Connecting the Past with the Present: Identifying Chemosynthetically Active Microbes and Measuring Primary Productivity at Deep-Sea Hydrothermal Vents

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Despite 40 years of research, knowledge of in situ metabolism of microbes carrying out carbon fixation in marine hydrothermal systems is still very limited. Particularly lacking are studies identifying the chemosynthetically active microbes and measuring rates of CO2 fixation in situ. Here, we present data from two innovative incubation approaches using for assessing chemoautotrophic production in deep-sea vent systems. On one hand, we quantified chemosynthetic primary productivity of natural microbial communities sampled from Crab Spa (9ºN East Pacific Rise) during 24 h shipboard incubations that maintained seafloor pressure and temperature. During these experiments, we measured carbon fixation, microbially-catalyzed inorganic redox reactions, and community composition, providing insight into both the identity and activity of natural populations under environmentally-relevant conditions. This allowed us to determine growth efficiencies for natural communities, providing constraints on potential magnitude of chemosynthetic primary productivity and the residence time of the subseafloor biosphere below Crab Spa. Taking this approach one step further, we have developed a robotic micro-laboratory for measuring rates of various processes directly at the seafloor. We successfully tested the instrument on a recent cruise to 9ºN EPR, allowing for the first time to determine rates of carbon fixation at both in situ pressure and temperature at diffuse-flow deep-sea vents, and to directly link these rate measurements to the expression of key genes involved in these processes. These approaches represent a major step forward in the way we study these ecosystems, by providing realistic estimates of their overall productivity and a means to assess their role in biogeochemical cycles.