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Biogeochemistry and geomicrobiology of cold-water coral carbonate mounds - lessons learned from IODP Expedition 307

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Large mound structures associated with cold-water coral ecosystems commonly occur on the slopes of continental margins, for instance, west of Ireland in the Porcupine Seabight, the Gulf of Cadiz or the Straits of Florida. In the Porcupine Seabight over 1500 mounds of up to 5 km in diameter and 250 m height lie at water depths of 600 to 900 m. The cold-water coral reef ecosystems associated with these structures are considered to be “hotspots” of organic carbon mineralization and microbial systems. To establish a depositional and biogeochemical/diagenetic model for cold-water carbonate mounds, Challenger Mound and adjacent continental slope sites were drilled in May 2005 during IODP Expedition 307. One major objective was to test whether deep sub-surface hydrocarbon flow and enhanced microbial activity within the mound structure was important in producing and stabilizing these sedimentary structures.

Drilling results showed that the Challenger mound succession (IODP Site U1317) is 130 to 150 meters thick, and mainly consists of floatstone and rudstone facies formed of fine sediments and cold-water branching corals. Pronounced recurring cycles on the scales of several meters are recognized in carbonate content (up to 70% carbonate) and color reflectance, and are probably associated with Pleistocene glacial-interglacial cycles.

A role for methane seepage and subsequent anaerobic oxidation was discounted both as a hard-round substrate for mound initiation and as a principal source of carbonate within the mound succession. A broad sulfate-methane transition (approximately 50 m thick)within the Miocene sediments suggested that the zone of anaerobic oxidation of methane principally occurs below the moundbase. In the mound sediments, interstitial water profiles of sulfate, alkalinity, Mg, and Sr suggested a tight coupling between carbonate diagenesis and low rates of microbial sulfate reduction. Overall organic carbon mineralization within cold-water coral mound appeared to be dominated by low rates of iron- and sulfate-reduction that occur in discrete layers within the mound. This was consistent with distributions of total cell-counts, acetate turnover (Webster et al. 2009) and hydrogenase activity (Soffiento et al. 2009). However, biomarker lipid distributions suggested that the Miocene sediments underlying the mound, into which sulfate is diffusing, as well as the sediments from the non-cold water coral reference site (U1318) contain higher abundances of living microbes. The results obtained from Expedition 307 are consistent with a picture emerging from other biogeochemical studies of cold-water coral mound and reef sites. Unless impacted by some external forcing (e.g. fluid flow or erosion event), the microbial activity in the underlying cold-water coral mound sediments is largely decoupled from the highly diverse, active surface ecosystem.

References:

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