

Hydrogeologic investigations at an overthrust karst aquifer of the Outer Dinarides, Croatia

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Research Area

The research area is located in the Gorski Kotar, a southeast tending green Karst mountain range of the **Outer Dinarides** in north-western Croatia with altitudes between 1000 and 1500 metres. It is well known for big Karst springs such as Kupa, Kupica and Zeleni Vir, belonging to the upper catchments of Kupa river. East of Delnice the karst spring Zeleni Vir is located below the village Skrad.

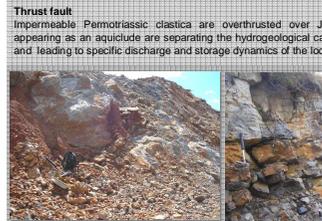


The discharge of Zeleni Vir spring ranges between **0.3 and 65 m³sec⁻¹** (Biondić et al., 2006) and is collected in a powerplant's pressure pipe line.

Geologically the region of the upper Kupa catchments belongs to the Outer Dinarides comprising mainly **Paleozoic to Mesozoic** formations. We follow the tectonic concept of Herak (1980), who identified **Jurassic formations** as karst aquifers below overthrust and confining **Permotriassic formations** (Biondić et al., 2006).

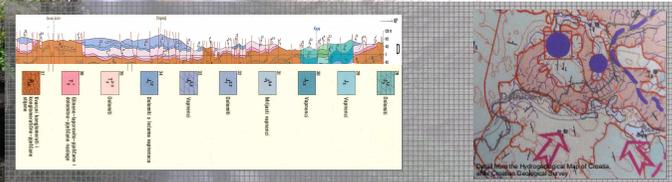


Spring zone
Appreciable karst springs discharge from Jurassic carbonate rocks. This aquifer lithology is highly karstified, big caves are bound to this area. Karst springs and caves are related to fold- and fault structures of the Outer Dinarides.

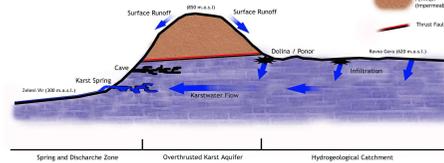


Thrust fault
Impermeable Permotriassic clastics are overthrust over Jurassic formations. Clastica, appearing as an aquiclude are separating the hydrogeological catchment from the spring zone and leading to specific discharge and storage dynamics of the local karst springs.

Hydrogeological catchment
Triassic and Jurassic formations are highly fractured and karstified. Speleothemes and palaeo soil fillings were observed.



Geological profile (left) from the 1:100 000 sheet „Delnice“ (HGI 1985, Savić & Dozet) showing impermeable Paleozoic clastics with a persistent thickness up to 1000 meter. This older stratigraphic interpretation is contrary to the modern hydrogeological map (HGI Hydrogeological map of Croatia) where Paleozoic clastics are overthrust over carbonate rocks (karstified), allowing a karst water flow below the impermeable formations (right).



Schematic profile-sketch
Showing the local hydrogeological model of a Jurassic karst aquifer which is overthrust by Paleozoic confining formations.

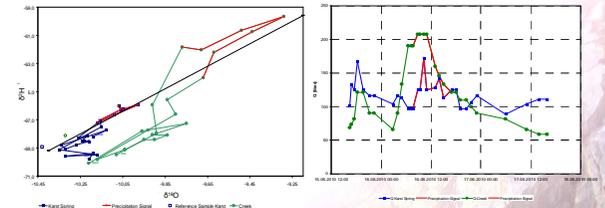


Fig 1 (left): Course of isotopic ratio during short termed monitoring at Zeleni Vir. Precipitation signal (marked red) shows the arrival of rainwater at the sample spot. The best fitting LMWL was taken from Vreca et al., 2006 [$\delta^2\text{H} = (7.6 \pm 0.4) \delta^{18}\text{O} + (10.5 \pm 4.0)$].

Fig 2 (right): Discharge graph with precipitation signal. red marking the arrival of rainwater at the sample spot.

An **event monitoring for stable isotopes** was done in Zeleni Vir (June 2010). A thundershower followed a rainless period. A sample spot was chosen that allowed a **parallel sampling of a karst spring and a surface runoff** dominated creek. The sample campaign lasted 48 hours.

Environmental isotopes of samples were measured using a **Picarro Inc. Isotopic Water Analyzer** combined with a CTC HTC-Pal autosampler (LEAP Technologies).

The karst spring shows a parallel but massively damped reaction on the event (Fig. 1). No decisive precipitation influence (event water) during 48 hours of monitoring was measured. This fits the general hydrogeological model (see profile sketch on the left) of a recharge area approximately 10 kilometres to the south. The estimated **linear velocity** in the local karst aquifer is less than 5cm/sec.

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