

## **Temporal variations of dissolved hydrocarbon gases during groundwater baseline monitoring and its implications – an example from Lower Saxony**

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Since the demand for hydrocarbon and geothermal exploitation, as well as underground storage capacities is still rising, environmental aspects increased in significance for permissioning as well as public perception and acceptance. A crucial related element is a potential leakage of gaseous hydrocarbons into upper aquifers, but an understanding requires baseline information. However, the determination of light hydrocarbon background concentrations within groundwater in Germany was scarce and selective. In 2014 we conducted an initial study on background concentrations of methane, ethane and propane, from approximately 1000 sampled groundwater wells covering the Federal State of Lower Saxony with an area of ~48.000 km<sup>2</sup>. To evaluate potential variations this complete campaign was repeated in 2016.

In this study we present that the 2016 data set supports the initial interpretation that dissolved methane's signatures are dominated by microbial processes (methanogenesis as well as methanotrophy). Although, measured concentrations range over 7 orders of magnitude, the majority of the sampled shows relatively low concentrations (<10 µl/l; n=924 out of 1357). Resulting from the repeated campaign we were able to compare data from ~750 wells each sampled in 2014 and 2016.

The observed relative variations between 2014 and 2016 concentrations are generally smaller than +/-25% (for 87% of sampled wells), however for dissolved methane concentrations smaller than 1 µl/l broader variations (~100%) are common.

This is also true for samples with low concentrations of ethane and propane. Due to their low abundances, determined concentrations were often around the analytical detection limit, therefore for samples with low abundances of dissolved hydrocarbons parameters derived from their abundances, such as the dryness as indicator for whether a gas has a mostly biogenic or thermogenic origin, have to be applied carefully.

The variation of methane's carbon isotopic composition of ~150 wells sampled in 2014 and 2016 is generally small around a few permill, although larger differences were frequently observed. Lacking a conclusive explanation yet, these differences are still subject to our continuous research.

Our study demonstrates the power, but also challenges and limitations of baseline studies if those studies have to be used as reference to detect presumed hydrocarbon gas contaminations. Nevertheless, for this purpose repeated sampling campaigns are urgently suggested to ensure a robust baseline.