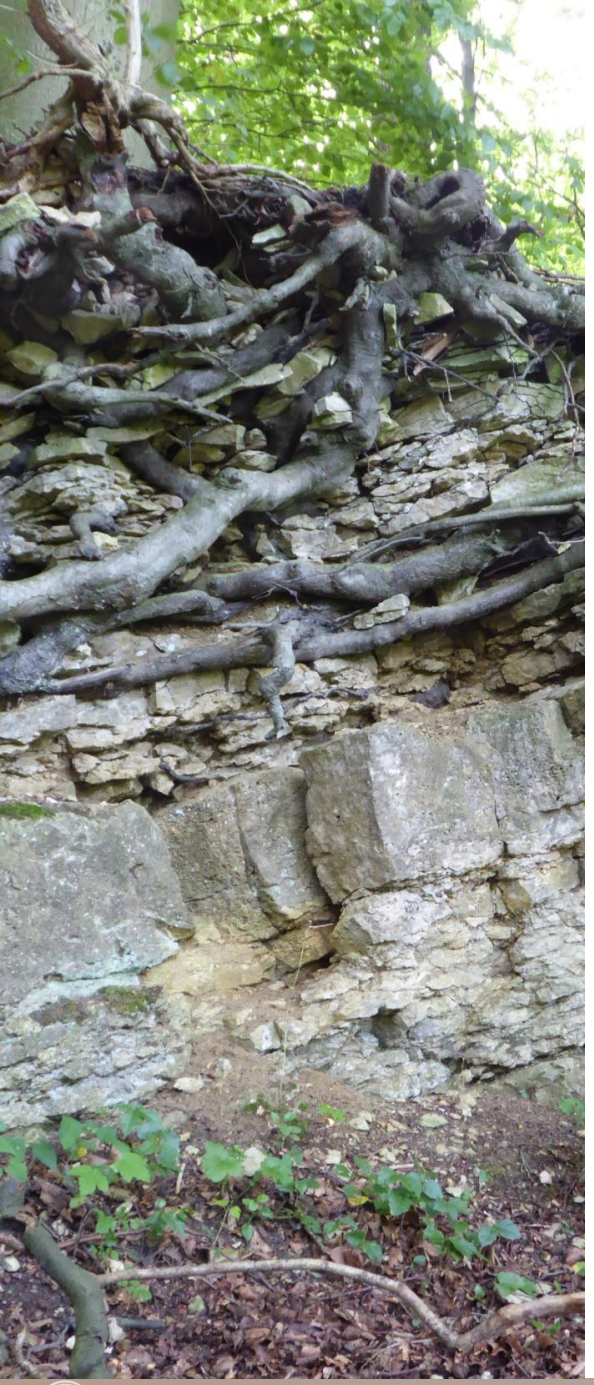

iDiv German Centre for Integrative Biodiversity Research

AquaDiva

FRIEDRICH-SCHILLER-UNIVERSITÄT JENA

Nitrate sources and sinks in oligotrophic groundwater

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Nitrogen cycling in karstic aquifers is key to drinking water quality

- 25% of the global water supply originates from karstic aquifers (Ford & Williams 2007).

