Hydrocarbon seeps on the northern Norwegian shelf: Clues from geochemical investigations

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Active natural hydrocarbon seeps were recently discovered on the northern Norwegian continental shelf west of the Vesterålen Islands. By using acoustic and geochemical investigations we reveal the modern and past extent, sources and pathways of the gas seepage. To assess fluxes and the origin of hydrocarbons we analysed sediment porewater chemistry and the stable isotopic composition of the C1-C4 hydrocarbons in three gravity cores.

We found a sulphate-methane-transition-zone (SMTZ) in 90 cm, 120 cm and >250 cm sediment depth in the three cores suggesting variable fluxes of ascending methane. Carbon and hydrogen stable isotopes of methane as well as the $\delta^{13}C$ values of C2-C4 hydrocarbons indicate a dominantly thermogenic source. Furthermore, considerable bio-degradation of propane and to some extent of n-butane occured. Based on 3 seismic profiles and 2 shallow drilling wells a possible late Jurassic to early Cretaceous source rock of the thermogenic gas components is suggested and the released hydrocarbons probably migrate along major unconformities between the basement and overlying Mesozoic sediments.

$CaCO_3$ and $BaSO_4$ precipitation at the present SMTZ depth is indicated by Ca and Ba porewater profiles. Several intervals of high solid phase Ca and Ba concentration, in sediments above the present SMTZ depth, track former SMTZs revealing episodes of higher methane flux in the past. Moreover, ubiquitous occurrence of methane-derived authigenic carbonates (MDAC) in the study area support considerable methane seepage in the past. Ongoing U-Th dating of the carbonates will further constrain the timing of methane escape events and may reveal possible links between past seepage activity and climate variations.