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The Herľany geyser – a unique hydrogeological and geotouristic locality in Europe

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Abstract: *The paper introduces the Herľany geyser as a unique geotouristic locality that would be appreciated as a member of any geosite network. Based on description of general geology and hydrogeology of the area, the text explains the origin of the cold-water geyser. Applying the method of geosites assessment, detailed geotouristic value of the geyser is specified for the first time.*
Key words: *geyser, Herľany, geotourism, geosite*

Introduction

Nowadays, efforts are widely discussed how to preserve, protect and promote various types of not only human but also natural sites and monuments. There are many organizations and associations (e.g., ProGEO, CO-DBP) dealing with these problems. As mentioned by the committee for the activities of the European Council in the field of biological and landscape diversity (Weighell, Torfason, 2002, CO-DBP, 2008), natural features are a vital part of world heritage and conservation of this heritage ensures that the future generations will also learn about the geological history of the planet, and their close environment through education and research, and that people will enjoy the beauty of the nature. Geotourism, as a newly emerging global phenomenon (Dowling, 2008), offers the ways how to achieve these aims. Therefore, it is very important to identify, characterize and introduce to the general public as many geotouristic localities (geosites) as possible. Below, the Herľany geyser is described with its specific water regime and considerable geotourism potential of Herľany village in the Eastern Slovakia.

Localization and characteristics

The geyser itself is situated in the old spa of the Herľany-Rankovce (Fig. 1), 28 km northeast from the city of Košice (Fig. 2), at the foot of the Slanské Mts. (*Slanské vrchy*).

Mineral springs have been known in the area since the XVIIth century. The first who draw attention to these springs was Daniel Textoris, a physician from Abov county. In the years 1772–1803, local scientists studied the springs and concluded that water can be used for balneotherapeutic purposes. In the XVIIIth century, a spa was developed in Herľany for treating the gastric, intestinal and rheumatic diseases. In 1869, it appeared that the yields of mineral springs are insufficient to cover the consumption of therapeutic mineral water. Hence, in 1870, a new drilling has been initiated, that resulted in "geyser inception".

The Herľany geyser differs from the "classic" geysers in low temperature of water because it is situated in the area of extinct volcanic activity. The geyser has been continuously active since 1872. Initially (1872), eruptions occurred every 8 to 9 hours, later on – every 18 to 20 hours with the discharge varying from 21 to 36 l/s. During the drilling, in 1873, strong eruption from 275 meters depth destroyed the derrick. Even stronger outburst took place in 1873/74 from 330 meters depth. Water column was over 100 meters high and eruption has lasted for 10 days. Finally, drilling was completed at about 400 meters depth (Fig. 3). Nowadays, the geyser spontaneously shoots water column from 10 to 15 meters high every 32 to 36 hours (Figs 4, 5). Eruption lasts approximately 25 minutes with an average discharge from 25 to 30 l/s. The time intervals between eruptions depend on rainfalls – during heavy rains the intervals reduce and *vice versa*. The temperature of erupted water varies from 14 to 18°C. According to Dobra and Pinka (2004), there were more than 40,000 eruptions during the Herľany geyser life (Figs 4, 5).