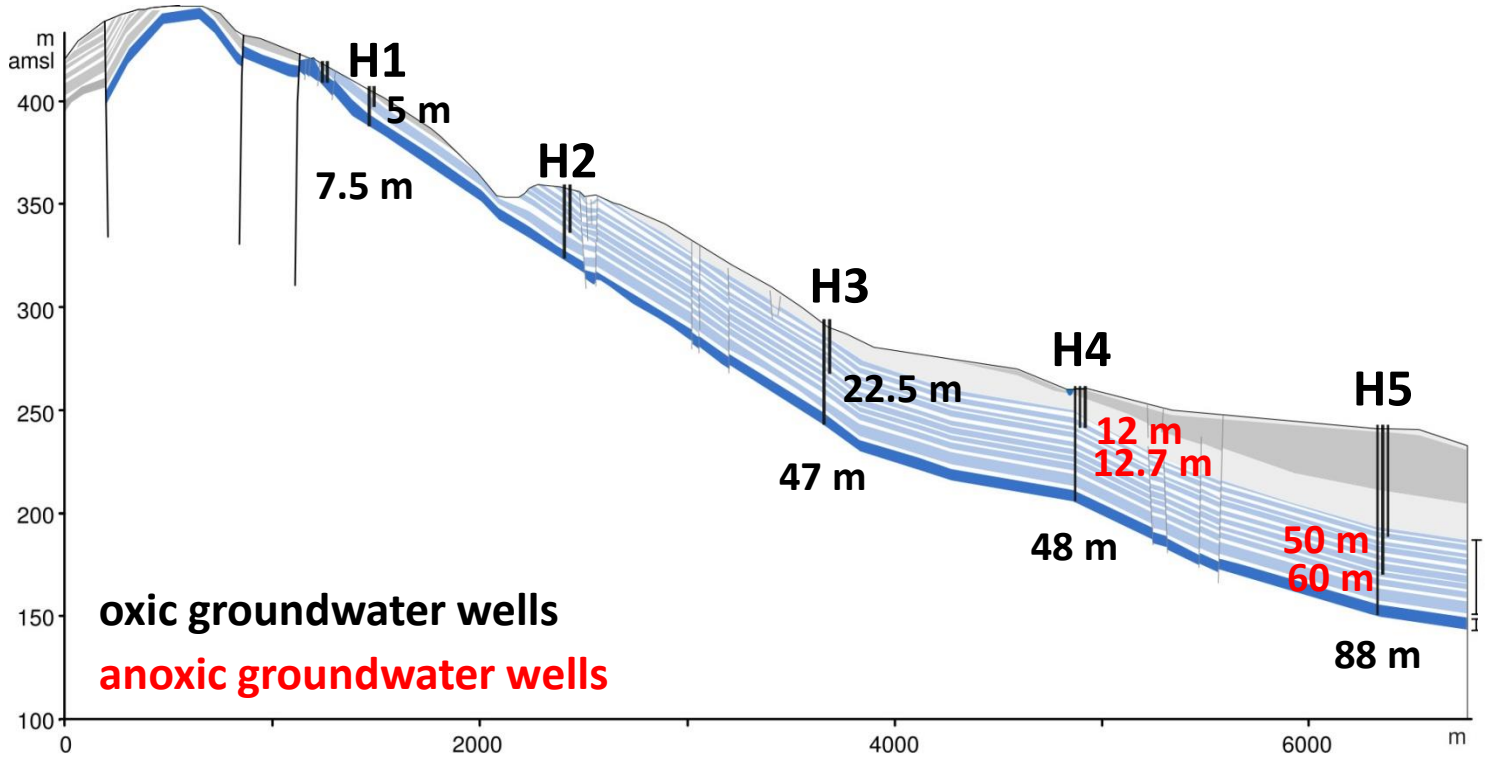
- Karstic aquifers are extremely vulnerable to surface input of nitrogen compounds due to fast infiltration and transport (Huebsch et al. 2014).

➢ **Strong need to understand processes leading to the formation or removal of nitrate in aquifers.**

The Hainich Critical Zone Exploratory

Field site of the CRC 1076 AquaDiva

Küsel et al. (2016), Frontiers Earth Science



The cross-section is taken from Kohlhepp et al. (2017), modified.

Limestone aquifers (Upper Muschelkalk)

