



International Course and Field Seminar  
**Characterization and Engineering of Karst Aquifers**



**REPORT**  
of the Sixth International Course and Field seminar  
**“Characterization and Engineering of Karst Aquifers”**  
Belgrade and Eastern Serbia - Serbia 27 – 31. May, 2019.



The sixth international course and field seminar *Characterization and Engineering of Karst Aquifers* was held in Serbia from 27 – 31. May, 2019. This year course was organized and held in Serbia because of several reasons whereas the main were financial and administrative. Along with raising of interest for the course, the obligations for the staff, expenditures and expectations accordingly raised, but have not been followed by all supportive factors on time. Although there were many difficulties in organizing and implementing the course, organizing team still managed to organize course in Serbia, since there were participants who expressed great interest in attending the course this year.

The course was organized by the Centre for Karst Hydrogeology of the Department of Hydrogeology (DHG), University of Belgrade - Faculty of Mining & Geology (hereafter FMG). This year the course consisted of two parts, first one reserved for lectures in classroom of DHG/FMG from 27 – 29 of May, while the second part was reserved for field trip to Carpathian karst of Eastern Serbia (the Kučaj-Beljanica Massif). The Course was attended by 15 participants from 5 countries (Bosnia & Herzegovina, India, Iran, Serbia and Sweden), while lectures were provided by 7 professors.

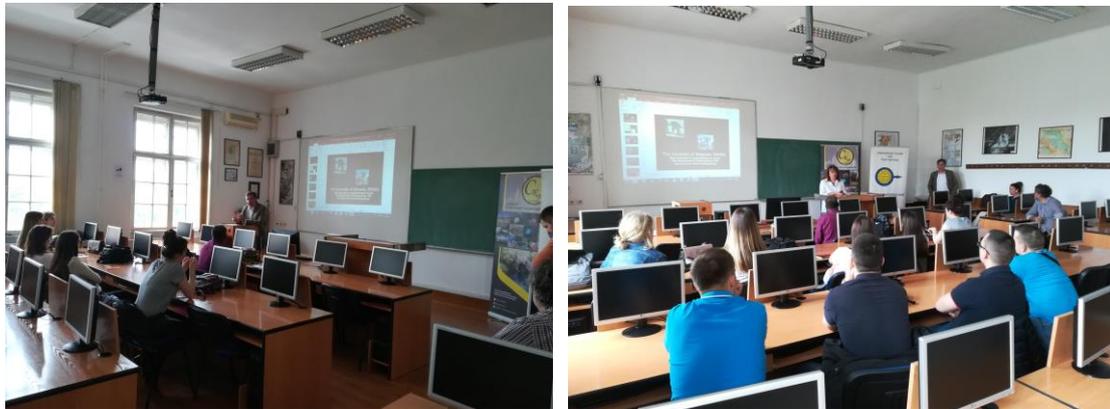
Experts who delivered their lectures during this year course were: Prof. Dr Zoran Stevanović, University of Belgrade, Serbia; Dr Petar Milanović, Ret. Assoc. Prof. University of Mostar, Bosnia & Hercegovina; Prof. Dr Dragan Milovanović, Ret. Prof. University of Belgrade,



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Serbia; Prof. Dr Vesna Ristić Vakanjac, University of Belgrade, Serbia; Prof. Dr Igor Jemcov, University of Belgrade, Serbia; Prof. Dr Saša Milanović, University of Belgrade, Serbia and Prof. Dr Vladimir Živanović, University of Belgrade, Serbia. As during the previous years, Dr Ljiljana Vasić, scientific researcher (DHG/FMG), provided lecture about work and professional practice, while Branislav Petrović and Veljko Marinović, researchers (DHG/FMG) had opportunity to give their lectures about specific topics and research work in karst for their doctoral theses.

Opening ceremony took place at 9<sup>00</sup> AM (27<sup>th</sup> May) with the welcome speech of Prof. Dr Zoran Stevanović and Prof Dr Vesna Ristić Vakanjac, vice Dean (FMG, University of Belgrade), who wished welcome to all participants as well as productive work and pleasant stay in Belgrade and Serbia.



Opening ceremony

As during previous years, Prof. Stevanović started lecturing part with an introductory lecture "*Introductory note about course; Historical development of karstology and karst hydrogeology; Importance of karst and karst distribution worldwide; Geo-heritage sites; Dinaric karst*". He described the system of education at the Faculty of Mining & Geology to the participants and presented all course topics, a table of content and the Course schedule for this year.



