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Annual laminae as measured using fluorescence in historic stalagmites from Baradla Cave, Aggtelek National Park, Hungary.

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Calcite and aragonite speleothems (stalactites and stalagmites) deposited in caves often display fluorescence. It may take the form of couplets of greater and lesser intensity that have been shown to be annual pairs in some carefully controlled instances such as deposits in 20th Century canal tunnels. The variations of intensity are related to seasonal variations in concentrations of fluorophores (chiefly fulvic acids) in the feed water to the speleothem.
To test for the possibility and replicability of couplet formation two small stalagmites likely to be of historic age were collected in Baradla Cave, Aggtelek National Park, Hungary, in 1992. This is a large cave in Triassic limestones and dolomites that have been intensely deformed by Carpathian tectonism to allow ready ground water penetration. As a consequence, it is profusely decorated with speleothems and has been a tourist attraction since the 18th Century. The samples were taken ten metres apart in an abandoned river passage at a depth of 40-60 m beneath the surface, which is mantled with terra rossas, rendzinas and luvisols mostly less than 50 cm in thickness. The vegetation cover is deciduous forest with small patches of grassland, spruce and pine. At a nearby meteorological station 30-year mean January and July temperatures are -3.5o C and 18.5o C respectively. Annual mean precipitation is 560 mm, with a summer maximum and actual evapotranspiration less than 400 mm.
Samples AGG-1 and -2 were bright white calcite stalagmites 90 and 70 mm in length respectively and 40-50 mm in width. They were growing on the blackened stumps of larger stalagmites that had been taken as souvenirs. Blackening was caused by smoky torches used in the earliest days of tourism, and replaced by lanterns around 1820 CE. 2 mm thick slices were cut perpendicular to the growth axes of the samples, polished, excited by electronic flash gun and photographed at 1/60th second with Kodak TMAX ISO 3200 film, using multiple exposures to capture delayed fluorescence. Experiments determined that there was negligible phosphorescence, that results were reproducible and were not affected by the grain of the film. Images were imported into IP-LAB Spectrum for data retrieval. They displayed strong couplet development with repeated layers of high-low fluorescence.
Assuming that each couplet represents one climatic year, Sample AGG-1 was 165 years in age when collected; i.e. it commenced growing in 1827 CE. The true base of Sample AGG-2 was destroyed in extraction; it yielded an age of 156 years. Both are in excellent agreement with the expected ages. Correlation of fluorescence intensity and derived laminae thickness between the two samples is also excellent when fitted with a three-year running mean to avoid misallocation of individual years. Interannual fluorescence intensity grew slightly between ∼1830 and 1900 CE, then was stable until minor decline commenced after 1970. Annual calcite lamina generally range between 0.5 and 1.0 mm in thickness in AGG-1after 1900 CE, slightly less before that time. Thicknesses in AGG-2 follow the same trend but are consistently 0.1 -0.2 mm thinner. There is little correlation with the matching mean temperature and precipitation records from a nearby meteorological station that began operating in 1962. Relationships with much lengthier meteorological records from Miskolc and Budapest are being investigated.