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Living benthic foraminifera from methane seep environments: A case study from the Adriatic Sea

Giuliana Panieri

*Dipartimento di Scienze della Terra e Geologico-Ambientali,
Università di Bologna, Via Zamboni 67, 40126 Bologna, Italy
panieri@geom.in.unibo.it*

Multiple abrupt, global climate shifts that correlate with highly negative $\delta^{13}\text{C}$ anomalies recorded in fossil foraminifera lead to the assumption that these negative excursions might reflect past intervals of massive dissociations of gas hydrates. In this context, the present work is focused on the ecology and stable isotopic compositions of living/recently living (protoplasm-containing) and dead (fossil) benthic foraminifera ($>63\mu\text{m}$) from modern or relatively recent settings. In particular, I investigated several areas in the northern Adriatic Sea where hydrocarbon gases are currently released and seepage-related, carbonate-cemented sediments occur at 30 m water depth. On the basis of present data, foraminiferal assemblages at these seeps are not unique, although some taxa appear to be more adapted to the prevailing conditions. Total foraminiferal density is higher in seeps than in background samples; this can be plausibly attributed to trophic conditions. Carbon isotopic signatures in shells of living/recently living benthic foraminifera do not conform to the very negative, methane-influenced carbon isotope values of the pore waters; similar values obtained in seep and background samples for the same species indicate biological factors. Differences in $\delta^{13}\text{C}$ values in foraminiferal cytoplasm from seep and control sites clearly indicate ingestion of different kinds of food. The $\delta^{13}\text{C}$ values in foraminiferal cytoplasm at the seep sites (*ca* -25.52‰) are lower than those in cytoplasm of the same species in control samples (*ca* -22.82‰), suggesting that *Beggiatoa* (which are known to produce lipids with very light $\delta^{13}\text{C}$ signatures; e.g., $\delta^{13}\text{C} = \text{ca } -65\text{‰}$), may be a food source for the foraminifera, and explaining the higher foraminiferal density at seep sites. Overall, however, on the basis of my present data, it is not clear what is the influence of biological and physical factors on carbon isotopic signatures of foraminifera living at methane seeps. Thus, additional biological and geochemical data are needed to assess the effect of past methane releases on benthic foraminifera.