Microbial Niches and Elemental Cycling in Hydrothermal Vent Fe Mats

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Iron microbial mats at hydrothermal vents mediate fluxes of Fe and other elements to the oceans. These mats are formed by Zetaproteobacteria, the only apparent Fe-oxidizers in the mats. Most studies have focused on this dominant species, and their roles in carbon fixation and Fe biomineral formation, but have not addressed the varied contributions of diverse Zetaproteobacteria. Furthermore, iron mats host a diverse group of microorganisms, including viruses, but we do not know how they interact with Zetaproteobacteria or contribute to element cycling across Fe mat microenvironments. To address this, we sequenced paired metagenomes and metatranscriptomes from Fe mats at Loihi Seamount and Mariana Backarc. These included discrete surface mat samples and large bulk samples that included deeper regions of the mat. The shallow mat sample was almost entirely a single Zetaproteobacteria lineage while deeper mat samples were composed of different Zetaproteobacteria, Deltaproteobacteria, Gammaproteobacteria, Bacteroidetes, Chloroflexi, Planctomycetes and Marinimicrobia. Overall, mat microbes expressed genes involved in oxygen, nitrogen, carbon, and iron cycles. Zetaproteobacteria genomes and transcriptomes indicated preference for different oxygen levels, and therefore mat depth. The Deltaproteobacteria were the second most abundant taxa in our deep mat samples, and included a novel clade in the uncharacterized DTB120 order, with strong evidence for nitrate reduction, heterotrophy, and iron cycling. In addition, we found evidence for viral contigs and complete viral genomes, including evidence for novel viral populations that have a history of infecting members of this microbial community. Together, the previously uncharacterized *DTB120* and the novel viruses help link iron, nitrogen and carbon biogeochemistry within hydrothermal vent Fe mat microenvironments. This suggests that diverse Zetaproteobacteria and the flanking community work together to contribute to geochemical cycles in the Fe mats, driving the community's overall ecological success.