Occurrences of Mineralized Waters and Mineral Springs in Kysuce and Their Meaning for Geotourism

Dominik Niemiec 1, Marian Marschalko 1, Miloš Duraj 1, İşik Yılmaz 2

1 VŠB-Technical University of Ostrava, Faculty of Mining and Geology, Institute of Geological Engineering, 17 listopadu 15, 708 33, Ostrava, Czech Republic
2 Cumhuriyet University - Faculty of Engineering - Department of Geological Engineering - 58140 Sivas, Turkey

E-mail address: marian.marschalko@vsb.cz

Abstract. Kysuce is a region situated in north-western Slovakia and it borders the Czech Republic on the west and Poland on the north. From the geological point of view, the locality is mainly formed by Tertiary flysch formation. This composition together with the relief of this location created very suitable conditions for occurrences of numerous mineral springs which can be found in this region. The increased concentration of mineral contents in the waters which find their expression not only through taste but also through their typical odour held the interest of local inhabitants already in the past centuries. Currently, they are frequently visited not only by inhabitants of the region but also by visitors to Kysuce. From the geotourism point of view, this region offers more interesting geological phenomena. Some of them, such as a crude oil seep in Korňa or occurrences of sandstone and agglomerate stone balls, rank among world unique.

1. Introduction

At present, water is becoming a rare commodity in the world. Environmental pollution, climatic changes and other factors substantially contribute to the fact that water supplies are continuously decreasing. In future, water will belong among top strategic raw materials. Thus, protection of water resources found on the Earth is very important. Fortunately, Central Europe still has sufficient water supplies. Mineral and mineralized waters have been sought-after since the past and at localities where they occur, important spa towns were founded. The locality of Kysuce in the Slovak Republic also has several occurrences of mineralized waters which are sought after mainly by the inhabitants of the region. The spring yields are not very high, and thus the waters are not used industrially. Tourist movement in the region and nature conservation, mainly in the 1970’s, played an important part in incorporating some of the springs into the list of natural protected areas. Activities of environmentalists, tourists and enthusiasts have also led to the current state when these locations are adapted and enabled for the needs of tourism. In the world, popularity of non-traditional forms of tourism – geotourism – is increasing. Out of many authors who have been dealing with this topic recently, we can list [1, 2, 3, 6, 8, 9, 12, 14].

2. Geological and geomorphological features of Kysuce

The area under investigation belongs to the Outer Western Carpathian from the geological point of view which form part of European Alpine Orogeny. Natural conditions of this area have already been studied by many other authors, such as [5, 7, 13].
2.1 Flysch Belt
A substantial part of the area is formed by the Tertiary flysch formation. Petrographic composition of the formation is rather monotonous and created with clastic sediments. Mainly sandstone and clayey sediments alternate here. A typical feature for this evolution is the nappe structure. Several units may be detailed here. These are mainly the Bystrica and the Rača Unit which belong to the Magura Nappe (inner) and partly also the Silesian Unit belonging to the Silesian-Krosno group (outer). A frequent appearance of slides is typical for this belt.

2.2 Klippen Belt
The south-eastern part of the area under study is formed by Mesozoic sediments. It is a narrow belt which forms a border between the Inner and Outer Western Carpathians. From the petrographic point of view, it is formed by a varied spectrum of limestones, often with cherts from the Jurassic to Lower Cretaceous. During the Middle and Late Jurassic, malm rock sedimentation mainly occurred there. Such less resistant minerals are found in the depressed areas between detached masses.

3. Brief hydrogeology and hydrology of the investigated area
From the hydrogeological point of view, the investigated area can be divided into two main units. The major part is occupied by flysch sediments which can be attributed to the first unit. Quaternary fluvial sediments near Kysuce and Bystrica rivers form the second unit. The most favourable conditions for water accumulation in the flysch belt are sandstone layers. Pelitic sediments are the opposite. In areas with majority of pelites, the yield of springs is occasionally 0.5 l/s at the most. Such springs are the most numerous there. The disadvantage of the springs is the fact that they dry out during the periods of low precipitation. The most abundant springs are those bound to the Quaternary river sediments (up to 100 l/s).

From the hydrological point of view, the streams of Kysuce area can be attributed to the Váh river basin. The main stream of Kysuce is the river Kysuce which flows through the whole Kysuce region (from Makov to Žilina). Its main tributaries are rivers Bystrica and Čierňanka. The river Kysuca also has many other minor tributaries. The river also drains the border areas of the Czech Republic and Poland. The mountainous terrain, flysch bed, anthropogenic influences and other factors participate in the fact that during the periods of higher precipitation totals, the river level rises very quickly and decreases fast again. The biggest waterworks in the region, built between 1983 and 1989, is the reservoir Nová Bystrica.

4. Mineralized springs in the area of Kysuce
Springs found in the area of Kysuce have different contents of mineral constituents. Flysch belt at the majority of the area does not allow ingress of waters into deeper layers. Due to this, water in such locations is not warmed up sufficiently and also is low mineralized. By contrast, in some parts of the region where there are favourable conditions from the point of view of petrographic composition and tectonic deformation, more mineralized seeps of water occur. These springs contain, apart from hydrogen sulphide, also outbursts of methane or crude oil. The significance of these springs is also proved by the fact that they were declared protected natural monuments.

