. Currently in GNSS measurements, only condition of non-obscured sky must be satisfied, respectively direct line of sight to the satellites (Labant et al., 2013). Determination of the spatial position by the GNSS technology is based on the principle of measuring the distance between satellites and the object, therefore the time required to travel this distance. The accuracy of single point determination is guaranteed by the SKPOS service with 2 cm in position and 4 cm in height. Objects of mining tourism identified by the GNSS technology are at a very high level in comparison with the GPS device used for navigation (accuracy of about  $\pm 20$  m).

Advantages and disadvantages of using the GNSS:

- The advantage of GNSS technology over terrestrial technologies, which are used in geodesy, is the possibility of measurements in all weather conditions and high accuracy of this technology. This means that long distances or coordinates of points that are separated by a few kilometers, can be determined with centimeter accuracy.
- Disadvantages lie in the inability to use this technology in the underground. Also, the measurement results can be worse with an increasing density of the forest or buildings (Staněk et. al., 2007).

### Methods of position determination using GNSS

Determination of the point position on the Earth's surface using GNSS can be realized by different methods of measurement (Labant et. al., 2013):

- Absolute method – (lower accuracy).
- Relative method – higher accuracy (RTK is the most frequently used method), (Fig. 2).

In any case, the data collection has to be sufficiently accurate and complete for the specified application. A set of basic spatial data is a representative result of an application

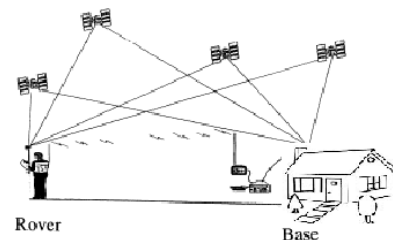


Fig. 2 Principle of RTK  
Source: [www.sciencedirect.com](http://www.sciencedirect.com)

of selected geodetic methods for determining the spatial position of the observed object. Geographic information obtained in this case is seen as a means of knowing the monitored phenomenon. Geographic information includes spatially associated information presented by X, Y and Z coordinates (Gergeľová et al., 2013).

### Methodology and methods of processing for selected area

Before the analysis of objects of the Hnilčík micro region, a terrain reconnaissance should be realized. For further processing of spatial information, it is necessary to obtain quality data about the position and altitude of these objects. In order to get sufficiently accurate data, the following is necessary:

- quality instrumentation,
- appropriate measurement methods,
- data processing.

To pass the land survey, it is necessary to establish a field sketch, i.e. a graphic and numeric tick of the studied area with the necessary particulars of the position and reference points of measurement, realized prior to survey and during or after the terrain reconnaissance. The customary procedure of geodetic practice is used for easier and quicker orientation. Objects of planimetry are usually recorded in the field sketch, so this sketch is drawn during the survey of planimetry, i.e. objects, points, lines and so on, thus it is not used to record the course of contour lines and altimetry. Formerly, also measured data were recorded in field sketches (angles, distances, stationing, perpendicular and others), (Fig. 3), (Pavlík, 2012).