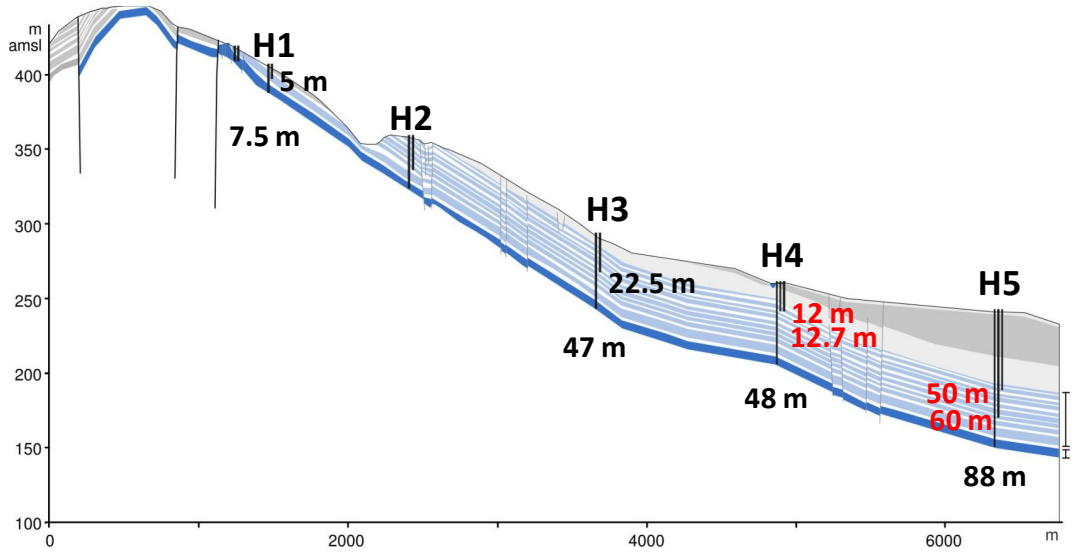
- **pH 7.0 – 7.5**
- **low availability of organic carbon**

