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Geotouristic attractions of the Ostrava part of the Upper Silesian Basin: geological and environmental sites

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ABSTRACT
In the Ostrava part of the Upper Silesian Basin there are many geotouristic sites connected with the underground mining of Carboniferous bituminous coal. Text is focused on those related to the geology of the Basin and environmental issues connected to coal mining. Of great intrest are outcrops of Mississippian sediments of the paralic Ostrava Formation, as well as two most important museums with permanent geological exhibitions. Some interesting geological features conncted to younger periods of Quarternary glaciation are also mentioned. Two types of publicly accessible sites related to the environmental burdens (burning coal heaps, saline mine water drainage system) are also described.

Key words: geotourism, Ostrava, Upper Silesian Basin, Czech Republic

INTRODUCTION

In the Czech Republic, the Czech part of the Upper Silesian Basin has always been the most important bituminous coal basin and at present it is a last bituminous coal basin in which mining operations are carried out. The extractive industry in the Ostrava conurbation is closely interconnected with the town, which makes it possible to study sites related to geology, coal mining and processing together with residential buildings and buildings designed for the management of mining industry. In this article we draw attention to the most interesting of these sites occurring in the area of present-day Ostrava, including the most important museums, in which the visitor can find information necessary for understanding the broader context of development of the Ostrava industrial conurbation.

STUDY AREA - GEOLOGICAL SETTING

The Upper Silesian Basin, which is situated in the area of Poland and the Czech Republic, is at present the most economically important European bituminous coal basin. Approximately four fifths of the area of the basin are there in Poland, the remaining part of the basin lies in the Czech Republic. The present-day extent of occurrence of sediments of the Upper Silesian Basin is affected by post-sedimentary erosion processes so that the original extent of the basin must have been undoubtedly greater (Dopita, 1997).

Carboniferous sediments of the Upper Silesian Basin (Late Mississippian to Pennsylvanian age), renowned for their deposits of bituminous coal, have been gradually developed from the underlying marine sediments of the Moravian-Silesian Palaeozoic Basin. After shallowing and ending the sedimentation of siliciclastic flysch (so-called Culm Basin), a transition to the sedimentation of paralic type took place (Kumpera, 1990). This is characterised by the prevalence of river and lake sedimentation, which is usually interrupted only by seldom, time-limited shallow-marine sedimentation. Under such conditions, environments suitable for the

origin of coal seams began to be created. The complex of sediments originating in these environments is called the Ostrava Formation (designated as the Paralic Series in the Polish part of the basin). In the area of its Ostrava sub-basin, the Ostrava Formation is divided (from the oldest to the youngest) into the Petřkovice, Hrušov, Jaklovec, and Poruba members (Dopita, 1997).

At the end of the Early Carboniferous (Mississippian), definitive withdrawal of the sea from the area of the Upper Silesian Basin occurred. After temporary interruption of sedimentation in the basin, the sedimentation was resumed with deposition of the Karviná Formation, to which the Upper Silesian Sandstone Series and the lower part of the Claystone Series corresponded in the Polish part of the basin. The youngest lithostratigraphical units, Cracow Sandstone Series and Kwaczala Arkose, are developed only in the Polish part of the basin (Dembowski, 1972; Kotas et al., 1988). The Karviná Formation was formed exclusively in continental conditions as combination of river and lake sedimentation. In the basin were also formed environments suitable for the development of coal swamps giving rise to coal seams. In the Czech part of the basin, the Karviná Formation is divided (from the oldest to the youngest) into the Saddle, Suchá, and Doubrava members (Dopita, 1997).

The exact spatial extent of sedimentation of the Upper Silesian Basin is not known because its upper boundary in the basin is erosional. In the Ostrava part of the Upper Silesian Basin, Neogene sediments of the Carpathian Foredeep are forming oiverburden to the Carboniferous sediments. That is why natural outcrops of Carboniferous sediments are scarce and small in surface area. Moreover, a number of outcrops have ceased due to anthropogenic activities. In the surroundings of the outcrops, sediments of the Upper Silesian Basin with coal seams occur at minimum depths below ground surface. For this reason, these places were also the places in which mining activities in the Upper Silesian Basin started. These places stood at the cradle of present-day vast industrial conurbations, namely Ostrava conurbation in the Czech Republic and Katowice conurbation in Poland.