Professor Zoran Stevanović



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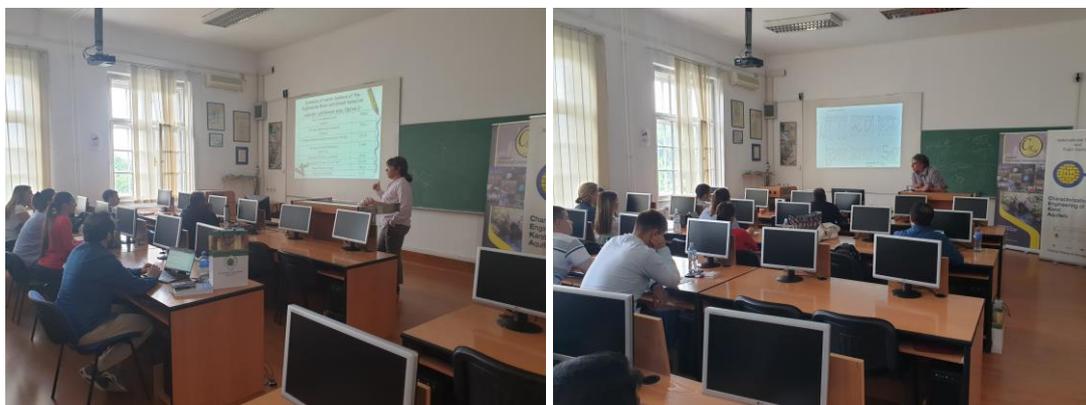
The next two lectures were delivered by Prof. Dragan Milovanović: “*Carbonate and non-carbonate rocks: mineralogy, depositional environments and classifications*” and “*Chemical factors of karstification and Role of tectonics*”.

In the afternoon session, after lunch break, two more lectures were held by Prof. Stevanović: “*Porosity and permeability of karstic rocks; Karstification process and its features: Surface and subsurface karst landforms*” and “*Groundwater circulation in karst: recharge, flow types and directions, discharge*”. After lectures, participants had opportunity to watch two movies titled “*Karst*” and “*Karst of Montenegro*”.



Professor Dragan Milovanović

Morning session on the second day of course was reserved for presentations about methods in karst hydrogeology. Firstly, Prof. Stevanović gave a lecture: *Methods in karst hydrogeology – an overview; geology, remote sensing, geophysics, water points inventory, groundwater tapping, hydrogeological properties and field tests*. After him, Prof. Vesna Ristić Vakanjac provided lecture titled: *Methods in karst hydrogeology – climate, hydrology, springs hydrograph analysis and stochastic models (exercise)*, and finally, morning session and lectures about methods in karst hydrogeology Prof. Saša Milanović finished with lecture *Methods in karst hydrogeology – geomorphology, speleology, speleo diving, hydrogeology maps, GIS and database*.



Professors Vesna Ristić Vakanjac and Saša Milanović



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In the afternoon session participants had an opportunity to learn practical aspects of karst hydrogeology, engineering concepts, and solutions. The first lecture was presented by Prof. Petar Milanović: *Problems related to construction of dams, reservoirs and other structures in karst; Investigation, design, corrective measures*, while the second lecture was case study form professional practice of Prof. Saša Milanović titled: *Leakage from reservoirs, specific research methods and remedial measures*.



Professor P. Milanović's lecture

After lectures, participants watched two DVD movies “*Trebišnjica*” and “*Protecting the nature: “Forgotten species”*” (movie by S. Milanović).

On the last lecturing day (29<sup>th</sup> May), morning session started with lecture of Prof. Igor Jemcov: *Modelling karst hydrogeological systems: Challenges and solutions*. After him, Prof. Stevanović provided important lecture: *Characterization of karst aquifers; Groundwater budget; Specific regime of karstic groundwater (quantity, quality); Safe yield*, while Prof. Vladimir Živanović gave lecture titled: *Karst aquifer vulnerability – assessment and visualization; Sanitary protection zones and measures*.



Morning session lectures provided by professors Igor Jemcov and Vladimir Živanović

Afternoon session was reserved for one professional practice lecture that was presented by Dr Ljiljana Vasić “*Quality dynamics at karst-springs. A challenge for drinking water supplies*”.



