



5 CZECH REPUBLIC: THE BÝČÍ SKÁLA (BULL ROCK) DISCHARGE AREA

5.1 Overview

The study area of Býčí skála (Bull Rock) consists of a group of springs and karst springs forming the discharge of the Jedovnický sinking stream and Křtinský sinking stream catchment. The area is situated in the central part of Moravian Karst, the best known karst area of the Czech Republic with highly developed karst features. Býčí skála (Bull Rock) cave itself is a large cave system connected via siphons to the cave system of Rudický ponor, the ponor cave system of Jedovnický stream. The total length of the system is ca. 15 kms. Jedovnický sinking stream and Křtinský sinking stream are allochthonous streams coming to the karst area from the upland built by highly compacted Lower Carboniferous sediments. After outflow in the Býčí skála group of springs, they flow to the Svitava river representing the regional drainage base in the deep valley built by igneous rocks. The group of springs near the Býčí skála consists of several springs and classical karst springs. The Olomučanský springs, which belong to this group of springs, are used for water supply of the Adamov town nearby.

The Býčí skála cave is frequently called "the most memorable cave of the Moravian Karst", mostly on the account of its prehistory. The entrance part of the cave is the site of the famous "Hallstatt burial" containing the bronze statue of the bull, which was discovered by Jindřich Wankel in 1872.

5.2 Geology

The Moravian Karst is formed by Middle to Upper Devonian limestones, which are mostly light to dark grey, with white calcite crevice accretions. The block-structured belt of these limestones is approximately 30 km long, 4 km wide and up to 2 km thick. According to the stratigraphy, there are five types of limestones and the thickness of the series of strata is 500 to 1000 m. On the western side the limestones transgressively overlap the granitoids of the Bmo igneous massif, while on the eastern side they are in turn covered with Lower Carboniferous sediments. In some places, the relics of the denudated Jurassic and Cretaceous strata overlying them can be found and these sediments also form gravel pipes in some deep depressions. During the Neogene the Moravian Karst overflowed, and the rest of marine clays are still to be found in several places. The Quaternary Period is represented by different types of loams and debris and fluvial graves, sands and clays. The geological scheme of Moravian Karst and its surroundings is shown in *Figure 12*.

The karstification of the Devonian limestone complex is irregular, from small fissures with sinter crust to big caverns several metres wide and deep linear karstification zones. The cave system is developed in different vertical levels.