METHODOLOGY

Choice of geological and environmental attractions of the Ostrava part of the Upper Silesian Basin was made using the data owned by the Faculty of Mining and Geology of the VŠB-Technical University of Ostrava. Major limit was an open access to described localities. There is a large number of interesting places such as burning coal dumps, mine water drainage systems or land reclamation areas, which have large scientific value and could be of interest for education and specific industrial/environmental tourism, but are not accessible freely.

All selected objects are described with the same structure – name, brief description, location with position on the map (Fig. 1) and GPS coordinates, recommended access, description with references to other information sources and picture. Such structure allows an easy orientation and might be in the future used for web presentations of local tourism as well.

SITES OF GEOLOGICAL INTEREST

Outcrops on Landek Hill

content: the best outcrops of Mississippian sediments in the Czech part of the Upper Silesian Basin

location: Ostrava-Petřkovice (Fig. 1), between N 49° 51.964 E 018° 15.420 and N 49° 52.285 E 018° 17.000

access: from Petřkovice along the red-marked tourist trail through the premises of former Anselm Mine (at present Landek Park) in the direction of Koblov. Sandstone outcrops appear at the westernmost point of

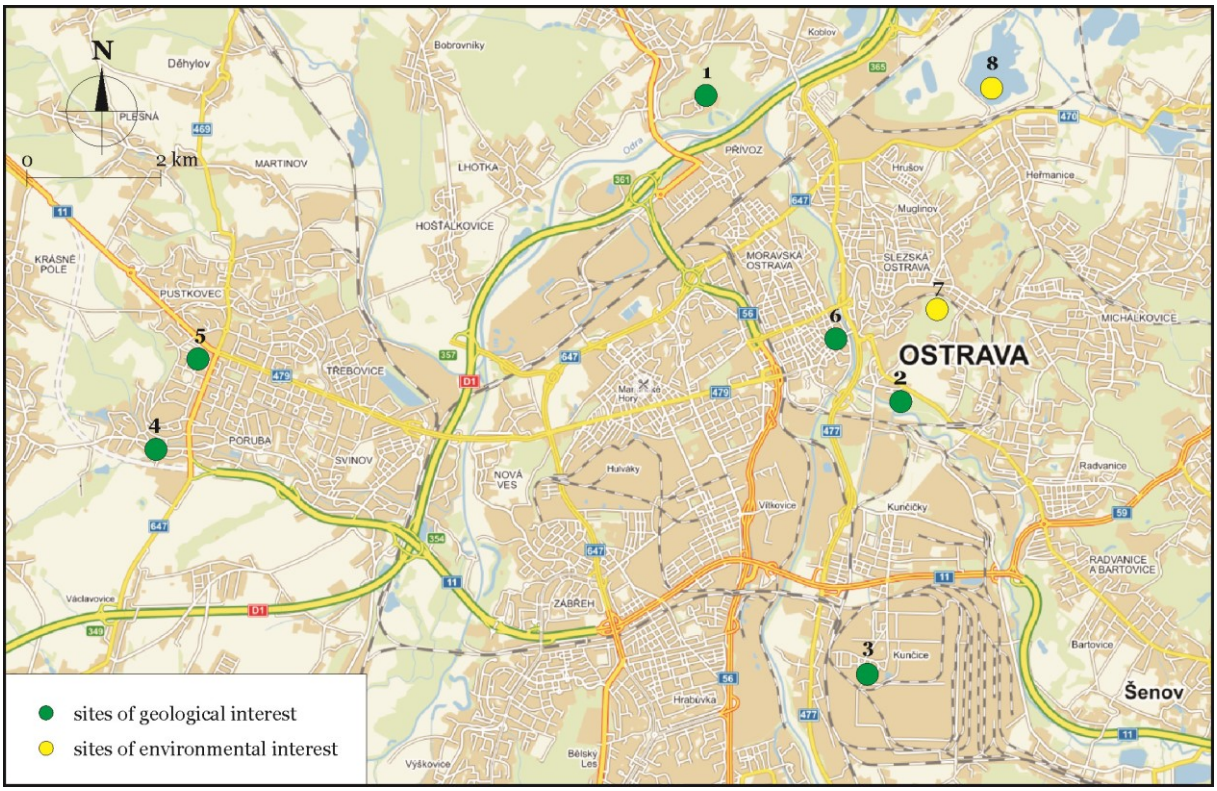

Fig. 1 Location of described sites. 1 – outcrop on Landek Hill, 2 – outcrops of the Castle Conglomerate, 3 – glacial erratic in Kunčice, 4 – glacial erratic in Poruba, 5 – František Pošepný Geological Museum, 6 – Museum of Ostrava, 7 – Ema heap, 8 – Heřmanice pond.

Landek Hill; a classical field trip locality begins at the back (east) portal of the Mine. The disconnected outcrops end closely before the bridge over the Oder River in Ostrava-Koblov. One can get to the locality also from this side (from the east); the recommended direction is however opposite in order to make it possible to proceed from older to younger sediments.

description: An almost continuous steep rock wall above the Oder River about 1,200 m long and 10-20 m high. The locality is easy to access, especially during the vegetative rest of plants. In the middle of the rock wall, layers are moderately inclined; on the other hand, in the west and in places in the middle part, the dip of the layers is considerable. The steep outcrop is formed by sandstones, siltstones, claystones (in places with marine fauna and fossilized parts of plants) and coal seams (Fig. 2A). In the lower part of the wall, several seams from the surroundings of the seam Neočekávaný from the upper part of Petřkovice Member are there. In the direct base of this coal seams, seatearth