A cover letter for the manuscript: “Karst and cave formation in Earth’s upper crust by cooling of CO2-rich geothermal flow”

Dear Editor,

Please find enclosed our manuscript, “Dissolution and cave formation in Earth’s upper crust by cooling of CO2-rich geothermal flow,” which we submit for consideration for publication in Nature Communications. This study combines geochemical and numerical analyses and field observations to demonstrate that cooling of CO2-rich geothermal flows is a major karst- and cave-formation mechanism in carbonate aquifers in Earth’s upper crust. In particular, the study sheds light on the enigmatic origin of large, isolated maze-like cave systems with no connection to the surface.

The submitted manuscript makes several important and broad implications: (1) The work emphasizes the dominance of a unique geophysical mechanism, the impact of which has been omitted or significantly underestimated in previous studies. (2) The results rely on a close comparison with field observations and match the observed cave morphologies. (3) The extensive expansion of the void-space in deep and shallow aquifers because of geothermal flows is crucial for a number of subsurface applications and has vast economic and environmental importance. These applications include, e.g., management of water resources, geothermal energy use, and CO2 geological storage. (4) The study deciphers intricate and enigmatic pattern formation, leading to the creation of isolated maze cave systems without genetic linkage to the surface. (5) The study emphasizes the link between global processes and balances, affecting the global carbon balance: Earth’s geothermal heat loss in conjunction with the large deep-seated CO2 fluxes that affect the evolution of the upper-crust rocks (which in turn affect back CO2 fluxes). For those reasons, we think that the manuscript will be of interest to the broad and specialist readership of Nature Communications.

The findings contradict the current paradigm summarized in the leading review literature, namely, that cooling of upwelling geothermal fluids plays a minor role in carbonate dissolution in general and in hypogene karst formation in particular (see, e.g., Klimchouk, 2019; Palmer, 2011). The paradigm may have been rooted in early calculations (Palmer, 1991), which involve, in our opinion, inaccurate assumptions. Furthermore, later numerical works showed relatively minor changes in the void space of rocks and did not demonstrate the formation of caves (Andre & Rajaram, 2005; Chaudhuri et al., 2013). Consequently, despite our large appreciation of these pioneering works and previous contributions, we respectfully request the exclusion of several potential reviewers due to conflicting views: (1) A. Palmer, Professor Emeritus of the State University of New York; (2) Professor A. B. Klimchouk, National Academy of Sciences of Ukraine; and (3) Professor H. Rajaram, Johns Hopkins University.

We suggest the following reviewers out of the intimate karst community:

* Professor B. Jamtveit, University of Oslo ([bjorn.jamtveit@geo.uio.no](mailto:bjorn.jamtveit@geo.uio.no))
* D. Ford, Professor Emeritus of McMaster University (dford@mcmaster.ca)
* Professor Xiaojing Fu, California Institute of Technology ([rubyfu@caltech.edu](mailto:rubyfu@caltech.edu))
* Professor M. Dentz, Spanish National Research Council (marco.dentz@csic.es)
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The authors declare to have no conflict of interests, and there are no companion or related manuscripts submitted elsewhere.

Sincerely,

R. Roded, E. Aharonov, A. Frumkin, N. Weber, B. Lazar, and P. Szymczak