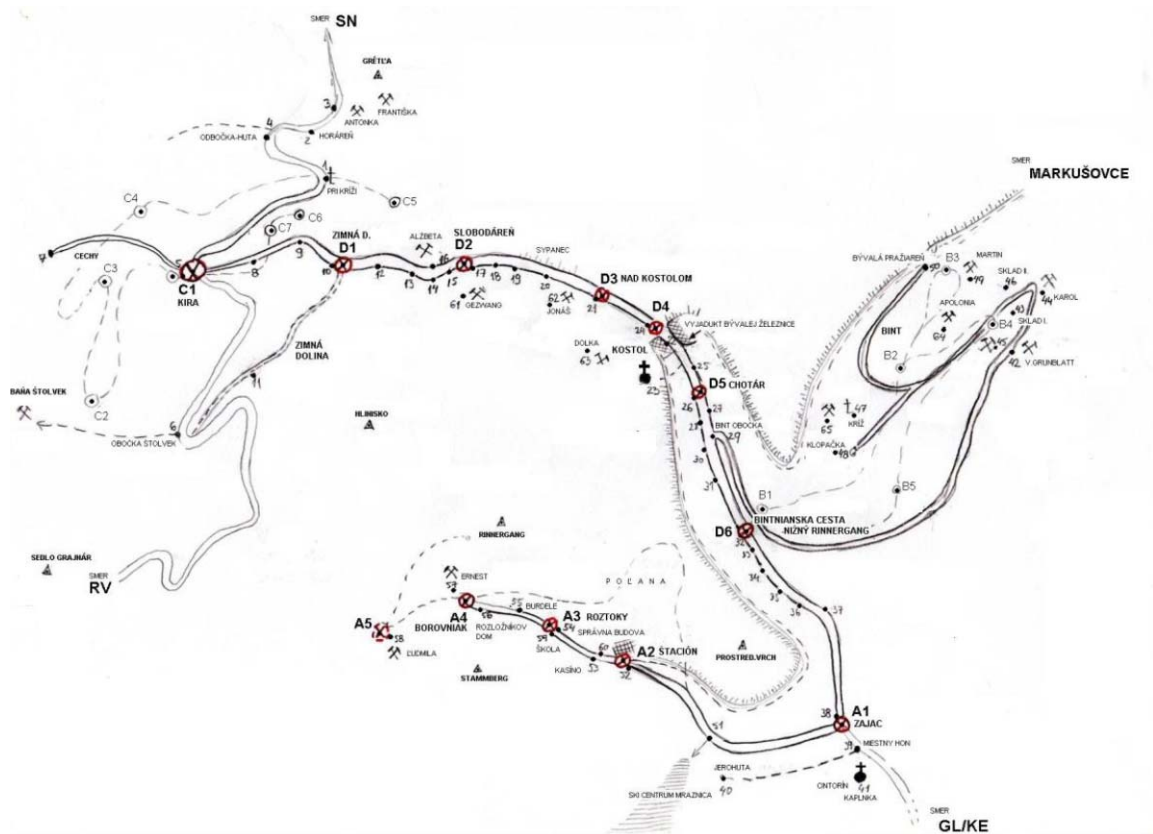


Fig. 2. Preview of sketch surveying (Pavlík, 2012).

The position and height of objects can be measured by using the RTK GNSS method by the Leica GPS900CS receiver (Fig. 4).

Using this method, a primary data about the position of points of interest can be obtained. Data obtained by this technology can be further processed with the support of GIS, which allows to add additional descriptive attributes to objects. 10 km from the Hnilčík micro region is located popular tourist place Dobšinská Ice Cave where GNSS technology was used in order to examine volume of ice diminution in the cave (Gašinec, et al. 2012).

### Use of GIS in mining tourism

At present, through the support of tools, GIS provide a modern approach to solve any problem issues in various areas of social life. They offer a quick access to spatially orientated information. The outputs of processing are mostly thematic and interactive maps. The current human activities are directly linked to the position that is defined in geographical space. Trends in information technology allow to „perceive all the circumstances around us spatially”. The advantage of the spatial perception of objects and phenomena is a creation of mutual spatial connections between them and a benefit from the acquired knowledge of interrelationship. GIS as a tool for the support of collection, analysis and presentation of spatial information helps to integrate information from multiple sources (Gergeľová et al., 2013).

Data received and collected by GPS and GNSS technologies are currently used for creating 3D GIS, in particular for the creation of digital terrain models and 3D models of buildings (Kuzevičová et al., 2012). Through a suitable GIS application interface, all observed objects in the area of mining tourism can be effectively processed, analysed and visualised. Using a GIS in geotourism (Gregori, Melelli, 2005) and mining tourism through analytical tools supports the possibility of processing various forms of information related to the area of interest. This ability ranks them highly. They also fully support the development of spatial models. Very popular are virtual tours, for example nature trails after mining activities, eventually museum expositions based on the mining activities.



Fig. 3. GNSS receiver.  
Source: Authors

### Conclusion

The paper was focused to introduce the possibility of GNSS and GIS for use in the application for mining tourism. The issue of mining tourism in Slovakia is still an unexplored topic. Slovakia is a country with very rich mining and historical heritage that should not remain unnoticed. Spatial documentation of objects of mining tourism plays an important role in the further approach of mining and geological monuments (Mixtaj et al., 2011). The focus of mining tourism should be concentrated on geological and mining monuments. Mining tourism has a great perspective, the basis of which is precisely a mining tradition. Parties interested towards higher attractiveness of regions oriented to the history of mining could effectively support the development of tourism in individual areas by using the presented available technology.

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