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Unexpected scarcity of ANME Archaea in the hydrocarbon-rich cold seeps of Monterey Canyon

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Marine hydrocarbon seeps are significant sources of seafloor methane and are typically colonized by a relatively predictable community of microorganisms, including anaerobic methanotrophic (ANME) archaea, that consume methane in sediments and prevent its release to the water column. By fixing nitrogen and reducing sulfate to sulfide, ANME and their symbiotic bacterial partners also play a critical role in deep sea sulfur and nitrogen cycling. Numerous seeps have been identified and observed over decades in Monterey Bay, CA, but their *in-situ* microbial communities have not been characterized. Here, we sampled sediment cores within and outside two Monterey Bay cold seeps. We combined porewater geochemical measurements with deep amplicon sequencing of 16S rRNA, *mcrA*, and *nifH* (DNA and RNA), and with quantification of *mcrA* and *nifH* genes and transcripts. Many aspects of these seeps were typical of seeps worldwide, including elevated methane and sulfide concentrations and depleted ∂^{13}C-DIC. However, we detected atypical microbial communities: no ANME 16S rRNA gene sequences were detected at Clam Field, and very few were recovered from Extrovert Cliff. The absence or low abundance of ANME-indicative cellular aggregates via microscopy, as well as *mcrA* and *nifH* genes and transcripts affiliated with ANMEs, substantiated the ANME deficiency. Instead, an abundance of sulfur-reducing bacteria closely related to those known to oxidize non-methane hydrocarbons were present. Although the reason for the lack of ANME is yet unclear, we postulate that non-methane hydrocarbon release in Monterey Bay perturbs seep communities, potentially disrupting the normal methane oxidation process in favor of non-methane hydrocarbon oxidation. Our findings reveal an unexpected interaction between carbon and sulfur cycles at Monterey Canyon cold seeps, suggest a previously unknown sensitivity of ANME to certain environmental conditions and/or community members, and highlight the potential for hydrocarbon seeps without this critical biofilter.