Minor upper aquifer assemblage
Lower main aquifer

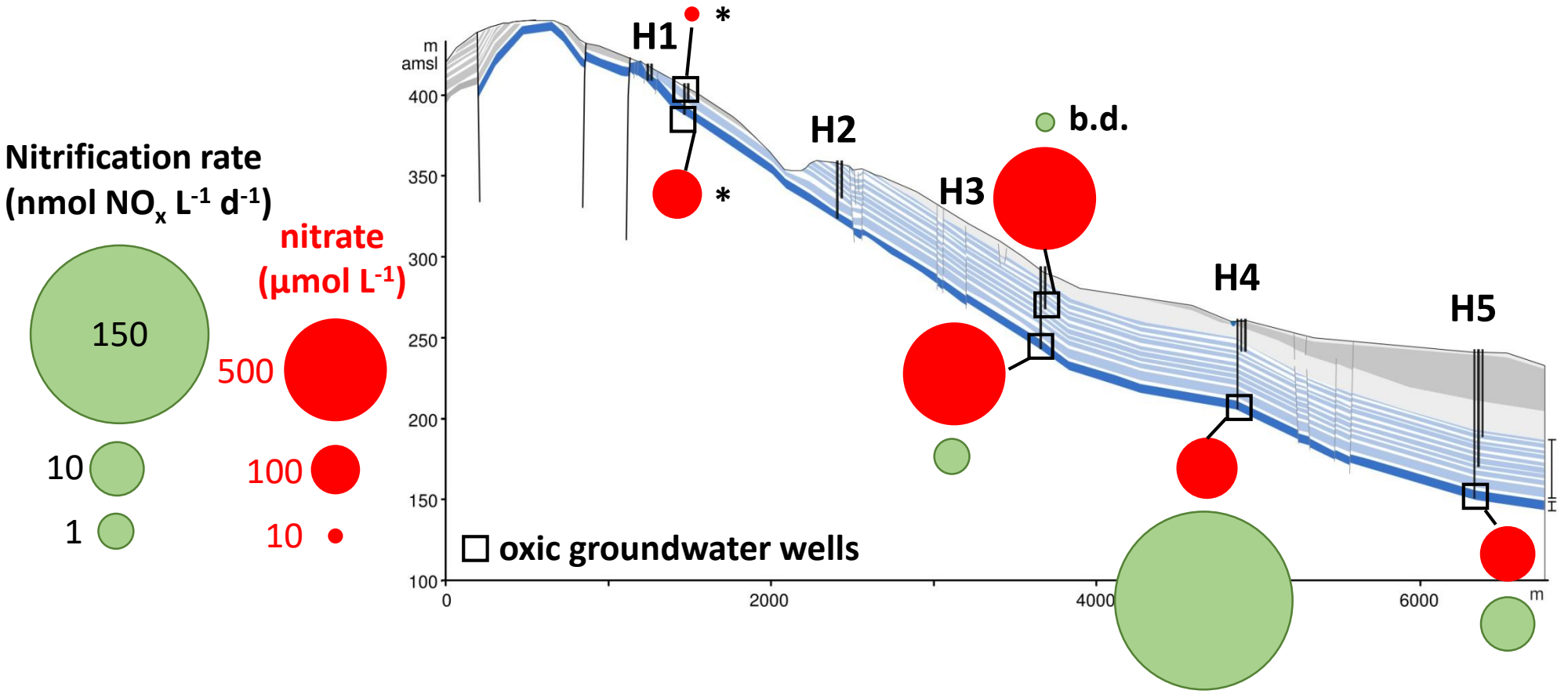
Research questions

What is the spatial distribution of nitrification and N_2-forming (nitrate-reducing) processes across the aquifers of the Hainich Critical Zone Exploratory?

Which are the key microbial groups driving these processes?



Nitrate distribution in oligotrophic groundwater is not reflected by nitrification activity