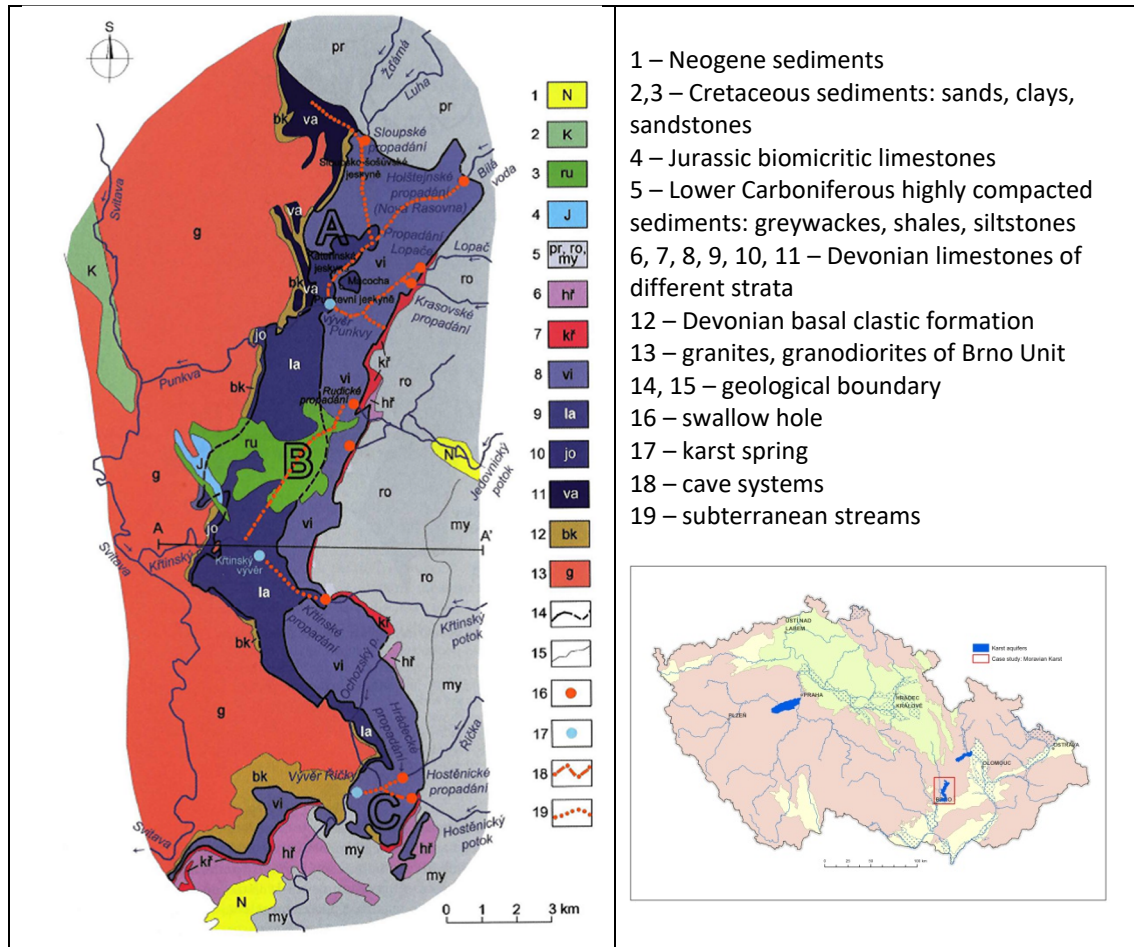


Figure 12: Geological scheme of Moravian karst and its surroundings (Krásný 2012).

5.3 Geomorphology

The Moravian Karst is situated to the area of Dražanská Upland, the elevation parts of which do not exceed 600 a.s.l. The landscape character of Moravian Karst is formed by plateaus with many sinkholes separated by deep canyon grooves. Most of the streams coming from the non-karstified part of the Dražanská Upland sink into the cave systems where the limestone area begins. The sinking streams created various cave labyrinths with many types of speleothems. Moravian Karst is divided into three parts belonging to different river catchments. The northern part of Moravian Karst is drained by the Punkva River and its tributaries. The Amatérská cave, the largest cave system in Czech republic, is to be found in the northern part of Moravian Karst with almost 35 km of tunnels and corridors. The southern part of Moravian Karst is a part of the Říčky sinking stream catchment with the Ochozská cave system.

The area of interest is situated to the central part of Moravian Karst to the Jedovnický and Křtinský stream catchment and is shown in Figure 13. The cave system Rudický ponor – Býčí skála cave formed by the Jedovnický sinking stream is the second longest in the Czech Republic, the overall length of the system is 12 km (see Figure 13). The Jedovnický stream sinks to a depth of 86m by several waterfalls, it has formed high canyons, huge halls as well as places very difficult to pass through. The Býčí Skála Cave and its surroundings is the discharge area of this cave system. The subterranean part of Křtinský stream and the cave system formed by it is mostly

unexplored up to now.

