



## REPORT

### of the visit of eminent experts in karstology Derek Ford and Petar Milanović to the Centre for Karst Hydrogeology

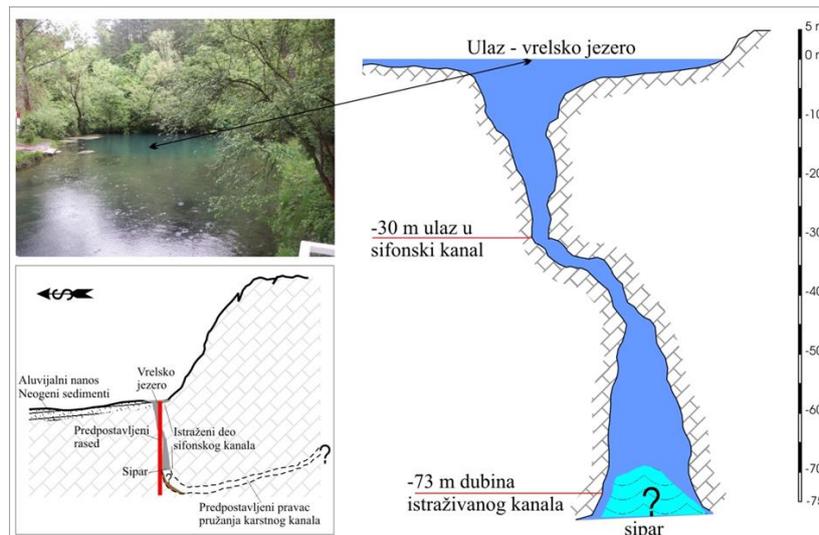


In honour of the Petar Milanović's 80<sup>th</sup> birthday, Centre for Karst Hydrogeology (CKH), together with Hydropower Plant Dabar, organized the Symposium Karst 2018 „*Expect the unexpected*“. After the Symposium, from 12 to 14 June 2018, CKH had the privilege to host world-renowned experts in the field of karst research - Derek Ford and Petar Milanović.

Members of CKH have decided that the location of the tour should be in the karst area of eastern Serbia, known for its numerous and attractive surface and underground karst phenomena, as well as beautiful nature. Field trip was guided by Dr Saša Milanović and Dr Ljiljana Vasić members of CKH, who were investigated this area for many years and whose data resulted with their doctoral dissertations. On every point, hosts were explained geology and hydrogeology of the site, as well as provided other information about local phenomena.

The first stop was the Mlava Spring located on the northern part of the Beljanica massif, which represents the underground morphological form with constant discharge of water to the surface, at the 305 m a.s.l. This spring is one of the first springs hydrogeologically observed in Serbia. J. Cvijić described this spring in 1896 as doline water pool with a constant water flow.

However, the most important knowledge of the spring morphology was contribution of the diving studies conducted by the numerous diving teams as (SRK Aqua Mont, ASOS, Triton, DHG-CKH). Numerous dives explored the karst channel to a depth of 73 meters. The lake has depth of about 30 m, after which the karst channel has almost vertical angle, which then expands into a funnel channel at a depth of additional 43 m (S. Milanovic, 2010).

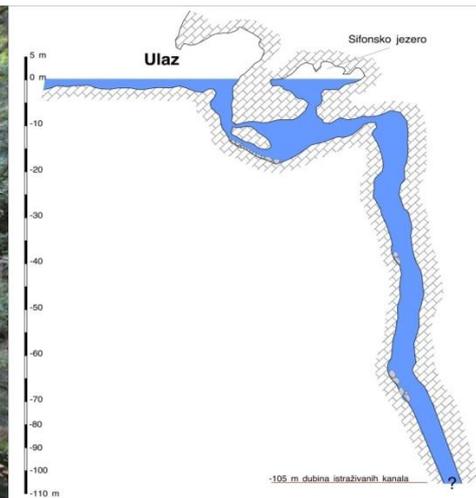
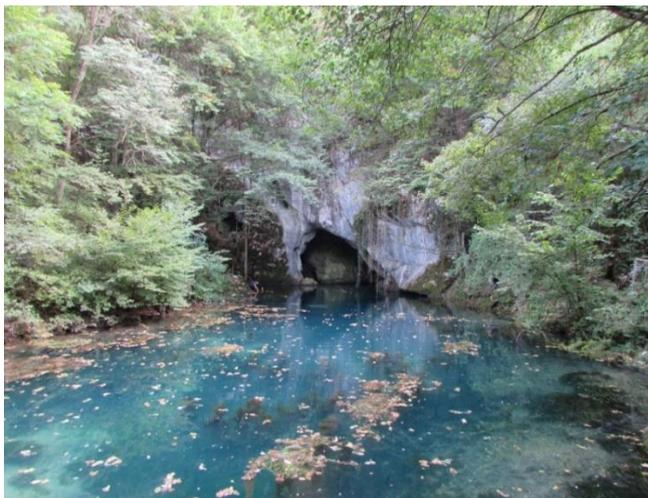


