

EGU22-2048

<https://doi.org/10.5194/egusphere-egu22-2048>

EGU General Assembly 2022

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



The peculiar nature of thermal diffusion coefficients in karst terrains and their control on cave temperatures

David Domínguez-Villar¹, Kristina Krklec², and Francisco J. Sierra³

¹University of Salamanca, Department of Geology, Salamanca, Spain (ddvillar@usal.es)

²University of Zagreb, Faculty of Agriculture, Department of Soil Science, Zagreb, Croatia (kkrklec@agr.hr)

³University of Salamanca, Department of Geology, Salamanca, Spain (sierra@usal.es)

Temperature in the inner section of most caves (i.e., away from well ventilated entrance sections) is controlled by external air temperature transferred underground by heat conduction. The key parameter that controls heat conduction is the thermal diffusion coefficient, that is specific for different materials. Although thermal diffusion coefficients can be calculated for specific carbonate rocks, the underground karst is not composed exclusively of bedrock since dissolution creates large pores and conduits filled with air and water that greatly impact thermal diffusion coefficients.

We studied a 5-year temperature record of the entrance of Los Pilonos Cave, in central Spain. The cave entrance is a sub-horizontal and meandering crawlway that limits the advection even in winter, making this cave ideal to study thermal conduction processes. Cave temperature was recorded along the 30 m section from the entrance by 10 TINITAG thermistors and external temperature was measured at ground and 2 m elevation levels. The thickness of bedrock cover above the cave was measured with a DISTO2 laser meter equipped with compass and clinometer providing uncertainties <0.05m.

The bedrock cover above the ceiling of the cave ranges from 8 to 15 m and all cave temperature records show annual thermal oscillations with different amplitudes and lag times in relation to the external annual thermal cycles. Cave temperature measurements support that heat conduction is the main heat transfer mechanism controlling cave temperature variability. Thermometers located under a thicker bedrock cover record less thermal amplitude of the annual signal and enhanced delays. The thermal diffusion coefficient was calculated from averaging the results from the thermal anomaly recorded at different depths and the lag time recorded at different depths. The dispersion of regression analyses ($r^2 > 0.9$) is large compared to analyses performed on non-karst bedrocks, supporting the existence of local heterogeneities in the underground karst. We also noticed that the lag times of individual loggers changed during the studied period (interannual variability), which can be attributed to variable ratios of water saturation in the local porosity. Therefore, when reporting the thermal diffusion coefficient of karst terrains, their triphasic nature (i.e., rock, water and air) should be considered. So, the average thermal diffusion coefficient of a specific cave could vary in space or time beyond calculated uncertainties depending variable

hydrological conditions.

Acknowledgements:

The project leading to this research has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No.101030314.