Geochemical detection of minor hydrocarbon seepage in marine sediments

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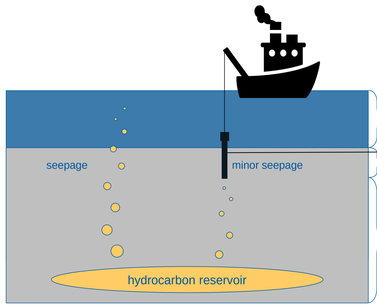
Motivation



Sedimentary geochemistry and microbiology altered by hydrocarbon (HC) influx

- Understand marine sedimentary ecosystems above HC reservoirs
- Detect chemical/biological changes in short (<3m) sediment cores using a multi-omics approach

Develop a powerful omics-based, minimally invasive hydrocarbon detection tool

Prospectomics project

- International EU project with 6 partners
- Use of genomics, proteomics, transcriptomics, geochemistry, machine learning

Sulfate reduction rates

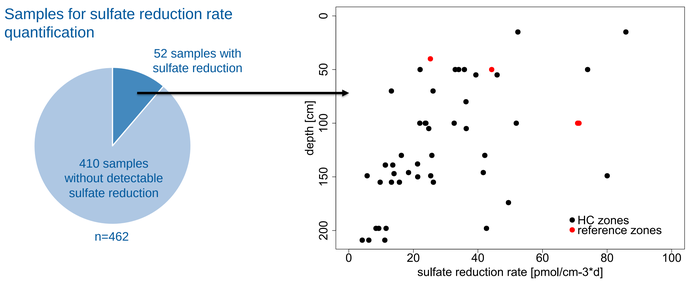
Sampling

Incubation with ^{35}S radiotracer

Extraction of sulfide

Scintillation counting of radiolabeled sulfide

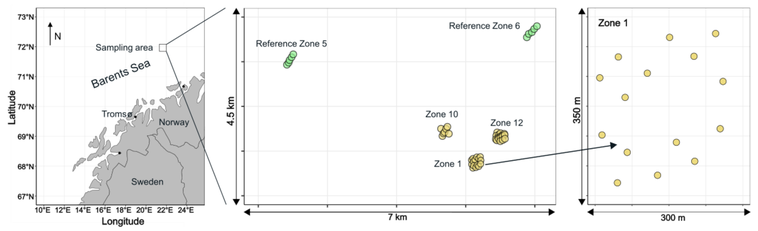
Samples for sulfate reduction rate quantification



- Ca. 10% of the samples show detectable sulfate reduction
  → Active microbial sulfate reduction
- Sulfate reduction occurs at low rates mainly in the HC zones
  → More electron donors available in HC zones due to seeping HC from below

HC seepage evokes low rates of microbial sulfate reduction above the AOM zone

Study area



- Barents Sea, Norway
- Cruise in November 2021
- 50 gravity cores from 2 reference zones and 3 hydrocarbon zones with non-visible seepage
- Sampling grid with 50 m resolution
- Samples for porewater analysis, geochemistry and microbiology analysis, depth resolution ≤ 20 cm

Conclusion

No net production/ consumption of alkalinity/ sulfate

BUT

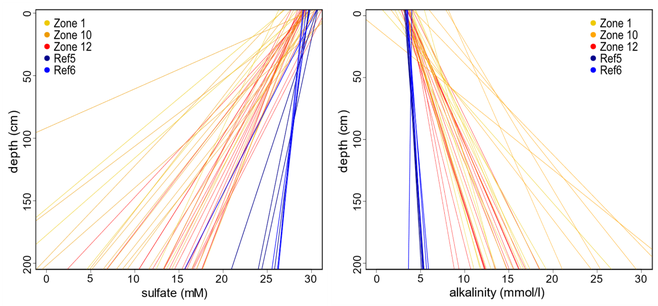
Low rates of microbial sulfate reduction measured above the AOM zone

Higher sulfate/alkalinty fluxes in HC zones

Some element profiles show reverse trends in HC zones, potentially caused by higher microbial activity

Combination of parameters can serve as potential indicator for minimal HC seepage

Alkalinity and sulfate profiles

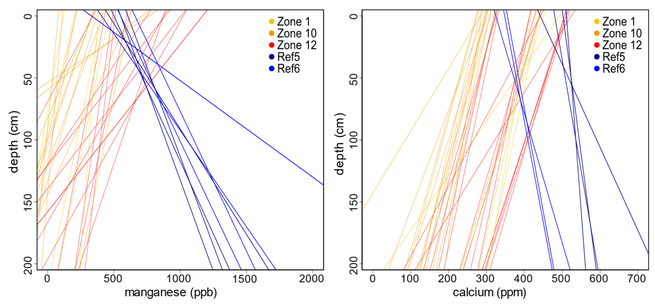


- Linear pore water profiles at HC and reference zones
  → No net turnover in the sampled depth interval
- HC zones show much steeper gradients than reference zones
  → Shallower sink of sulfate/source of alkalinity below core interval, most probably anaeorobic oxidation of methane (AOM)

$CH_4 + SO_4^{2-} \rightarrow HS^- + HCO_3^- + H_2O$

Higher sulfate and alkalinity fluxes in HC zones

Element profiles



- Manganese and calcium pore water profiles show reverse trends between HC and reference zones
  → Does manganese precipitate with sulfide in HC zones ?
  → Is calcium incorporated into microbially altered clay minerals in HC zones?

Element profiles are influenced by higher microbial activity in HC zones

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