Cross section of Mlava spring (S. Milanović 2010)



Left: The Mlava spring; Right: Discussion about spring recharge, discharge, mean residence time and quality of the water

The next stop was the Krupaja spring, one of the biggest karst springs which drains Beljanica karst massif at altitude of 220 m a.s.l. Water emerges from the cave openings, which channels are predisposed by NE-SW faults. The shallow channels, dipping to a depth of 20 m, followed by 70 meters in length leaving a dry siphon room. The deepest channel is vertical and it is explored to a depth of 133 m (see Figure 4.20. b) by cave divers. Krupajsko spring is one of the deepest explored karst spring in Serbia (Milanović S., 2010; Vasić, 2017).



Left: Krupajsko spring; Right: main siphonal channel of the spring (S. Milanović, 2010)



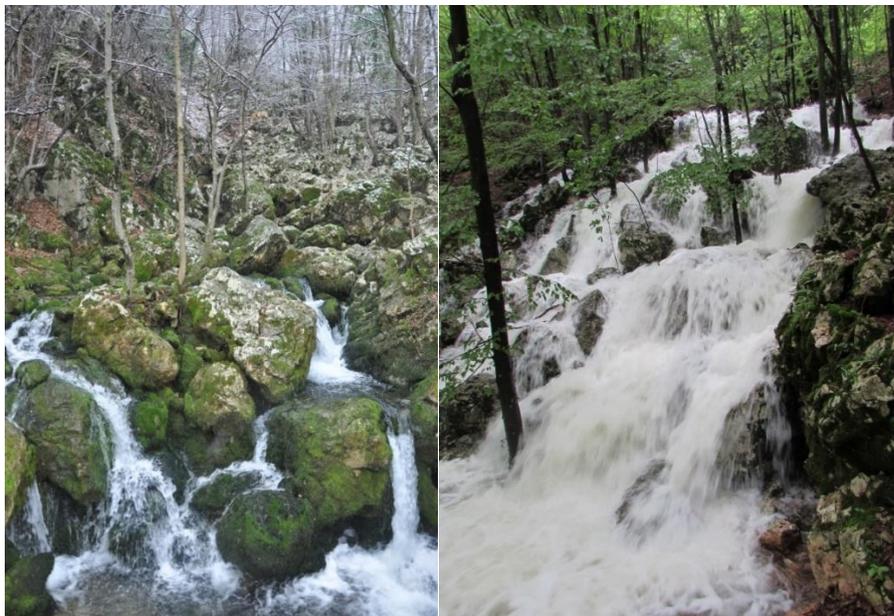
Left: Presentation about geology and hydrogeology of the site; Right: P. Milanović, Lj. Vasić and D. Ford on the Krupaja spring

A thermal spring on Krupaja has a temperature of 26 °C and as such represent a spring with natural warmest groundwater (thermal) within Beljanica massif. Spring is about 50 m away from Krupaja spring, and occurs at altitude of 220 m above sea level, on contact of the overtrushed Permian sandstones and Lower Cretaceous (Urgonian) limestones, and characterized by siphonal type of circulation with continuous discharge of about 2 l/s (Vasić, 2017).



D. Ford on thermal Krupaja spring

The guests of CKH were also able to see one strong spring with gravitational type of circulation – Veliko vrelo. This spring discharges from wide spring zone which is vertically shifted depending on stage of groundwater level. Spring is not tapped. Discharge of this spring ranges from 85 to 7000 l/s. Water from this spring form beautiful waterfall called Veliki Buk.



Vertically shifting of Veliko vrelo spring discharge zone (left: Medium groundwater flow during the visit; right: maximum in May 2014, Vasić, 2017)



P. Milanović, D. Ford with Lj. Vasić on Veliko Vrelo spring on the left; on the right with S. Milanović on the Veliki Buk waterfall

In the late afternoon, guests had opportunity to see Nekudovo ponor (swallow hole), which is located in the Resavica canyon at an altitude of 630 m a.s.l., on the contact of impervious Paleozoic schists and limestone. The sinkhole fully absorbs the stream flow, with a maximum amount of about 200 l/s. This ponor is connected to the Crnica spring at the western edge of Kučaj massif.



