Geophysical Research Abstracts
Vol. 12, EGU2010-4787, 2010
EGU General Assembly 2010

Integrated research on the Pen Duick cold-water coral mounds: the MiCROSYSTEMS approach

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The ESF EuroDIVERSITY MiCROSYSTEMS project aimed to turn the cold-water coral (CWC) mounds on the Pen Duick Escarpment (PDE) in the Gulf of Cadiz into a natural laboratory, exploring this highly complex biotope and to characterize its biodiversity. A common point of discussion with all other CWC mound provinces, surpassing its broad range of regional and morphological variability, concerns the driving forces regarding the initiation of these complex deep-water systems. Both oceanographic and geological processes have been proposed to play a significant role in the mound nucleation, growth and decline. During IODP Expedition 307, the importance of biogeochemical processes was already elucidated. Here, we present the preliminary results of the MD169 campaign as an integrated case study of three PDE CWC mounds: Alpha, Beta and Gamma mounds.

Although cold-water corals are a common feature on the adjacent cliffs, mud volcanoes and seafloor, no actual living reef has been observed during the many ROV surveys. This multidisciplinary study aims to present a comprehensive and holistic view on the local dynamic geological and oceanographic environment. Coring data suggests (past or present) methane seepage near the Pen Duick Escarpment. Several sources and pathways are proposed, among which a stratigraphic migration through uplifted Miocene series underneath PDE. Its dominant morphology has influenced the local hydrodynamics within the course of the Pliocene, as documented by the emplacement of a sediment drift. Predominantly during post-Middle Pleistocene glacial episodes, favourable conditions were present for mound growth. An additional advantage for CWC mound nucleation near the top of PDE is offered through seepage-related carbonate crusts which might offer elevated colonization positions. Present-day seabed observations also suggested a possible important role of open coral rubble frameworks in the mound building process. These graveyards not only act as sediment trap but also as micro-habitat for a wide range of organisms. The presence of a fluctuating Sulphate-Methane Transition Zone is responsible for diagenesis, affecting both geochemical as physical characteristics, transforming the buried reef into a solid mound. Nevertheless, these seepage fluxes seem to be locally variable. As such, the origin and evolution of the PDE CWC mounds is, probably more than any other NE Atlantic cold-water coral mound province, located on the crossroads of environmental (hydrodynamic) and geological (seepage) pathways.