4.1 Ochodnica spring
The spring is named after the Ochodnica municipality which is located approximately 7 km from the town of Kysucké Nove Mesto. Hydrogen sulphide which liberates from the water is responsible for its colloquial name ‘vajcovka’ (addled-egg water). Currently, the spring is a protected natural monument. The construction work on the spring in 1979 was well-meant, but in fact it impaired the quality and productivity of the spring, and several corrections followed. Nowadays, the spring is protected with a wooden shelter and it is stone-faced with a natural-stone wall. Hydrogen sulphide leaks from the headstream in regular, approximately five-minute intervals. The water flows away into the Ochodnica
4.2 Bukov mineral spring
In the near surroundings of the town Čadca, we can find several interesting springs which have been tourist destinations of local inhabitants for a long time. The Bukov spring belongs to substantially mineralised springs. This spring is located in the settlement of Bukov near Čadca, approximately 1 km away from its centre. It is the most interesting and most visited mineral spring in the town. It is visited by school field trips, city dwellers and tourists as well. The mineral spring is situated right next to the road and due to the leakage of hydrogen sulphide into the surroundings, it is called ‘vajcovka’ (added-egg water) by local people. Nowadays, it can be reached by car as well. The protection of the spring was started back in 1973 when it had been declared a protected natural monument. The current location of the spring, which is surrounded by a stone wall where the water passes through, is not the original one. It was necessary to redirect the water from the spring, which was originally situated on the opposite side of the road, with the help of construction works on the forest road. The spring water joins the Bukov stream which is right under the spring. The last reconstruction of the spring took place in 2008. According to the conducted analyses, the water is classified as lightly-mineralised one with neutral pH values. The water shows positive effects on digestion. It is interesting that the spring has a lowered seep between 7 and 9 a.m. On their way from the town, tourists find the adapted spring under a little chapel on the left-hand side before Bukov.

4.3 Vojty mineral springs
In the southern part of Čadca, there are also three mineral springs in the settlement of Vojty. These springs are situated on the northern slope of the Vojty hill. The springs are easily reached from the site following tourist signs. The springs are located on the same tectonic displacement as the Bukov spring.

The first mineral spring appears after 15-minute walk from the settlement. The spring is called ‘Vajcovka I’ (added-egg water I). The spring has not been declared a protected natural monument yet and it is well maintained.

The second mineral spring is found approximately 1 200 m from the starting point. It is the most famous of the springs. It is called the ‘Principal mineral spring in Vojty’. People refer to it as ‘salty water’. In 1973 this mineral spring was declared a protected natural monument. It is a natural spring of sodium-carbonate water; the pH is around 8.2. The interesting fact about the mineral spring is that the water contains methane which discharges into the surrounding due to bubbling. This suggests that its most probable source is a deposit of caustobioliths found in lower beds. Tectonic dislocation of this area allows methane to rise to the surface along the breaks and simultaneously it expels mineral water. The water from this spring streams in a mountain brook which is found right next to the seep. The spring is covered with a wood-shingle roof and there are also benches nearby. Information about this monument can be found on an information board.

The third mineral spring, named ‘Vajcovka II’ (added-egg water II), is the least visited local spring. It is the most distant one from the starting point. Currently, the spring is very unique from chemical point of view.

4.4 The mineral spring in Horelica
It is the least mentioned spring which is also found in Čadca, in the town district Horelica above the settlement U Klimka. The spring is situated on the left-hand side of the Klimko stream along which there is a pavement. Next to the pavement, there also seeps water enriched with hydrogen sulphide, called ‘vajcovka’ (added-egg water). The spring is located approximately 300 m from an elevated highway. Also this spring can be supposed to have its mineralised seep related to the tectonic dislocation at this area.
5. Conclusions
The above mentioned mineral springs are only a minor illustration of the interesting natural phenomena in the Kysuce Region. These natural phenomena have long been parts of the hiking trails. Some of the springs are also situated next to roads. The development of non-traditional tourisms has also recently reached this region too. Lately, an extensive network of trails for hiking and cycling has been built there, which makes available many of the tourist attractions of the local living and inanimate nature. Another, more recent form of tourism is geotourism. This topic is a subject of growing attention of scientists not only in the neighbouring countries [4, 11, 16], but also in Slovakia [1, 10, 15]. This new form of tourism also provides good conditions for the development at this area. Many localities valuable from the point of view of geology have been protected natural monuments for years and some of them may become ones in the near future. Therefore, many objects already are prepared for geotourism. In addition to the above mentioned springs, there are other springs there, with low mineralisation, but mostly maintained by local people. During the past 60 years, but mainly after 1989, religious tourism has developed there too. The destination of this type of tourism is the Živčáková mountain where in 1958 the Virgin Mary was said to reveal several times. Upon her request, the first spring was dug there, the others came later on. This healing water became sought-after and the location is now a famous place of pilgrimage. Shortly after the revelation, Pater Pio wrote in one of his letters that this place would once be Slovak Lourdes. These springs are today, even though they are only low-mineralised (particularly in Mn and Fe), the most sought-after location from the point of view of tourists. Another geological phenomenon is a crude oil seep in Korňa where oil spontaneously seeps onto the surface. Other peculiarities include stone ball jointing of rudaceous and psammitic minerals in a narrow belt at several localities. Apart from these unique phenomena, there is more to be admired and hopefully such destinations will attract due interest in the future.

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