

DISSOLVED METHANE, ETHANE, AND PROPANE IN GROUNDWATER (NW GERMANY): CONCENTRATIONS, $\delta^{13}\text{C}$ SIGNATURES, TEMPORAL VARIATIONS

C.J. Illing¹, S. Schloemer¹, M. Blumenberg¹, J. Oest², J. Elbracht²

¹ Federal Institute for Geosciences and Natural Resources, Germany

² State Authority of Mining, Energy and Geology, Germany

Introduction

On the background of an increased awareness for possible environmental impacts of hydrocarbon resources' or geothermal exploitation and underground storage, research in this field was intensified during the last decade. Therefore, improved knowledge of natural background concentrations is needed and became a strong research focus. One frequently discussed topic is stray gas, i.e. (thermogenic or biogenic) gas that enters groundwater resources and ultimately the atmosphere.

Prior to our first comprehensive study in 2014, there was no baseline study for Germany's major gas producing area (Federal State of Lower Saxony; hosting more than 90 % of the domestic natural gas production, see Schloemer et al., 2016). Based on this initial work, subsequent sampling continues through 2017.

For this study groundwater wells across Lower Saxony (~48.000 km²) have been sampled and analyzed for dissolved hydrocarbon gases (methane, ethane and propane). During our first campaign in 2014 ~1000 sampled wells have been analyzed and gave a first estimate on naturally occurring concentrations. To increase the spatial coverage and evaluate potential variations this campaign was repeated in 2016, resulting in a data set of about 1300 sampled wells (Fig 1A) of which >700 wells have been sampled twice in ~2 years.

Results and discussion

Measured methane concentrations range from 20 nl/l up to 60 ml/l with a majority of samples showing low concentrations, 61 % of the samples showed concentrations below 10 $\mu\text{l/l}$ (Fig. 1B). Ethane and propane were detectable in a small subset of sampled wells and were generally low in concentrations (ethane with a median at 35 nl/l and propane at 18 nl/l). The occurrence of ethane (and propane) in samples, showing unusual ethane/propane ratios in concert with abundant biogenic methane are tentatively interpreted as ubiquitous (microbial) background. Methane's isotopic composition ranges from -110 to +25 ‰ (vs. VPDB) and is clustering around -70 ‰. Overall, the 2016 data set is supporting our initial interpretation of a microbial dominated methane signature.

In general, the relative variation in methane concentrations among twice sampled wells (2014 and 2016) is smaller than +/- 25 % (87 % of sampled wells). Higher variations are observable in samples with concentrations <1 $\mu\text{l/l}$. For methane $\delta^{13}\text{C}$ values the absolute temporal variation for most measured samples was below +/- 2 ‰ (Fig 1C), broader variations (>5 ‰) occur in 25% of the samples, commonly linked to lower absolute methane concentrations. Conclusive explanations, whether or not these variations are caused by naturally occurring processes are subject to continuous research.

Conclusions

In general, the comparison of 2014 and 2016 groundwater data suggest an overall low temporal variability of concentrations of dissolved hydrocarbon gases in Lower Saxony. However, our results also illustrate the necessity of repeated sampling to account for natural variations, most notably if the concentrations of dissolved gases are low. This holds in particular if results are intended to determine the (natural) background and/or usage as reference to detect presumed hydrocarbon gas contamination of aquifers.

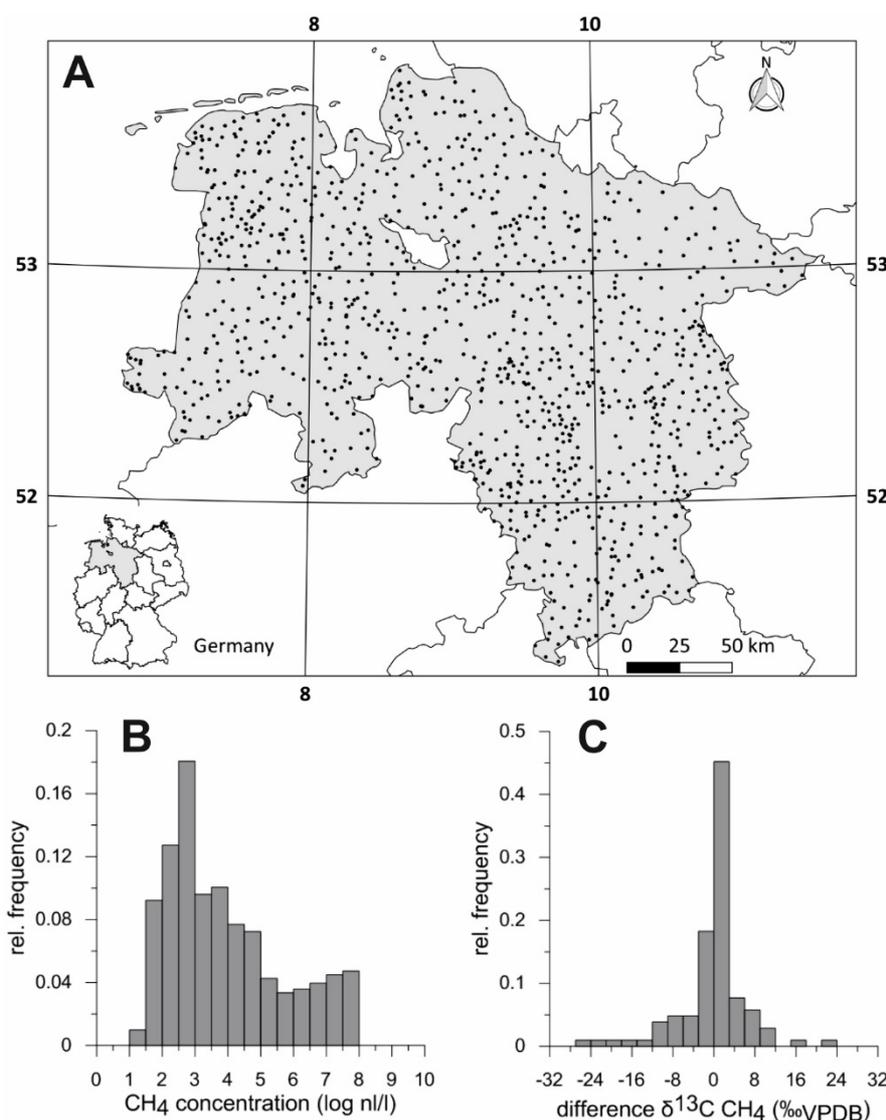


Figure 1: A) Distribution of the sampled groundwater wells across Lower Saxony B) Histogram showing the distribution of methane concentrations among wells sampled from 2014 through 2016 (in case of repeated sampling the last concentration was considered). C) Histogram showing variations of methane's $\delta^{13}\text{C}$ signature between the 2016 and 2014 datasets.

References

Schloemer, S., Elbracht, J., Blumenberg, M. and Illing, C.J., 2016. Distribution and origin of dissolved methane, ethane and propane in shallow groundwater of Lower Saxony, Germany. *Applied Geochemistry* 67, 118-132.