with fossilized plant roots occur. The middle part of the steep rock wall (about 470 to 800 m from the beginning of the outcrop) with subhorizontal layers of claystones to siltstones represents the sediments of the Naneta Group of Faunistic Horizons with marine fauna (Dopita & Kumpera, 1996). They are followed by an about 50 cm thick layer of the light grey clayey rock that is a product of resedimenmtation the volcanic material – so-called Main Ostrava Whetstone. This layer lies in the uppermost part of the Petřkovice Member and its upper surface forms the boundary between the Petřkovice and the Hrušov members. The dating of zircons from this horizon provided a value of 327.35 ± 0.15 Ma, so it belongs to the Serpuhkovian Stage of Mississipian (Jirásek et al., 2013a). Further towards the bridge at Koblov, sediments of the Lower Hrušov Member outcrop.

Outcrops of the Castle Conglomerate Unit

content: outcrops of Mississippian fluvial sediments in the Czech part of the Upper

Silesian Basin

location: Ostrava-Silesian Ostrava (Fig. 1), between N 49° 49.761 E 018° 18.094 and N 49° 49.631 E 018° 18.693

access: The locality can be accessed from the Silesia-Ostrava Castle. It is necessary to go along Podzámčí Street to the bridge over the Lučina River and at its north end to go down to the valley to a footpath running along the right bank of the River and continue going up the stream. Non-continuous outcrops occur in the steep slope on the left side.

description: The locality consists of a system of outcrops in former building stone quarries (Fig. 2B). The steep rock wall is mainly comprised of coarse-grained sandstones with sporadic cobbles, in which quartz prevails. In the lower part of the outcrops, a thin coal layer accompanied with grey coal siltstones is exposed in places. The sandstones are only moderately inclined and form clearly distinguishable bodies – river channels and sandbars. Visible is only the upper part of this unit, named the Castle Conglomerate Unit. It is a unique, up to 115 m thick complex of mostly coarse-grained to medium-grained sandstones with conglomerate intercalations in the lower part of Poruba Member of the Ostrava Formation. It can be observed along the whole axis of the basin from Frenštát pod Radhoštěm in the south to beyond the town of Rybnik in the north and forms a filling of a wide palaeovalley. The exceptional coarse granularity of the rocks is either a reflection of tectonic activity or a the onset of one of Middle Carboniferous glacial periods (Jirásek et al., 2013b). In spite of not being a high-quality building material (see original stones in walls of Silesia-Ostrava Castle), it was more suitable for construction purposes than the other sediments of the Ostrava Formation.