* nitrification rate not measured

Comammox bacteria dominate ammonia oxidizer communities at nitrification hotspot

ammonia oxidizer community composition

ammonia oxidizing bacteria

ammonia oxidizing archaea

nitrification $NH_4^+ \rightarrow NO_2^- \dashrightarrow NO_3^-$

$NH_4^+ \rightarrow NO_3^-$

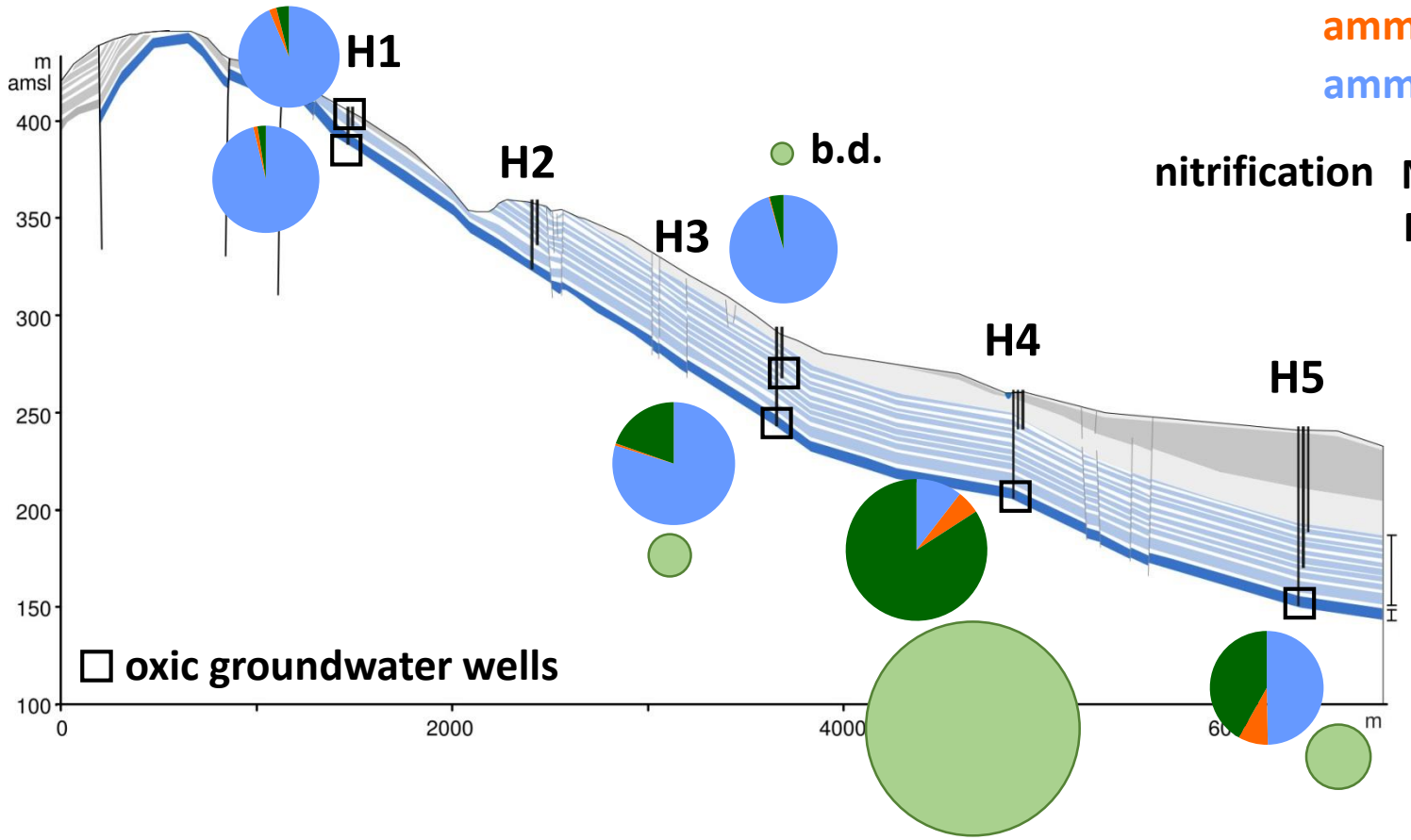
comammox bacteria (complete ammonia oxidation to nitrate by one organism)

