The link between sedimentary sulfur biogeochemistry and growth patterns of cold-water coral mounds (Challenger Mound, IODP Exp. 307)

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Challenger Mound, a 150 m high cold-water coral mound in the eastern Porcupine Seabight, was drilled during Expedition 307 of the Integrated Ocean Drilling Program. To gain insight into present and previous depositional and diagenetic conditions linked to mound development, we conducted a range of analyses with focus on sedimentary iron and sulfur geochemistry, including the determination of dithionite-extractable Fe-phases, and stable isotopic compositions of pore-water sulfate and solid-phase reduced sulfur. Our findings suggest that rates of microbially mediated diagenetic processes such as sulfate reduction, and linked coral dissolution and carbonate precipitation patterns in mound sediments were highly variable over time. Within the top 40 m, small sulfate concentration decreases (<7 mM) mirrored by increasing δ^{34}S-sulfate values indicate slow net present-day sulfate reduction rates. Below 50 mbsf, sediment intervals with strong ^{34}S-enriched imprints on chromium reducible sulfur (pyrite S), high degree-of-pyritization (DOP) values, and semi-lithified diagenetic carbonate-rich layers characterized by poor coral preservation, were observed. These layers provide evidence for the occurrence of enhanced microbial sulfate-reducing activity in the mound in the past. We suggest that rapid mound aggradation, likely connected to very favorable environmental conditions for coral growth, drove greater rates of sulfate-reducing activity in the surface sediments. At the same time, repeated pauses or very low mound aggradation rates led to the installation of redox-fronts in the sediment for prolonged time periods that created favorable conditions for reactive Fe-oxide depletion and associated coral dissolution, and subsequently followed by periods of diagenetic carbonate formation. The variable rates of microbially driven iron and sulfur diagenesis contribute to frequent successions of layers of different coral preservation and lithification throughout the mound sequence. This study, for the first time, provides evidence for a link between cold-water coral mound formation patterns and the rates of biogeochemical processes in mound sediments over time.