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Tracing the influence of minor hydrocarbon seepage on sulfur cycling in marine subsurface sediments

All hydrocarbon (HC) reservoirs tend to leak to some extent, releasing small quantities of HCs that migrate upwards into the overlying sediments, e.g. seeps. Through microbial activity, these HCs can be completely metabolized before reaching the seafloor, thus not creating any surface manifestations. Despite their inconspicuous nature, these HC fluxes can potentially influence the geochemistry of surrounding sediments and the composition and activity of microbial populations therein, as they add electron donors into the system.
We analyzed 50 gravity cores from the South Western Barents Sea. The sampling sites were located in three areas overlying known HC reservoirs (HC sites) and two reference areas (reference sites) of pristine seabed not affected by HC leakage. Despite the very similar nature of their sediment composition (clay-rich, organic-poor), the 50 gravity cores revealed considerable variability in pore water concentration gradients of various dissolved ions. Nearly linear profiles of pore water sulfate and alkalinity were observed, indicating that there is minimal to no net production or consumption of these ions within the sediment. Still, low rates of sulfate reduction (pmol × cm^3 × d^{-1}) were measured and modeled, primarily at HC sites. Transcriptomic analysis of functional marker genes provided further evidence of enhanced metabolic activity by sulfate-reducing bacteria and methanogenic/methanotrophic archaea at HC sites.
Our findings demonstrate that inconspicuous HC seepage plays a significant role in sedimentary biogeochemical cycles by shaping pore water concentration gradients, influencing sulfate reduction rates, and altering the microbial community composition and activity in marine subsurface sediments. Therefore, sediment geochemistry combined with omics potentially constitutes as a non-invasive tool for HC exploration.

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