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Methane concentration and isotopic composition ($\delta^{13}\text{C}-\text{CH}_4$) in the Nerja Cave system (South Spain)

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Air in underground caves often has methane (CH_4) concentrations below the atmospheric level, due to methanotrophic or other unknown CH_4 consuming processes. Caves are thus considered a potential sink for atmospheric methane. If globally important, this underground CH_4 oxidation should be taken into account in the atmospheric methane budget, in addition to the known soil methanotrophy and tropospheric/stratospheric sinks. A large set of data is however necessary to understand how and how much methane from external atmospheric air is consumed in the caves. While methane concentration data are available for several caves worldwide, its isotopic composition and variations in space and time are poorly documented.

We measured methane concentration and stable C isotope composition ($\delta^{13}\text{C}$) in the Nerja cave (Southern Spain) air during two surveys in March and April 2015. CH_4 concentration decreases progressively from the more external cave rooms, with atmospheric levels of 1.9 ppmv, to the more internal and isolated rooms down to 0.5 ppmv. $\delta^{13}\text{C}$ increases correspondingly from -47 ‰ to -41 ‰ (VPDB). CH_4 is systematically ^{13}C -enriched ($\delta^{13}\text{C} > -45$ ‰) in areas of the cave where the concentration is below 1.4 ppmv. This combination of concentration decrease and ^{13}C -enrichment towards the more internal and isolated zones of the cave confirms the importance of CH_4 oxidation, likely driven by methanotrophic bacteria. Further data, including stable H isotope composition of sub-atmospheric CH_4 concentrations, CO_2 and microbial analyses, shall be acquired over time to assess the actual role of methanotrophic bacteria and seasonal controls in the CH_4 consumption process.