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Calibration of benthic foraminifera as proxy of methane release in the Vestnesa Ridge (Western Svalbard): Ecological and stable isotopic approaches

Pierre-Antoine Dessandier (1), Giuliana Panieri (1), Jochen Knies (2), Aivo Lepland (2), Simone Sauer (3), Haoyi Yao (1), Wei-Li Hong (2), and Gerhard Bohrmann (4)

(1) CAGE, University of tromsø, Tromsø, Norway (pierre-antoine.dessandier@uit.no), (2) Geological Survey of Norway, Trondheim, Norway, (3) IFREMER – Unité de Recherche Géosciences Marines, Plouzané, France., (4) MARUM – Center for Marine Environmental Sciences and Department of Geosciences, University of Bremen, Germany

Natural modern and past methane seepage episodes have been identified from the LGM (Late Glacial Maximum) 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 and the drilling campaign MSM57/1 R/V MARIA S. MERIAN in 2016 with the main goal to investigate active pockmarks and reconstruct paleo-methane emissions.
In our study, modern day samples are used to calibrate benthic foraminifera as a tool to reconstruct methane emissions in the fossil record. We investigated 1) living and fossil assemblages and 2) stable isotope (d13C and d18O) signals of benthic foraminifera in push cores from methane-related microbial mats collected from ROV-assisted G.O. Sars cruise. The ecology of benthic foraminifera was determined by comparison of foraminiferal data with pore water and organic matter data. Push cores analyses showed that benthic foraminifera live in methane-enriched sediments with less dense and diverse faunas than in the reference core without methane influence. Agglutinated species, which are usually dominant in the Arctic environments, were replaced by species adapted to eutrophic conditions in methane seepages. Secondary overgrowth of carbonate usually occurring in methane seepage sites was clearly identified on both benthic and planktonic foraminiferal tests. Interestingly, the d13C measured on dead benthic foraminifera was well correlated with the d13C of the dissolved inorganic carbon, which suggests that the methane release was somehow recorded in foraminiferal tests.
These ecological and isotopic patterns were applied on the long MeBo cores to reconstruct the past emissions of methane in the Vestnesa Ridge. Reference core is used to reconstruct the paleo-environmental evolution in this region over the last 150 000 years. The chronology of methane releases was reconstructed in two MeBo cores from active pockmarks, considering the excursions of isotopic signal and faunal distribution of benthic foraminifera. The chronology allows us to hypothesize the processes controlling the methane release in the Arctic environments from the LGM.