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Constraints on Long-Term Seismic Hazard From Vulnerable Stalagmites from Vacska cave, Pilis Mountains of Hungary

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Damaging earthquakes in central Europe are infrequent, but do occur. This raises the important issue for society of how to react to this hazard: potential damages are enormous, and infrastructure costs for addressing these hazards are huge as well. Obtaining an unbiased expert knowledge of the seismic hazard (and risk) is therefore very important.
Seismic activity in the Pannonian Basin is moderate. In territories with low or moderate seismic activity the recurrence time of large earthquakes can be as long as 10,000 years. Therefore, we cannot draw well-grounded inferences in the field of seismic hazard assessment exclusively from the seismic data of 1,000- to 2,000-years observational period, that we have in our earthquake catalogues.
Long-term information can be gained from intact and vulnerable stalagmites (IVSTM) in natural karstic caves. These fragile formations survived all earthquakes that have occurred, over thousands of years - depending on the age of them. Their “survival” requires that the horizontal ground acceleration has never exceeded a certain critical value within that time period.
Here we present such a stalagmite-based case study from the Pilis Mountains of Hungary.
Evidence of historic events and of differential uplifting (incision of Danube at the River Bend and in Buda and Gerecse Hills) exists in the vicinity of investigated cave site. These observations imply that a better understanding of possible co-seismic ground motions in the nearby densely populated areas of Budapest is needed.
A specially shaped (high, slim and more or less cylindrical form), intact and vulnerable stalagmites in the Vacska cave, Pilis Mountains were examined. The method of our investigation includes in-situ examination of the IVSTM and mechanical laboratory measurements of broken stalagmite samples.
The used approach can yield significant new constraints on the seismic hazard of the investigated area, since tectonic structures close to Vacska cave could not have generated strong paleoearthquakes in the last few thousand years, which would have produced a horizontal ground acceleration larger than the upper acceleration threshold that we can determined from the intact and vulnerable stalagmites. A particular importance of this study results from the seismic hazard of the capital of Hungary.