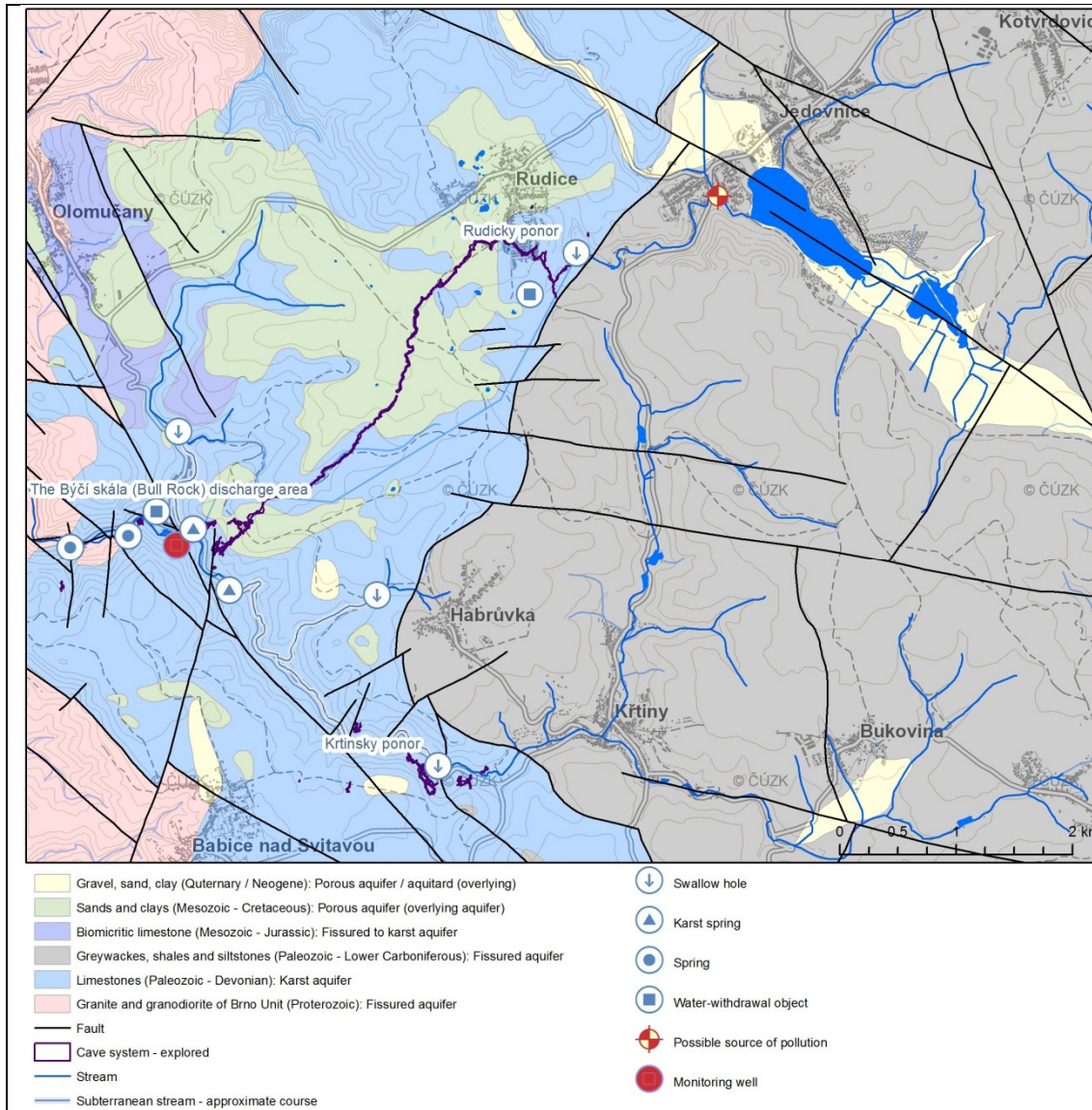


Figure 13: Scheme of Jedovnický and Křtinský stream catchment and its discharge area at Býčí skála

5.4 Climate

The climate character of the area fluctuates from humid continental to temperate oceanic. The average annual temperature is ca. 8, 5 °C. The temperature difference between summer and winter is relatively high, in January the average temperature is -2, 5 °C and in July 18, 5 °C. The area receives around 550 mm annual precipitation, most of it during summer period. Sporadic rainfall is relatively constant throughout the year but concentrated heavy rainfall is more frequent in the months of May to August.



