PALEO-SEAWATER DENSITY RECONSTRUCTION AND ITS IMPLICATION FOR COLD-WATER CORAL CARBONATE MOUNDS IN THE NORTHEAST ATLANTIC THROUGH TIME

Wolf-Christian Dullo [1]*, Andres Rüggeberg [2], Sascha Flögel [1] and Jacek Raddatz [3]
[1] GEOMAR Helmholtz Centre for Ocean Research Kiel Wischhofstr. 1-3 - cdullo@geomar.de
[2] Unit of Earth Sciences, Dept. of Geosciences, University of Fribourg
[3] Geoscience University of Frankfurt

Abstract
Cold-water coral build-ups in the NE Atlantic are bound to distinct water mass characteristics. A key parameter is seawater density. Based on gravity cores and ODP piston cores we demonstrate this relationship for the geological past and the onset of carbonate mound growth on the NW European continental margin.

Keywords: Cnidaria, North Atlantic

Carbonate buildups and mounds are impressive biogenic structures throughout Earth history. In the recent NE Atlantic, cold-water coral (CWC) reefs form giant carbonate mounds of up to 300 m of elevation. The expansion of these coral carbonate mounds is paced by climatic changes during the past 2.7 Myr. Environmental control on their development is directly linked to controls on its main constructors, the reef-building CWCs. Seawater density has been identified as one of the main controlling parameter of CWC growth in the NE Atlantic. One possibility is the formation of a pycnocline above the carbonate mounds, which is increasing the hydrodynamic regime, supporting elevated food supply, and possibly facilitating the distribution of coral larvae. The potential to reconstruct past seawater densities from stable oxygen isotopes of benthic foraminifera has been further developed: a regional equation gives reliable results for three different settings, peak interglacials (e.g., Holocene), peak glacials (e.g., Last Glacial Maximum), and intermediate setting (between the two extremes). Seawater densities are reconstructed for two different NE Atlantic CWC carbonate mounds in the Porcupine Seabight indicating that the development of carbonate mounds is predominantly found at a seawater density range between 27.3 and 27.7 kg m−3 (σΘ notation). Comparable to recent conditions, we interpret the reconstructed density range as a pycnocline serving as boundary layer, on which currents develop, carrying nutrition and possibly coral larvae. The close correlation of CWC reef growth with reconstructed seawater densities through the Pleistocene highlights the importance of pycnoclines and intermediate water mass dynamics (Fig. 1).

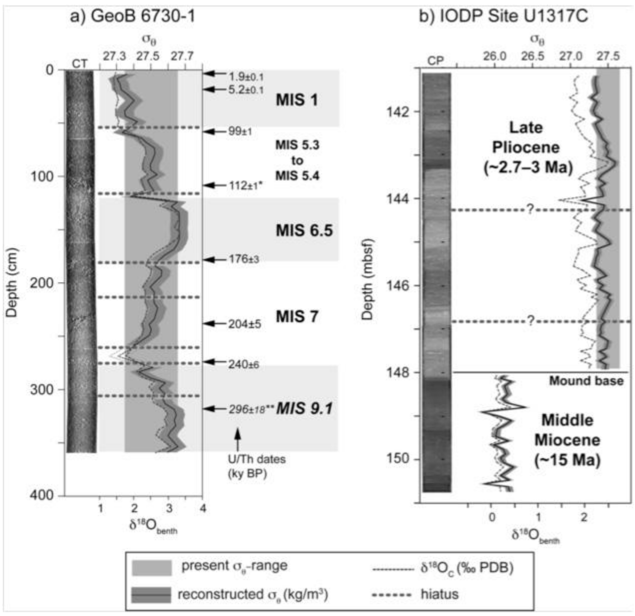

Fig. 1. Figure 1: (a) Downcore record of core GeoB6730-1 of the past ~300 kyr for Propeller Mound. U/Th age data are in thousand years before present (kyr B.P.); corresponding Marine Isotope Stages (MIS) are indicated. The vertical gray bar highlights the present-day density range of σΘ = 27.35–27.65 kg m−3 for living cold-water corals reefs of the NE Atlantic [Dullo et al.,2008]. Reconstructed paleoseawater densities are shown by black line; dark grey envelope indicates the error bar. Computer tomographic (CT) images indicate occurrence of corals throughout the core with varying densities. An asterisk denotes mean value of three age determinations (see Table S1), and two asterisks denote large error comprising MIS 8.3 to MIS 9.2 (see supporting information). (b) Sedimentary record of IODP Site U1317C between 151 m and 141 m below the seafloor (mbsf). The vertical grey bar corresponds to the present-day density envelope.

Overall, CWC carbonate mound growth portrays prolific marine benthic ecosystem development and is linked to small changes in ambient bottom water characteristics (i.e., density). These results show that marine benthic ecosystems occupy very narrow and specific ecological niches, which are very sensitive and even at risk to the actual global environmental changes, such as bottom water warming and acidification. As a consequence, our findings have lead to a robust diagnostic key tool for the interpretation of basin-wide sudden onset or shutdown of carbonate mound growth during Earth history.

References

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