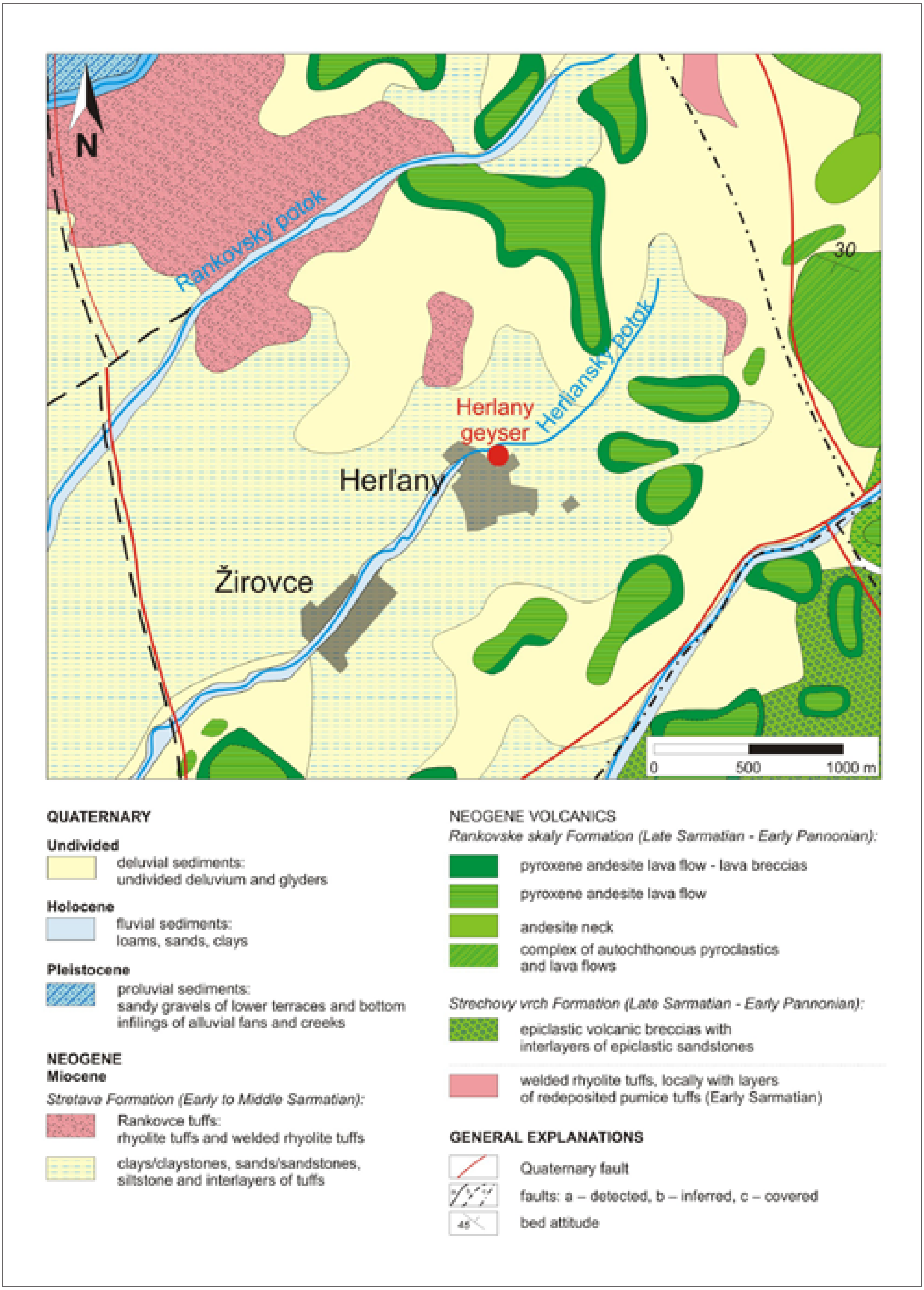

Fig. 1. Geological map of the Herľany area (after Kaličiak et al., 1991 and Bezák (ed.), 2008; modified)

