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Assessment of the cave environments appropriate for the reconstruction of the Quaternary settings in Croatia – speleothem-based approach

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Speleothems, as secondary carbonate deposits precipitated in stable cave environment, preserve high-resolution signals of paleoenvironmental changes, mostly recorded in variations of stable O and C isotopes, and trace elements. In order to contribute to the reconstruction of the Quaternary changes in Croatia, three caves were selected within different geomorphological regions, altitudes, and climate settings: Modrič Cave (32 m a.s.l.) situated on the eastern Adriatic coast (Cfa climate), Nova Grgosova Cave (239 m a.s.l.) in the central Croatia (Cfb climate) and Lokvarka Cave (760 m a.s.l.) located in mountainous region (Cfb climate). All caves are located in the epikarst zone and contain actively growing speleothems. Since only the calcite deposited in isotopic equilibrium with cave dripwater can preserve reliable proxy records from the past, the primal goal and essential part of this type of studies is assessment of the appropriate cave environment for such calcite precipitation. In order to characterize local surface and cave microclimate and hydrology, as well as isotope fractionation effect, we have been conducting 2-year monitoring of surface and cave air temperature and relative humidity, isotopic composition of meteoric and dripwater, and drip intensity at the positions of the speleothems collected for the future high-resolution stable isotope analyses.

Preliminary results after the first year showed that in Nova Grgosova Cave air temperature generally reflects the mean annual surface temperature, being 11.4 °C inside and 11.2 °C outside the cave. Air temperature of Lokvarka Cave is around 7.5 °C, while the surface temperature is 9 °C, but such difference is common in the caves with descending passages which act as a cold air trap. The essential fact is that the air temperature and relative humidity are constant or of very small range throughout the year. As for the Modrič Cave, in spite the warmer climatic year its cave atmosphere is characterized by air temperature around 16.4 °C which closely matches the 23-year air temperature series of the surface (16.1 °C).

As for the drip rates, which show the response of the dripsites to the surface rain event, we identified three different types of dripping: high-responsive in Lokvarka Cave, practically unresponsive in Modrič Cave, while Nova Grgosova Cave hosts moderate and unresponsive sites. Comparison of the rain and drip water stable isotope assemblages of each drip site shows whether the water has been sufficiently homogenized on its way from the surface through the epikarst to the caves, not only at the drip sites with stable discharge regime, but also at those with variable discharge. Finally, the modern calcite stable isotope composition gives the ultimate proof for appropriateness of particular sites/stalagmites for the reconstruction of the past events.

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