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Climatic variations during the Holocene inferred from radiocarbon and stable carbon isotopes in a high-alpine cave

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Laser ablation coupled online to accelerator mass spectrometry [1] allows analyzing the radiocarbon (^{14}C) concentration in carbonate samples in a fast and spatially resolved manner. This novel technique can provide ^{14}C data at a spatial resolution comparable to that of stable carbon isotope measurements and, thus, can help to interpret $\delta^{13}C$ signatures. In this work, we analyzed $\delta^{13}C$ and ^{14}C of a Holocene stalagmite from the high-alpine Spannagel Cave (Austria). Combined $\delta^{13}C$ and ^{14}C profiles allow identifying three growth periods : (i) the period > 8 ka BP exhibits relatively low $\delta^{13}C$ values with small variability combined with a comparably high dead carbon fraction (dcf) of around 60%. This points towards C contributions of an old organic carbon reservoir in the karst potentially mobilized due to the warm climatic conditions of the early Holocene. (ii) Between 3.8 and 8 ka BP, a strong variability in $\delta^{13}C$ with values from -8 to +1‰ and a generally lower dcf was observed. The $\delta^{13}C$ variability was most likely caused by changes in gas exchange processes in the cave, which are induced by reduced drip rates as derived from lower stalagmite growth rates. Additionally, the lower dcf indicates that the OM reservoir contributed less to stalagmite growth in this period possibly as a result of reduced precipitation or because the OM reservoir became exhausted. (iii) In the youngest section between 2.4 and 3.8 ka BP, comparably stable and low $\delta^{13}C$ values combined with an increasing dcf reaching up to 50% are again hinting towards a contribution of an aged organic carbon reservoir in the karst.

[1] C. Welte, et al., (2016). Anal. Chem., 88, 8570– 8576.