5.5 Hydrogeology

Moravian Karst is an open transit karst-fissured hydrogeological structure according to Kullman (1990). The structure is recharged not only with infiltration of rainfall and with surface water inflow, but also with lateral drainage from non-karstified surroundings. Due to the geological position between fissured aquifers and morphological character with low-level drainage base, Moravian Karst acts as a water-trap. Hydrogeological structure of Moravian Karst is drained by springs and stream, part of the water recharges deeper circulation systems within carbonate rocks and is drained into clastic sediments of Carpathian Foredeep. The existence of groundwater communication between karst hydrogeological structure and its non-karstified surroundings is serious obstruction for the evaluation of natural groundwater resources.

The study locality itself covers the Jedovnický and Křtinský stream catchments. These sinking streams flow through the structure in open channels and feed the main karst springs in the drainage area near Býčí skála. Besides this concentrated flow in conduits there is a diffuse flow in fissured matrix, which in fact forms more than 99,9 % of karst aquifer. Some of the springs in the drainage area are fed with groundwater from the fissured matrix, e. g. the Olomučanský spring (water withdrawal object), which is not connected to any sinking stream.

5.6 Hydrodynamic characteristics of the springs (and river)

The flow rates measured in the karst springs at Býčí skála vary widely in dependence on climatic conditions. High flow rates exceeding 1 700 l/s were registered in 2010 (Kůrková 2011) during extremely rainy period. During dry periods, the flow rates do not exceed 70 l/s, some of the springs are even intermittent. The flow rate of the Křtinský karst spring reaches 250 l/s during rainy periods and does not exceed first tens of l/s during dry periods.

The yield of the water withdrawal object, Olomučanský spring is more stable, which may point to the contribution of deeper groundwater circulation.

5.7 Data available for the project

1. Monitoring well VB9807			
Data type	Time step	Monitoring period	Time period
Groundwater level	continuous	> 10 years	1988–present
Major anions/cations	half-yearly	> 10 years	1988–present
Pesticides	half-yearly	5–10 years	2014–present
Nutrients	half-yearly	> 10 years	1988–present

2. Olomučanský spring			
Data type	Time step	Monitoring period	Time period
Major anions/cations	yearly	> 10 years	1980–present
Nutrients	yearly	> 10 years	1980–present
Discharge	weekly	> 10 years	1980–present

3. Josefov, Křtiny, Jedovnice river gauge station			
Data type	Time step	Monitoring period	Time period
Flow-rate	daily	> 10 years	1975–2000
Flow-rate	continuous	> 10 years	2000–present



4. Other springs			
Data type	Time step	Monitoring period	Time period
Chemistry	occasional data		
Flow-rate	occasional data		
Stable isotopes	occasional data		

In addition, data from trace tests are available. Monitoring objects are shown Figure 16