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*Isotopic methods in karst, GW ageing – Kučaj-Beljanica (Serbia) case” and two junior experts Branislav Petrović and Veljko Marinović who give their lectures about specific topics and research work in karst which they are dealing with in their doctoral theses: “Karst aquifer vulnerability; Anthropogenic impact and hazards; Karst Disturbance Index” and “Groundwater management and transboundary aquifers in karst: problems and solutions”.*



Afternoon lectures of Ljiljana Vasić, Branislav Petrović and Veljko Marinović

On the fourth day of the course (30<sup>th</sup> May) started field trip, and all participants, together with professors Stevanović and S. Milanović and organising team, were moved to the Eastern part of Serbia to the Kučaj-beljanica Massif. The excursion lasted for two days, and during the first day students visited Bogovina Regional Water Supply System for Timok Region, where they saw “Mrljis” spring and tapping system with three wells which tapping karst groundwater for water supply of the city Bor.



First stop “Mrljiš” waterworks system

On the Mrljis catchment area they had opportunity to hear from prof Stevanović, who led this project and also is the author of the monograph “*Management of karstic aquifer of regional water system “Bogovina” (Eastern Serbia)*”, about detailed researches that were conducted for water supply of Timok Region, as well as about engineering solutions. After discussion, Prof. Stevanović divided participants into three smaller groups and gave them particular tasks.

After one hour of practical and field work at the site, participants presented their solutions for the obtained tasks. This was an excellent exercise, where participants had their own opportunity to see geological and hydrogeological features of the area, investigate them briefly, and to realise what would be the best solution for investigation and methodology to apply in order to manage groundwater resource for the purpose of water supply.



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Prof. Stevanović is giving tasks to students



Three groups of participants discussing how to solve their tasks



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Next stop was the Bogovina cave, one of the longest caves in Serbia, which is located on the eastern part of the Kučaj Mountain. The length of the examined channels is more than 6 km, and the part of the cave that is arranged for tourists is in the length of 550 m. During the cave visit, participants enjoyed in beautiful halls of the cave and cave ornaments, while professor S. Milanović had a talk about detailed speleological research and speleo diving investigations that was conducted in this cave, as well as about morphology of the karst channels and conduits within the cave.



Visiting of the Bogovina cave

Next and the last stop for the first day was an archaeological site Felix Romuliana, the ancient imperial palace that is UNESCO World Heritage Site of Serbia, located south of the Danube River. After visiting this site, participants moved to the Bor city, where they had common dinner and overnight.



Felix Romuliana

On the next field trip day, first stop was near the Zlot city, where participants saw Lazar's cave and springs of Zlot. Firstly, Professor Stevanović introduced participants with geology and hydrogeology of this area, and also showed them Zlot springs which are drained in this area.



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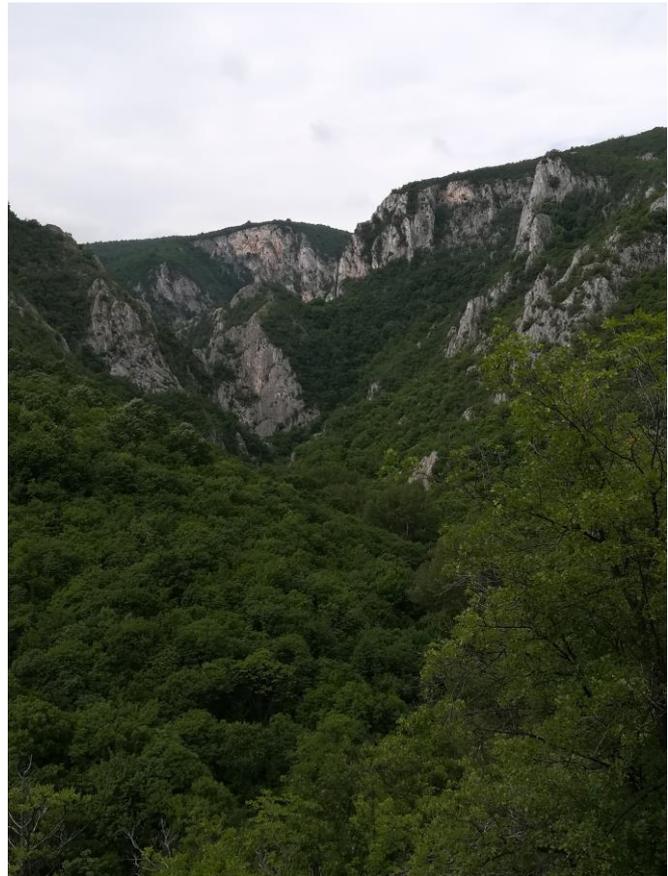
After short walk, participants entered the Lazar's cave, the longest explored cave in Serbia, where famous Jovan Cvijić was one of its first explorers. The cave has well developed karst conduits and channels, whose length is more than 15 km. After visiting the cave, participants walked to the view site, where they had opportunity to see the outlet part of the Lazar's Gorge, the deepest and the longest canyon in eastern Serbia.