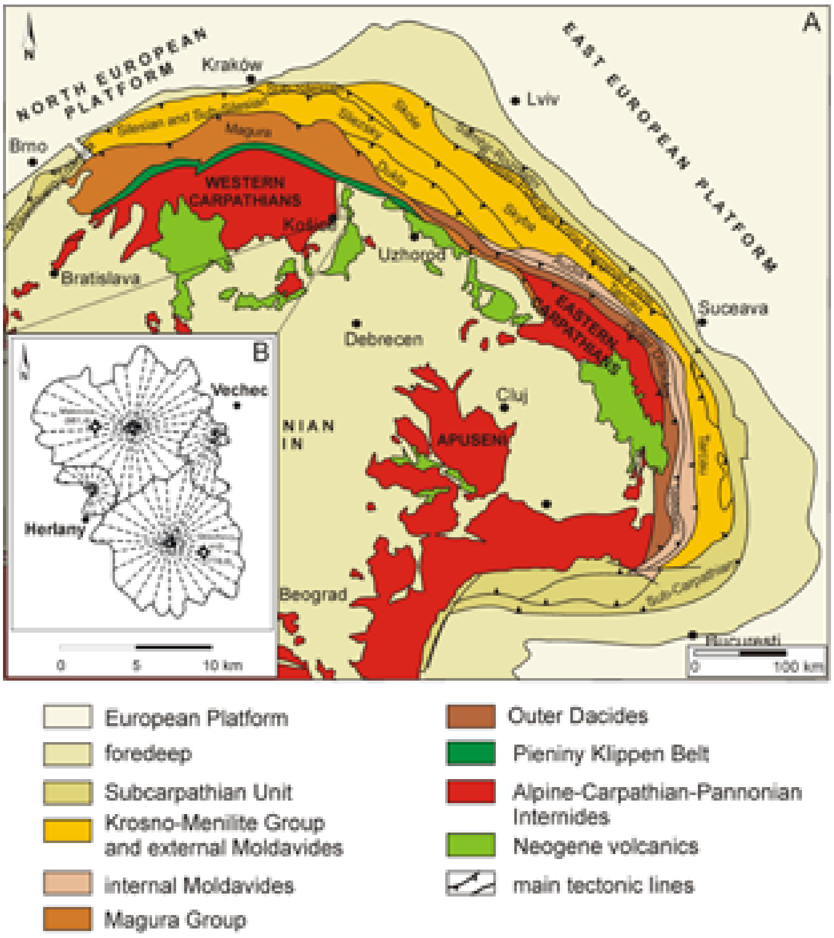

Fig. 2. Geological map of the Alpine-Carpathian-Pannonian region (after Kováč et al. *fide* Oszczypko, 2004; modified) (A); sketch map of volcanic formations in the Slanske vrchy Mts. near Herľany (East-Slovakian Neogene Volcanics) (B) (after Ozdin, Mesiarkinova, 2010; modified)

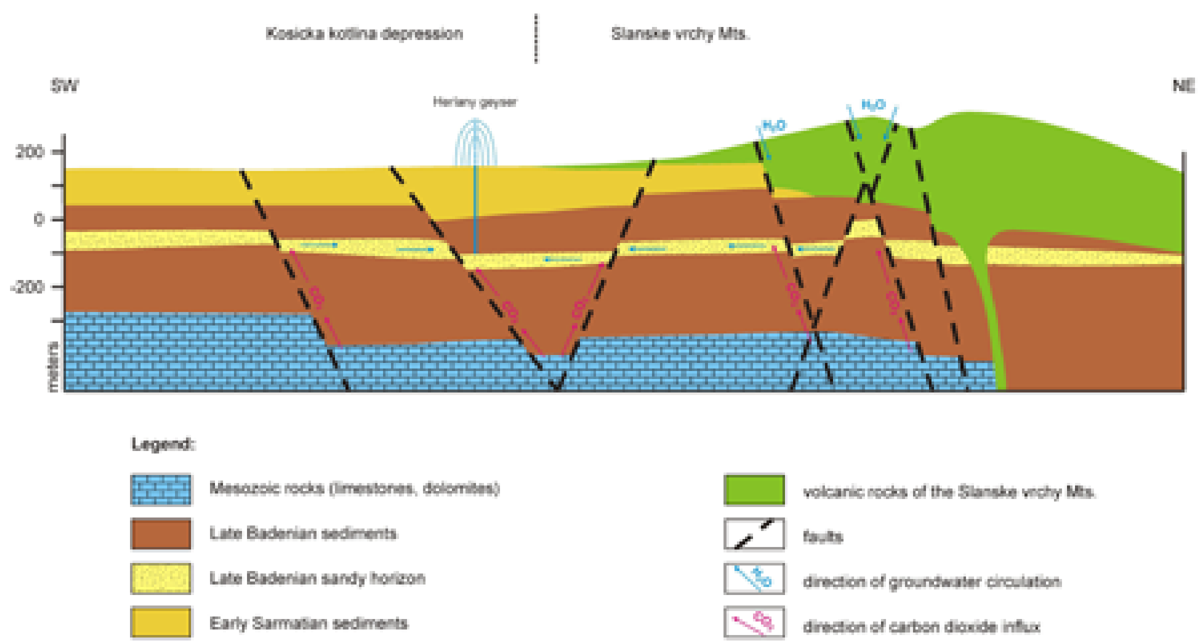

Fig. 3. Geological cross-section of the Herľany area with directions of groundwater circulation and carbon dioxide influx, horizontal distance not to scale (after Rudinec *et al.*, 1979)

Fig. 4. Wellhead of Herľany geyser, photo L. Štrba

Fig. 5. Erupting Herľany geyser, photo L. Štrba

Geology of the Herľany area

The Herľany area belongs to the East-Slovakian Neogene Volcanic Belt (Fig. 1; e.g. Biely *et al*., 1996). Volcanics in the surroundings of Herľany are mostly pyroxene andesite lava flows (Kaličiak *et al*., 1991). The K/Ar age of pyroxene andesite from the *Makovica* stratovolcano is 11.9 Ma (Ďurica *et al*., 1978) and the age of amphibole measured with the fission track method is 11.2±0.6 Ma (Repčok *et al*., 1988). Moreover, the isotopic age of hypersthene-augite andesite from the *Strechový vrch* stratovolcano is 10.8±0.3 Ma (Kaličiak *et al*., 1991) and the K/Ar age of pyroxene andesite from this locality is 12.35 Ma (Ďurica *et al*., 1978).