Nitrification rate (nmol NO_x L^{-1} d^{-1})

150

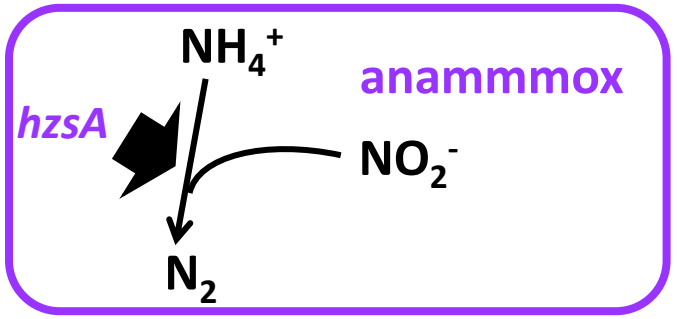
10

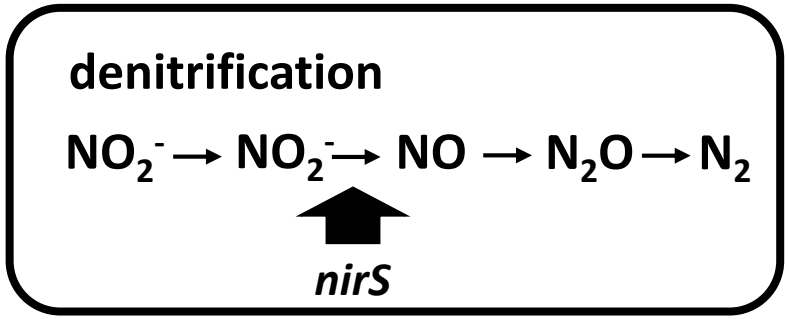
1

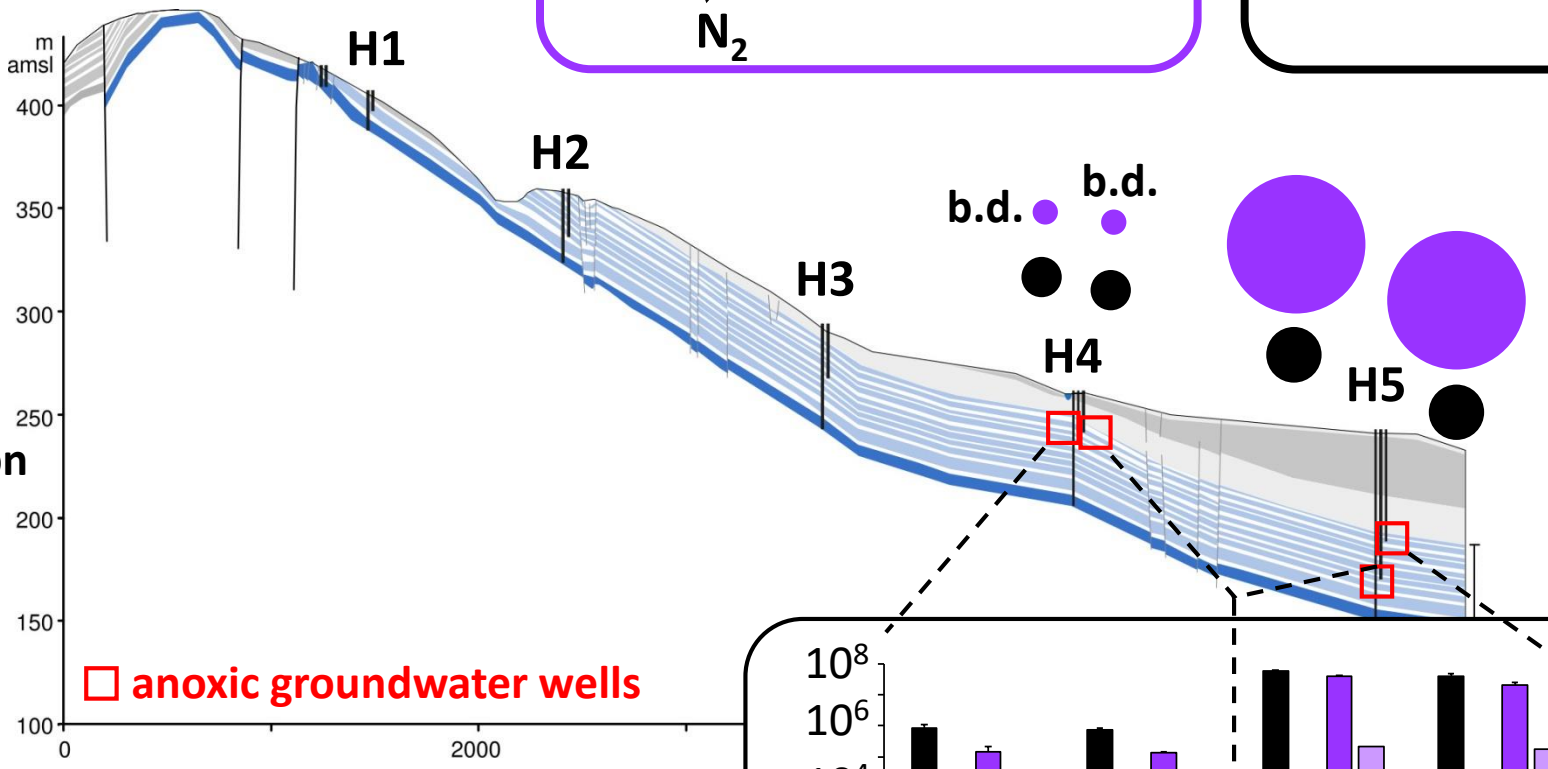


Nitrification appears to be driven by comammox bacteria.

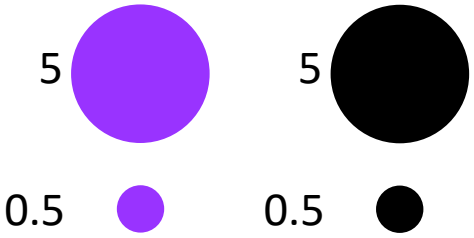
Anammox is the dominating N_2-forming process in anoxic groundwater



