Correlating the biogeochemistry and microbial ecology of a cold methane seep in the Costa Rica Pacific Margin

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Marine methane seeps are globally distributed, highly dynamic features that serve as islands of biological and geochemical diversity on the seafloor. Careful studies of the ecotone, or transition zone, between the seep and surrounding deep sea environment are necessary to understand the impacts of seeps on the broader ocean biome, but these ecotones remain poorly understood. We describe the geochemical (major ions and carbon isotopes) and biological (megafauna and microbial 16S rRNA gene) diversity of over 80 carbonate rocks and sediment cores up to 24 cm deep retrieved from 13 DSV Alvin dives between 2017-2018 at Mound 12, a methane seep on the Costa Rica Pacific Margin. To provide a first-order spatial analysis of the seep, each core was initially classified as “active”, “transition”, or “inactive” based on *in situ* megafaunal observations (with active sites colonized by crabs of families Galitheidae and Kiwaidae, myriad species of shrimp, vestimentiferan tubeworms, and bivalve molluscs) or the presence of bacterial mat or shimmering water. Geochemical and microbial community data indicated that sites colonized by *Kiwa puravida,* the Costa Rica yeti crab, were among the most active, and consistently had high sulfide concentrations, ^{13}C-depleted dissolved inorganic carbon, and increased numbers of anaerobic methane-oxidizing aggregates (ANME). Polychaetes and hydroids were characteristic of transition zones. However, transition cores contained similar microbial sediment communities as inactive cores, indicating a narrower zone of activity for microorganisms than for megafauna. Interestingly, carbonate rocks harboured similar microbial communities whether they were found in the active or inactive zone, indicating that carbonates from dormant methane seeps may provide insight into the impacts of these seeps over longer timescales.