All these ages correspond to the Sarmatian-Lower Pannonian time span. Epiclastic volcanic breccias, sandstones and conglomerates, redeposited andesite tuffs and other pyroclastics are present mainly in the peripheral parts of the *Makovica* and the *Strechový vrch* stratovolcanoes or smaller parasitic cones of the *Rankovské skaly*.

In the Neogene (22–11 Ma), the Herľany area was flooded by the see in which various facies of coarse- and fine-grained detrital sediments were deposited, mostly conglomerates, sandstones, siltstones and claystones of thickness from 800 to 1,000 m. These sediments cover Mesozoic limestones and dolomites. In the Sarmatian, during the marine deposition episode, an extensive volcanic activity has started, which resulted in the formation of the *Slanské vrchy* volcanic mountains. The mountains are composed of the chain of andesite volcanoes preserved only as the relicts due to intensive posteruptive erosion. However, it is still possible to identify the volcanoes structures: (1) the central crater zones consisting of hydrothermally altered rocks and intrusive complexes of diorite porphyries; (2) transition zones (stratovolcano mantle) consisting of inclined andesite lava flows; and (3) peripheral volcanic zones including redeposited pyroclastic and epiclastic breccias, conglomerates and sandstones (Fig. 2; Dobra, Pinka, 2004).

According to Rudinec and Magyar (1996), the well, nowadays known as the Herľany geyser, penetrated the following stratigraphic units (from the top): (i) the Secovce Formation (Pliocene), 50-meters-thick; (ii) the Stretava Formation (Lower Sarmatian), 150-meters-thick and (iii) tuffs down to the well bottom at 404.5 meters depth, of thickness increasing from 20 meters in the west to 50 meters in the east. The area is cut by dip-slip faults which created structural depression (basin) partially covered by the western part of the *Slanské vrchy* neovolcanics. The Secovce Formation consists of mottled clays, coaly clays, lignites, tuffs and tuffites whereas the Stretava Formation is composed of clays/claystones, sands/sandstones and siltstones interbedded by tuffs (Kaličiak *et al*., 1991).

Complicated geological structure of the Herľany area was affected by tectonics, mainly by normal faults, which resulted in the formation of horst-and-graben structural pattern. The faults deformed both the Neogene volcanic complex and the underlying, pre-Neogene complexes. These faults provided very important patchways of groundwater circulation regime.

Besides suitable geological conditions in the area, the activity of the Herľany geyser is influenced by the system of groundwater circulation and the system of carbon dioxide influx, which is the main energy source (Kaličiak *et al*., 1991). Rainwater infiltrating through the volcanic rocks of the *Slanské vrchy* merges with the groundwater. These waters participate partly in a shallow groundwater circulation system and discharge in joint- or bedding-controlled springs located at the boundaries of different rock types. Another part of groundwaters migrates into the deeper rock formations along numerous faults, and recharges clastic and volcanic horizons within the Neogene complex. The driving force of water eruptions from the Herľany well is carbon dioxide. The gas saturates groundwater and the whole system "works" as a siphon, as already supposed by Zsigmondy (1877). Carbon dioxide migrates predominantly along faults from the Mesozoic formations underlying the Neogene sediments (Fig. 3). Increased concentrations of carbon dioxide in Mesozoic rocks were documented in boreholes (Dobra, Pinka, 2004).

Geotouristic value of the geyser

There are several approaches how to evaluate natural object from the point of view of geotourism. Wimbledon *et al*. (2000) proposed the principles for assessment of scientific value of geosites. They specified 9 questions that should be answered by the proposer of a geosite in order to subjectively specify its value.

