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Cold-water corals and hydrocarbon-rich seepage in Pompeia Province (Gulf of Cádiz) – living on the edge

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Abstract. Azooxanthellate cold-water corals (CWCs) have a global distribution and have commonly been found in areas of active fluid seepage. The relationship between the CWCs and these fluids, however, is not well understood. This study aims to unravel the relationship between CWC development and hydrocarbon-rich seepage in Pompeia Province (Gulf of Cádiz, Atlantic Ocean). This region is comprised of mud volcanoes (MVs), coral ridges and fields of coral mounds, which are all affected by the tectonically driven seepage of hydrocarbon-rich fluids. These types of seepage, for example, focused, scattered, diffused or eruptive, is tightly controlled by a complex system of faults and diapirs. Early diagenetic carbonates from the currently active Al Gacel MV exhibit δ^{13}C signatures down to −28.77 ‰ Vienna Pee Dee Belemnite (VPDB), which indicate biologically derived methane as the main carbon source. The same samples contain ^{13}C-depleted lipid biomarkers diagnostic for archaea such as crocetane (δ^{13}C down to −101.2 ‰ VPDB) and pentamethylicosane (PMI) (δ^{13}C down to −102.9 ‰ VPDB), which is evidence of microbially mediated anaerobic oxidation of methane (AOM). This is further supported by next generation DNA sequencing data, demonstrating the presence of AOM-related microorganisms (ANMEs, archaea, sulfate-reducing bacteria) in the carbonate. Embedded corals in some of the carbonates and CWC fragments exhibit less negative δ^{13}C values (−8.08 ‰ to −1.39 ‰ VPDB), pointing against the use of methane as the carbon source. Likewise, the absence of DNA from methane- and sulfide-oxidizing microbes in sampled coral does not support the idea of these organisms having a chemosynthetic lifestyle. In light of these findings, it appears that the CWCs benefit rather indirectly from hydrocarbon-rich seepage by using methane-derived authigenic carbonates as a substratum for colonization. At the same time, chemosynthetic organisms at active sites prevent coral dissolution and necrosis by feeding on the seeping fluids (i.e., methane, sulfate, hydrogen sulfide), allowing cold-water corals to colonize carbonates currently affected by hydrocarbon-rich seepage.

1 Introduction

Cold-water corals (CWCs) are a widespread non-phylogenetic group of cnidarians that include hard skeleton scleractinian corals, soft-tissue octocorals, gold corals, black corals and hydrocorals (Roberts et al., 2006, 2009; Cordes et al., 2016). Typically, they thrive at low temperatures (4–12 °C) and occur in water depths of ca. 50–4000 m.