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Foraminiferal depth distributions as indicators for biogeochemical conditions in the sediment

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Marine benthic faunal complexity increased in the Phanerozoic due to enhanced oxygenation of ocean bottom water and the establishment of infaunal microhabitats. To gain insight in the evolution process of bioirrigating fauna and the influence of these taxa on the biogeochemistry of the sediment is difficult, since their fossil remains are scarce. Experiments with modern marine sediment that mimic geological periods with low and high activity of bioirrigation may reveal the effect of irrigation on biogeochemical cycling, but do not provide a link to the past. We propose that fossilizable foraminiferal infauna associated with bioirrigation may be traced back in geological time and may act as indicators of degree of bioirrigation. Before experiments will be set up with different levels of bioirrigation, an investigation has been carried out to determine if and how foraminiferal assemblages reflect or affect the biogeochemistry of the sediment.

Benthic foraminifera may affect microbial activity and distribution patterns by predation and gardening and so influence nutrient cycling. On the other hand, oxygen penetration depth, organic matter availability, and organic matter mineralization rates governed by bacteria, may provide boundary conditions to the inhabitable space of foraminifera. The production of EPS by diatoms and bacterial cultures has been shown to enhance the stability of sediment. Foraminifera that graze on bacteria or on EPS, may therefore also have an impact on the sediment stability.

In this experimental study coastal marine sediment from the North Sea was collected and incubated in cores under in situ temperature conditions. These undisturbed cores were compared to (1) cores where foraminifera were killed by a heat shock, resulting in the presence of bacteria and absence of meiofauna and (2) cores were bacte-

rial activity was significantly reduced by antibiotics, whereas the meiofauna, especially foraminifera, were unaffected. Foraminiferal depth distributions, bacterial total counts, and aerobic and anaerobic respiration rates were determined in 0.5 to 1 cm depth slices of the cores. This allowed us to investigate the effects of the treatments on the biogeochemistry of the pore water and the effect of the interaction of both ecosystem components. Also, some sediment characteristics were analyzed, such as porosity, carbohydrate content, EPS concentration, and cohesive strength in order to study the effect of the foraminiferal-bacterial link on the stability of the sediment.

First results demonstrate decreased aerobic and anaerobic respiration rates in the cores with only foraminifera and only bacteria as compared to the undisturbed core, indicating that foraminifera do stimulate bacterial activity. Porosity did not significantly change in the cores that were treated with heat or antibiotics. The colloidal hydrocarbon fraction in the treated cores was significantly higher compared to the undisturbed cores, with highest values in the antibiotics treated cores, specifically at 0.5 to 1 cm depth. This may indicate the lyses of the dead bacterial cells, contributing to high colloidal hydrocarbon concentrations. EPS concentrations were highest in the heat treated core, were live foraminifera were absent. A possible explanation may be that foraminifera graze on bacteria with their surrounding EPS or directly on EPS and have therefore an impact on sediment stability.