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Foraminiferal proxy from active methane pockmarks in the Arctic: relationships between the distribution and isotopic signature of fauna and pore water geochemistry.

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Natural modern and past methane seepage episodes have been identified along the Vestnesa Ridge (Arctic Ocean, west of Svalbard, at 79°N). Several active pockmarks emitting methane (1200 m water depth) were targeted during the PS1606 cruise R/V G.O.Sars in 2016 with the main goal to investigate active pockmarks and characterize their influence on benthic foraminiferal distribution and isotope signature.

In our study, modern day samples are used to calibrate benthic foraminifera as a tool to reconstruct methane seepage episodes in the fossil record. We investigated 1) living (Rose Bengal stained) and dead foraminiferal assemblages and 2) stable isotope ([U+F064]13C and [U+F064]18O) signals of benthic foraminifera in 11 push cores from methane-related microbial mats collected during the remotely operated vehicle ROV-assisted G.O. Sars cruise.

Push core analyses showed that benthic foraminifera live in methane-enriched sediments with less dense and diverse faunas than in the reference core, without methane influence. However, these habitats are characterized by higher organic carbon supply, resulting in some cases in a larger abundance of opportunistic species such as Cassidulina spp. Agglutinated species, which are usually dominant in the Arctic environments, are almost absent in sediments covered by microbial mats. Low benthic foraminiferal densities are correlated with diffusive methane where very negative [U+F064]13C of the organic matter is measured, while methane advection seems to less affect foraminiferal microhabitats. Secondary overgrowth of authigenic carbonate usually occurring in methane seepage sites is clearly identified on both benthic and planktonic foraminiferal tests. Interestingly, the [U+F064]13C measured on both living and dead benthic foraminifera is well correlated with the [U+F064]13C of the dissolved inorganic carbon in the pore water profiles, which suggests that the methane release was somehow recorded in foraminiferal tests. This relationship does not appear to be linear but clearly shows a positive correlation. The foraminiferal [U+F064]18O increases within the sulfate-methane transition zone, suggesting an effect of mg-calcite or gas hydrate dissociation. The affected faunal distribution as well as the foraminiferal isotopic record highlight the potential use these indicators together to reconstruct the past methane emissions in the Arctic.