Sourcing methane in karst systems: experiences in European caves

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Abstract / Introduction

Recent studies have demonstrated that the sub-atmospheric CH_4 concentrations in underground air imply that caves are functioning as CH_4 sinks (Mattey et al., 2013; Fernandez-Cortes et al., 2015) and provide evidence that the subterranean atmosphere of karst systems may play a key role in regulating greenhouse gases in the atmosphere.

In this study we have measured CH_4 variability and carbon isotope composition associated with karst environments over several annual cycles from 8 caves in a S-N transect along Europe. The sites cover a spectrum of local climates (oceanic and continental), bedrock lithology (limestones, gypsum or shales), cave microclimatic conditions and ventilation pattern, geomorphological and speleogenesis types (epigenic and hypogenic caves).

We demonstrate that the increase in the residence time of atmospheric-derived air in the subterranean environment provokes a more effective CH_4 consumption, depleting CH_4 concentrations almost to zero throughout an annual cycle. Carbon isotopic data show that the methane dynamics of subterranean environments on karst is consistent with atmospheric methane consumption and, in some cave locations, with minor biogenic methane sources that are highly diluted with cave air with sub-atmospheric CH_4 concentrations. Methane consumption may be related to methanotrophic bacteria but since cave air CH_4 concentrations can also be correlated with the ionization degree of cave air and ground air-derived CO_2 and radon an abiotic mechanism may also contribute to the methane depletion process. The potential mechanisms involved on the depletion of atmospheric-derived CH_4 in subterranean atmospheres will be discussed, including the potential reaction with ions and the methanotrophic consumption.