Rybár (2010) proposed a method of geosite evaluation based on scoring system (point ranking). He defined 10 criteria for object evaluation. Using this method, it is possible to determine exact score of each assessed object. Although it must be emphasized that this method is highly subjective the application of point sheet provides better opportunities to determine more accurate value of an object. This method was used to determine the geotouristic value of the Herľany geyser.

Applying the point ranking suggested by Rybár (2010) to the Herľany geyser, we can quantify the geotouristic value of this object (Tab. 1). As a natural object, the geyser "scored" 68 points from maximum 80. It definitely indicates significant value of the Herľany geyser as a geotourism attraction. Despite its incontestable value, the geyser is not a part of any geopark or geosite network. In Slovakia, there are two operating geoparks – the Novohrad-Nograd

Geopark (*Novohrad-Nógrád Geopark,* member of the European Geopark Network) and the Banska Stiavnica Geopark (*Banská Štiavnica Geopark,* Cimermanová, 2010) but the geyser is located too far from the areas of both geoparks. Based on the "*Conception of geoparks in Slovakia*" from 2008, the geyser is included into the area of planned Dubnik Geopark (*Slanské vrchy*), which aims to present to the public the world-famous opal mining area with the remnants of mines.

The specific properties of the Herľany geyser, totally different from those of the hot water geysers worldwide, make this object unique in Europe. Another human-made cold water geyser is located in *Sivá Brada* ("Grey Beard") not far from *Spišské Podhradie* town. That site has been known since the XVIIth century due to two mineral springs flowing out from the top of a travertine mound. In 1956, a well was drilled down to 132 m depth in order to supply mineral water to the nearby bath. Reservoir encountered mineral water of temperature 11°C highly saturated with carbon dioxide at 120 m depth. Initially, eruptions took place thrice a day and water column was about 15 m high. With the time, the energy of circulation system ceased and now this is only a spring bubbling of carbon dioxide, which is supplied from deep sources through the fault system (Tatarko, 1990). In German city *Andernach* we can observe the highest cold water geyser eruptions in the world (water column reaches 64 meters). This object is comparable with the Herľany geyser but differs in chemical composition of water and the mechanism of eruptions.

Tab. 1. Point ranking of the Herľany geyser attractiveness as a geotouristic object

CHARACTER	SCORE
Primary geological properties	
Object does not belong to any geosite network but its character corresponds to such networks	5
Uniqueness	
Object unique within Europe	8
Object accessibility	
Comfortable access	8
Existing scientific and professional publications	
Scientific and professional geological literature	8
Conditions of observation (research)	
Suitable	8
Safety criteria	
Object and surroundings safe	8
Information availability at the object	
Available and quality information on the Internet	8
Visual value of the object	
Object in landscape with no view on its surroundings	3
Value of provided services	
Accommodation and catering offered	7
Object in the tourist area	
Object visited by holidaymakers	5
TOTAL	**68**

Tab. 2. Sites of (geo)tourist interest near the Herľany geyser

Locality near the geyser	Description	Distance [km]
Kamenica Creek	common opals in the left bank of the creek	1.3
Vyšná Kamenica	water dam	1.5
Hrádok	remnants of Medieval fortress	2
Malé brdo	state nature reserve	2.5
local creeks in Banské village	limnoquarzites	3
Rankovské Skaly	remnants of parasitic cone	3
margins of forest meadows	fleshy opals	5

Access to the Herľany locality is very comfortable. It is possible to use public transport (bus) or private car. Moreover, Herľany is a trailhead of many bicycle trails. As the locality was a scientific field of interest, there is a plenty of available, scientific and/or popular (not only geological) literature (*e.g*. Derco, 1955; Rudinec *et al*., 1979; Kaličiak *et al*., 1991; Tometz, 2001; Dobra, Pinka, 2004). Finally, the value of the geyser site is increased by its accessibility for disabled visitors.

General tourism and geotourism potential of described locality is also supported by the presence of other (geo)tourist sites close to the geyser (Tab. 2).

Conclusions

The Herľany geyser represents a rarity due to its character and properties, and without dispute, it can be considered as European peculiarity. Knowledge and understanding of this unique object can help to preserve and protect this peerless natural monument, which would not be created without the "human intervention". For the first time, the Herľany geyser was evaluated from the point of view of geotourism. It can be assumed that the score of 68 points (from 80 possible) indicates indisputable geotouristic potential of the object. Development of this potential can contribute to the progress of (geo)tourism in the Herľany area and in Slovakia.

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