Introduction to the geology and hydrogeology of the Zlot springs area



Visit to Lazar's cave



Lazar's Gorge

After this stop, group continued filed trip to the Beljanica Mountain, where they were able to see the some of the most famous springs in the Eastern Serbia, Mlava and Krupaja springs. On the way to the Beljanica Mountain, the bus made one more stop in Brestovačka banja Spa to visit numerous healing springs with slightly sulphurous and oligomineral water, with temperature in range 20 to 41 ° C, and to hear about history and hydrogeological features of this Spa.



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The Brestovačka banja Spa

The first of two stops within the Beljanica Mountain was the Mlava Spring, one of the strongest karst springs within Beljanica Massif, with deep syphonal circulation which represents a morphological pit type underground form, with a constant discharge of water to the terrain surface at an altitude of 305 m above sea level. This spring is also one of the first monitored springs in Serbia. Cvijic described this spring in 1896 as a doline basin with a constant groundwater outflow. On the spring site, professor S. Milanović introduced participants with the knowledge about the morphology of the Mlava Spring karst channel obtained via cave diving investigations conducted by numerous diving teams, which investigated the karst channel up to a depth of 73 meters. He also told that the Mlava lake itself is about 30 m deep, and surpassing that depth through a syphonal karst channel which becomes almost vertical, and then expands into a infundibular channel at a depth of 43 m.



Discussion on the Mlava Spring

The next and the final point for that day and for excursion was the Krupaja Spring, whose drainage area consists of actually three occurrences (Krupajsko vrelo, Krupaja thermal spring and Krupaja borehole). Krupajsko vrelo represent a very strong ascending spring, formed in the area of red Permian sandstone overtruss over Urgonian limestone. The quantities of water that are drained on this spring vary seasonally (251 to 8776 l/s), and the maximum recorded flow was in the May 2014 floods were about 31 m<sup>3</sup>/s discharged from the spring. A thermal spring on Krupaja has a temperature of 26 °C and discharge rate of about 2 l/s. Borehole B-1



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is located 10 meters from the natural thermal spring and it has temperature of 18 °C and it is tapped for water supply of nearby villages.



**Krupaja Spring**

In addition to short lectures on geology, hydrogeology, speleodiving and hydrochemistry of groundwater, provided by professor S. Milanović and Dr Lj. Vasić, participants had the opportunity to measure the Krupaja Spring discharge, as well as directly in the field to determine some of the basic hydrochemical parameters using portable field equipment (pH, temperature, electrical conductivity, redox potential, dissolved oxygen, turbidity, alkalinity, calcium and bicarbonate content and so on) by themselves.



**Field exercise (measurement of the Krupaja spring flow velocity and hydrochemical parameters)**

At the end, after common lunch, the closing ceremony was held (31<sup>th</sup> May) and all attendants who completed the course received a Certificate of Attendance.

Reported by  
Dr Ljiljana Vasić



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CEKA Team of the year 2019 !

**Questionnaire – Results of respond**

**1. The quality of content for the workshop**

Poor	
Fair	
Good	43%
Excellent	57%

**2. The quality of presentation**

Poor	
Fair	
Good	57%
Excellent	43%

**3. The level of technical material presented in the workshop**

Poor	
Fair	6%
Good	50%
Excellent	44%



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**4. In terms of benefitting my professional/academic practice, the workshop was**

Not useful	
Somewhat useful	19%
Very useful	81%

**5. Will you use some of the knowledge that you have learnt on the course?**

No, unlikely	
Maybe, possible	10%
Yes, likely	90%

**6. The length of the workshop**

Too long	6%
Too short	37%
Just right	57%

**7. How do you like field trips, and were they too long for you?**

They were good, but lasted too long	
The time we spent on stops was too long	
Everything was fine	43%
I would like to have more excursions than lectures	57%

**8. I would recommend this workshop to others interested in karst**

No, unlikely	
Maybe, possible	
Yes, likely	100%

**11 What is your overall evaluation of the course (1- worst; 5-best)?**

1	
2	
3	6%
4	50%
5	44%