Glacial erratic in Kunčice

content: largest gracial erratic in the Czech Republic

location: Ostrava-Kunčice (Fig. 1), N 49° 47.540 E 018° 17.939

access: freely accessible from the Vratimovská Street

description: During Pleistocene period, the continental glacier for two times reached the area of present-time Ostrava (Tyráček, 2011; Nývlt et al., 2011). Some of the youngest sediments in the area therefore originate in glacier malting and connected presence of glacial rivers and lakes. In such situation were also deposited glacial erratics – rocks brought by the moving glacier from the north to the south. Such rocks differ from native rocks of the region. Largest one was found in 1954 during the construction of metallurgical plant (Vodička, 1954). Its size is ca 3,2×2,5×1,5 m (Fig. 2C) and weight ca 20 t. Such unusual boulder of porphyric biotite granite probably originate in Sweden of southern Finland. It was moved to the publicly accessible place and later elevated on the concrete easel. It was recognized as a Natural Monument in the year 1989.

Glacial erratic in Poruba

content: second largest gracial erratic in the Czech Republic

location: Ostrava-Poruba (Fig. 1), N 49° 49.357 E 018° 09.181

access: freely accessible from the Vřesinská Street

description: Second largest glacial erratic and the one with greatest length was found in the Porubka Stream in Svinov. In 1928 it was moved to the centre of Poruba to form monument commemorating 10th anniversary of Czechoslovakia establishment. To its present place was moved in 1968 (Fig. 2D). Its size is ca 3,7×1,7×1,2 m and weight ca 13 t. Such unusual boulder of porphyric granite/granodiorite probably originate in Sweden of southern Finland (Lexa, 2007). It was recognized as a Natural Monument in the year 1990.

František Pošepný Geological Museum

content: geological museum with a collection devoted to the Upper Silesian Basin

location: Ostrava-Poruba (Fig. 1), N 49° 49.910 E 018° 09.815, for entrance fee and opening hours see http://geologie.vsb.cz/gp

access: The Geological Museum is part of the campus of VŠB–Technical University of Ostrava (Fig. 3A).

description: At the establishment of Mining School at Příbram (from the year 1865 Mining Academy, since the year 1918 VŠB), a mineralogical collection was bought in the year 1849; it has grown over years. In the year 1945, collections together with the University were moved to Ostrava, where they were finally deposited in a new building of Geological Museum, named after professor František Pošepný, a prominent 19th century economic geologist (Adamus et al., 1997). At present, 12 displays (mineralogy, petrography, paleontology, economic geology, and others), including the collection devoted to the Upper Silesian Basin are open to both the students and the public. Open-air exhibition of rocks from the Bohemian Massif and Carpathians was opened in 2016 right at the front of the museum.

Museum of Ostrava

content: museum with a collection devoted to the Upper Silesian Basin

location: Ostrava-Moravian Ostrava (Fig. 1), N 49° 50.110 E 018° 17.580, for entrance fee and opening hours see http://www.ostrmuz.cz

access: the building of the Old Town Hall in Masaryk Square in the centre of Ostrava (Fig. 3B).

description: The Museum of Ostrava was created by merging already existing two institutes in the year 1924. It is housed in the building of the Old Town Hall. One of the most important parts of geological collections is a rich collection from the mines of the Ostrava-Karviná Coalfield; the collection contains more than 22,000 items (Kroutilík, 1968). The basic parts of the collection are specimens of fossil fauna and flora collected by important paleontologists: Václav Šusta (1892-1953), František Řehoř (1933-2001), Milada Řehořová (*1935), and Eva Purkyňová (*1933).