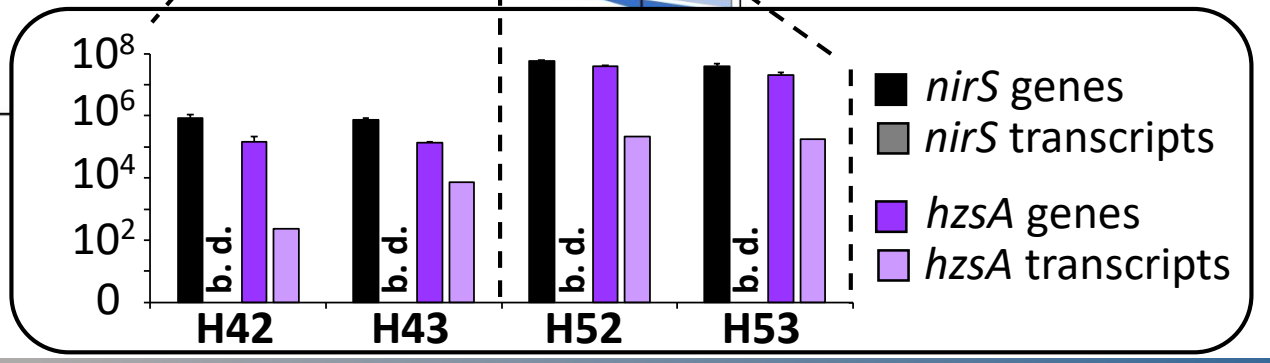




anammox rate (nmol N_2 L^{-1} d^{-1})



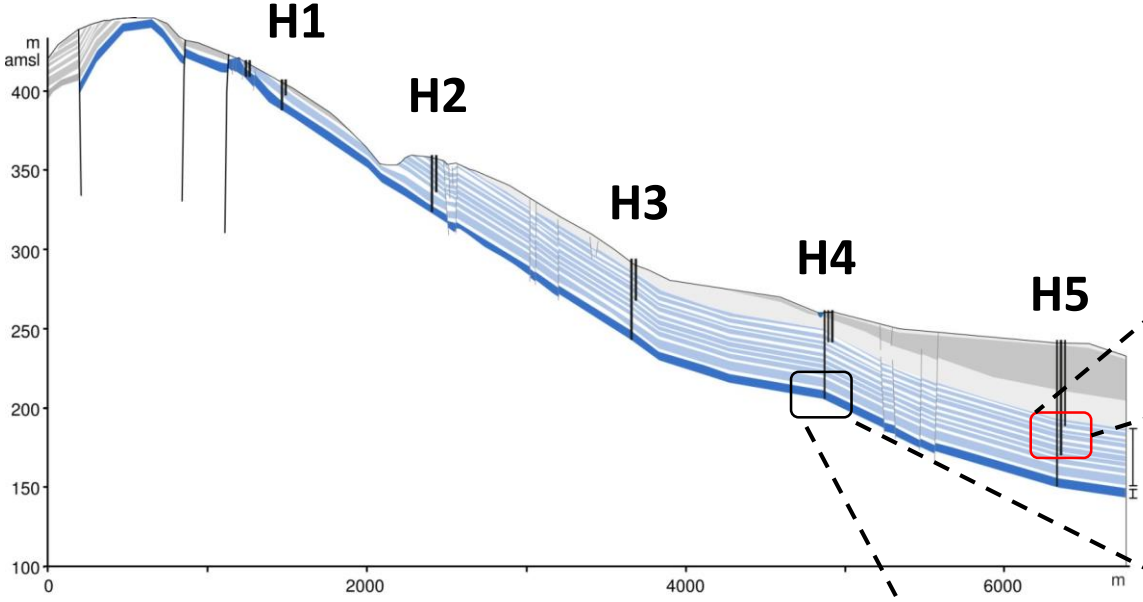
denitrification rate



b. d. = below detection

Conclusions

Heterogeneous distribution of nitrate-forming and nitrate-reducing processes in oligotrophic carbonate-rock aquifers



Anammox „hotspot“: anammox dominating process of N_2 formation

NH_4^+ + NO_2^- → N_2

Nitrification „hotspot“

NO_2^- → NO_3^-

NH_4^+ → NO_2^-

Potentially important role of comammox

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