Nekudovo sinkhole

The next and the last stop for this day was Sisevac, location where Crnica spring is drained. Also, investigations conducted in the Sisevac resulted with drilled borehole SIS-1, which is used for spa tourism, energy and other needs of the private owner. Borehole was drilled up to 216 meters and it obtained very considerable outflow from well of 18 l/s, with a water temperature of 36 °C, which is the highest temperature at the Kučaj-beljanica massif. On the next day, the guests visited the Crnica spring. Spring occurs at 350 meters a.s.l., on the contact of Urganian limestones and red Permian sandstones. Discharge of the spring varies from 275-1350 l/s.



Left: The Crnica spring; Right: S. Milanović showing to D. Ford intrusion of thermal water in the riverbed of the Crnica River with thermo-vision camera

Later on, members of the excursion continued to the southern edge of Kučaj-beljanica massif, where they visited the Grza spring, located at an altitude of 410 m a.s.l, also located at the contact of Urganian limestones and red Permian sandstones. Diffusive gravity spring has several zones of discharge that move vertically depending on the groundwater level in karst aquifer. Connection with Velika Brezovica ponor is confirmed by many tracing tests. Spring is not tapped and the yield of water ranging from a minimum of 15 l/s to more than 4000 l/s (Vasić, 2017).



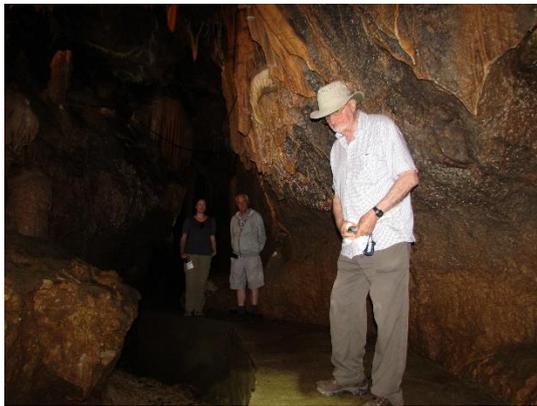
Left: D. Ford, S. Milanović and P. Milanović at the bridge over the Grza river; Right: D. Ford noted the important details related to the spring

The next stop, included cold spring – source of Crni Timok River as well as subthermal spring Krivovirska Banjica. Crni Timok spring drains the bigger part of southern Kučaj, and it occurs at 375 m of altitude in the Krivi Vir village. Spring flow out from the cave channel and it is partially tapped for the local water supply for the villagers of Krivi Vir. The spring is located at the contact of Urganian limestones and Neogene sediments of Krivovirski basin on fault with direction E-W. Spring has dominant gravitational type of circulation, with discharge of water which ranges from the minimum 20 l/s to more than 2500 l/s, but also has much deeper channels where groundwater spend around 5-6 years. Kivovirska banjica subthermal spring is located on some 400 meters downstream from the Crni Timok spring and has a temperature varying from 15-23 °C, indicating a strong mixing of cold water during high water period. The discharges vary from 50 to 180 l/s (Vasić, 2017).



Left: S. Milanović and D. Ford on the Crni Timok spring; Right: Lj.Vasić, D. Ford and P. Milanović on the subthermal spring Krvovirska Banjica

The two more sites, the Bogovina cave and Lazar canyon had been also visited but because of the strong storm visits were shortened.



The Bogovina Cave and Lazarev kanyon

On the last excursion day, members of excursion had opportunity to visit famous stone bridges Vratna consisting of three stone bridges occurrences, firstly investigated by J. Cvijić. The first one, called Small stone bridge represent fascinating gate 34 meters in height, while the measured length is 30 and width 15 meters. Little bit lower is Bigger stone bridge.



Left: on the way to stone bridges; Right: D. Ford below Bigger stone bridge

During the ride back to Belgrade, several stops have been along magnificent Djerdapska klisura gorge.



Djevdapska klisura gorge

During this very pleasant excursion, guests and hosts had opportunity to enjoy moments they spent together, talks, good local wine and traditional domestic food.

Members of the Centre for Karst Hydrogeology would like to take this opportunity to thank Derek Ford and Petar Milanović for lovely moments they shared with us as well as for positive energy and knowledge they gave us. Thank you!

Reported by

Dr Ljiljana Vasić