SITES OF ENVIRONMENTAL INTEREST

Ema Heap

content: a cone-shaped burning heap, the highest point of the centre of Ostrava

location: Ostrava-Silesian Ostrava (Fig. 1), N 49° 50.390 E 018° 18.885

access: freely accessible along the yellow-marked tourist trail from Silesia-Ostrava Castle, Sýkora Bridge or Ostrava Zoo

description: Tailing heaps represent a significant environmental burden from the underground coal mining. In the Ostrava part of the coalfield, more than 100 heaps with an approximate volume of 65,000,000 m^3 were formed in the past (Havrlant & Martinec, 2003). The most distinctive and best known of them is the cone-shaped heap of the Trojice Mine, incorrectly called Ema Heap. Although in the sixties of the 20th century deposition on cone-shaped heaps was forbidden, the material was deposited in the same way till the cessation of mining activities in the Trojice Mine in the year 1967. The volume of the heap is about 28,000,000 m^3 and a height above the original Burňa Valley is about 80 m (Klát & Slíva, 2011). In the year 1952, spontaneous ignition appeared in the heap and, in spite of restoration (sealing with fly ash and burnt tailings) and forest rehabilitation, the core of the heap is still thermally active ((Fig. 3C, Kroutilík, 1954; Havrlant & Martinec, 2003). In the year 2012, the owner of the land forbade access to the heap to avoid potential danger; a year later, the ban was removed.

Heřmanice Pond

content: pond used as retention reservoir for mineralized mine water

location: Ostrava-Heřmanice (Fig. 1), N 49° 52.300 E 018° 19.500

Fig. 2 A – outcrop on Landek Hill with Coal No. 074, B – outcrops of the Castle Conglomerate Unit in the Lučina Valley, C – glacial erratic block in Kunčice, D – glacial erratic block in Poruba.

access: a nature trail leading around the pond begins near the crossroads of Orlovská and Vrbická streets

description: It was mine drainage that became a big problem of coal mines in the Ostrava-Karviná Coalfield in the second half of the 20th century. What is problematical is especially high salinity chloride water with total mineralization of up to 300 g/l (Matýsek et al., 2014), which occurs in Carboniferous rocks and overburden. The amount of pumped water is up to 20,000,000 m^3 per year and thus the desalination of this water would be economically unfeasible. That is why the water is drained from the mines and discharged under control. The amount of salts in the Oder River at the Czech-Polish border is determined in intergovernmental agreements, so that at low flow rates, part of water was accumulated in Heřmanice Pond and from it the water was discharged when water level in the river was rather high. Since the cessation of mining activities, a fixed water level has been maintained in interconnected mine workings and the water has been continuously pumped in the Generál Jeremenko Mine and Žofie Mine. It is expected that water salinity will be decreasing with time (Brosch, 2005). The locality is, as wintering grounds (thanks to the salinity, the pond does not freeze easily) and assembly point of at least 250 bird species, a part of Natura 2000 European network (Fig. 3D). For the reason of occurrence of many rare amphibians and birds, it was designated a Natural Monument in the year 2013.

DISCUSSION

The amount of geological points of interest of the Ostrava region is limited by the geological structure of the area, where the interesting coal-bearing Late Caboniferous strata, with only minor exceptions, are covered by the younger sediments of Tertiary and Quaternary. This is the reason why the most economically significant bituminous-coal basin