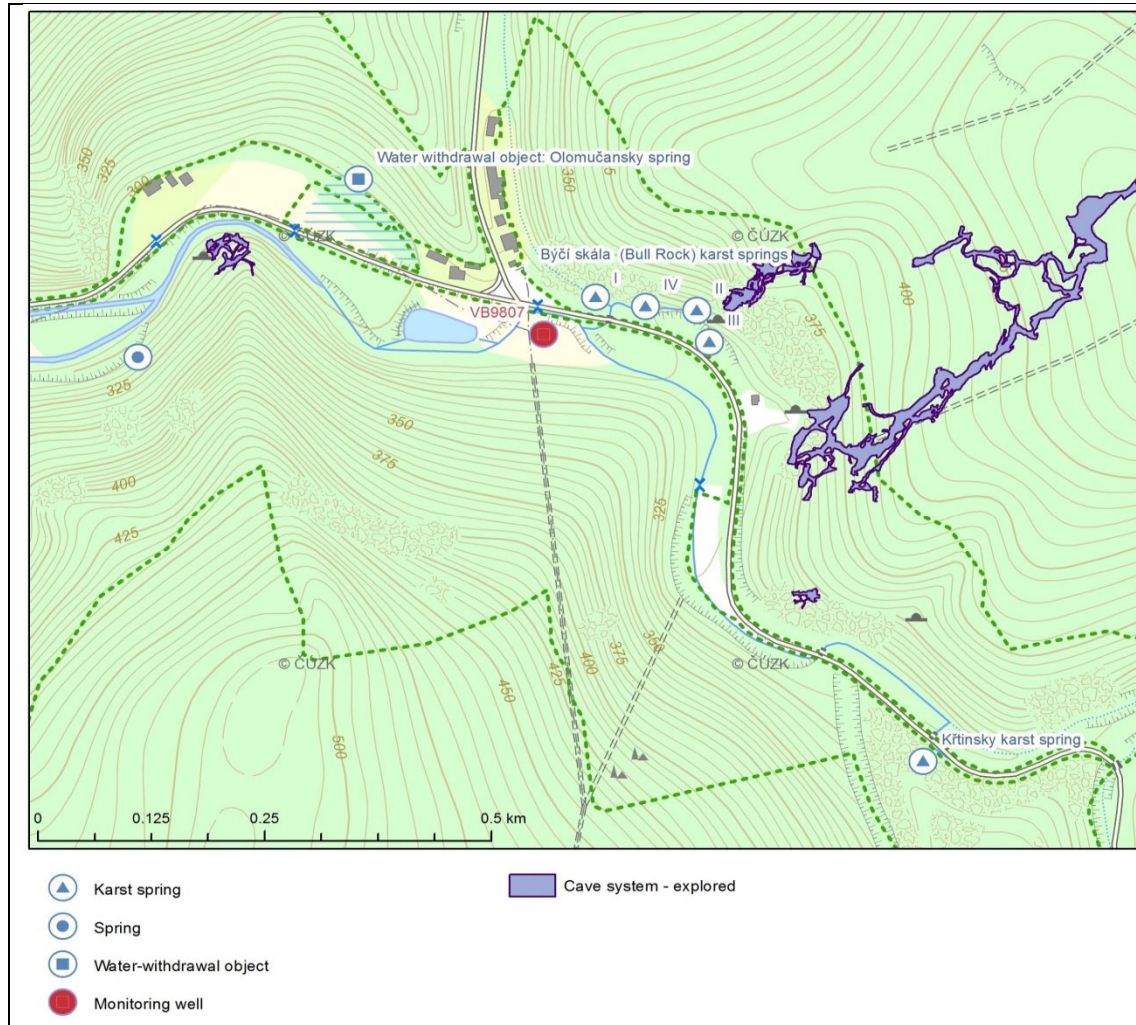


Figure 14: Detailed scheme of the Býčí skála discharge area.



5.8 Summary

Pilot name	The Býčí skála (Bull Rock) Springs – discharge area of the Jedovnický and Křtinský sinking stream catchment		
Country	Czech Republic	EU-region	Central Europe
Area (km ²)	65	Lithology	Limestone
Short description: Býčí skála (Bull Rock) group of springs is the discharge area of the karst hydrogeological structure in the catchment of the Jedovnický and Křtinský sinking streams. Flow rates of the main springs vary widely due to climatic conditions. One of this group of springs, Olomučanský spring, is used for water supply of the Adamov town nearby.	Water withdrawal object: Olomučanský spring Býčí skála (Bull Rock) karst springs Křtinský karst spring Legend: - Karst spring (blue triangle) - Spring (blue circle) - Water-withdrawal object (blue square) - Monitoring well (red circle) - Cave system - explored (purple shaded area)		
Monitored objects	Well (one), spring (two), river gauge station (three)		
Monitored data	Groundwater level, discharge, flow rates, temperature, EC, chemistry, (isotopes, fluorescence – occasionally)		
Contact person	Eva Krystofova (eva.krystofova@geology.cz)		



5.9 References

- Krásný, J. (2012): Podzemní vody České republiky. (Groundwater in the Czech Republic.) – Česká geologická služba. Praha.
- Kullman, E. (1990): Krasovo-puklinové vody. (Karst-fissured waters). – SGUDS. Bratislava.
- Kůrková, I. (2011): Charakter proudění a šíření hydraulické odezvy ve vybraných jeskyních Moravského krasu. (Flow pattern and hydraulic response propagation in selected caves of Moravian karst – diploma thesis.) – Univerzita Karlova. Praha.