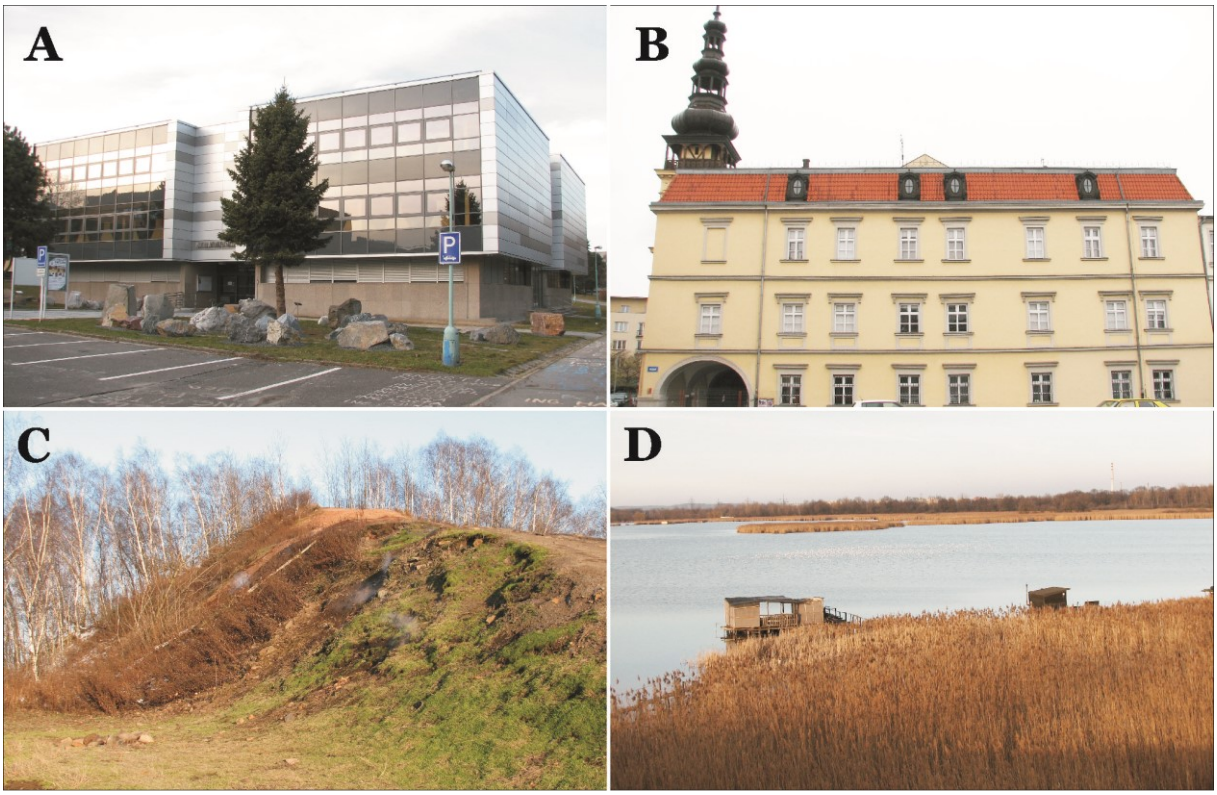

Fig. 3 A – František Pošepný Geological Museum after reconstruction in 2015 , B – Museum of Ostrava in the Old town hall, C – apical part of the Ema heap with signs of thermal acticvity, D – Heřmanice pond during the winter.

practically lacks places useful for teaching geology. A similar situation exists also in the neighboring Polish part of the Upper Silesian Basin. On the contrary, natural attractions related to Quaternary glaciation, such as glacial erratic boulders, are quite common.

In the case of environmentally interesting sites, the selection was not limited by the lack of sites, but by the possibility of their visits without significant restrictions. There are many remarkable localities in the Ostrava region not mentioned in the text, which are mostly related to the industrial history of the town (heaps, mud settling ponds, reclaimed areas of industrial sites, etc.). These are subject to the scientific interest of environmental specialists, but from the point of view of the wider public they are often limited by the need to obtain entry permits. Also their attractiveness without a dedicated guide is relatively small.

Out of reach of this article were industrial and architectural monuments of Ostrava region, whose meaning is still not fully appreciated. However, due to their extent, we have decided to focus a separate article on them.

CONCLUSIONS

The submitted article draws attention to yet unappreciated possibilities provided in the Ostrava part of the Upper Silesian Basin. In a relatively small area, many sites not mentioned in common travel guides can be found. They can be well-used in geological and environmental education.

Since the beginning of the 20th century, Ostrava is renowned centre of the bituminous coal mining and connected metallurgical and chemical industry. Mining activities already ceased during 1994 in the town itself by closure of the Odra Mine. From that point later on, Ostrava conurbation is seeking for opportunities to introduce tourist attractions connected to its mining history. Unlike in

other European mining towns, the choice of education guides, trails dealing with both geological and environmental features is very limited or almost missing. From the sites described above, only the František Pošepný Geological Museum is mentioned at official web presentation of local tourist attractions (Turistické atraktivity Ostravy, 2016). Enlargement of such choice by new localities would allow establishing new offer focused on education and industrial heritage.

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