The shallow submarine hot vent system off Milos (Greece) – a natural laboratory to study hydrothermal geomicrobiology

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Shallow submarine hydrothermal systems are extreme environments with unique biogeochemical conditions, originating from the mixing of hot, reduced fluids and cold, oxygenated seawater, promoting the establishment of diverse microbial communities. The hydrothermal system off the Greek island Milos (Cyclades, Aegean Sea) is characterized by predictable steep geochemical and thermal gradients, fluids loaded with toxic chemicals, like arsenite, making it ideally suited to study the microbes inhabiting the sediments and their metabolisms and adaptations to these extreme conditions. We performed a detailed study on diverse hydrothermal sediments off Milos, using Illumina sequencing of 16S rRNA, in order to investigate changes in bacterial diversity. These analyses revealed community shifts from (1) Gammaproteobacteria at sites marginally influenced by hydrothermal activity, to (2) Epsilonproteobacteria in the surface layers with elevated temperatures, and (3) Thermotogae, Dehaloccoida and Thermodesulfobacteria in the deeper layers with high temperatures. Stable isotope probing experiments with 13C-bicarbonate were furthermore performed to identify the metabolically active microorganisms carrying out chemoautotrophy. By combining the determination of the uptake of 13C into microbial lipids with rRNA based analysis, we are able to show that Epsilonproteobacteria dominate dark carbon fixation. The shallow submarine hydrothermal vents off Milos present itself as a system that is uniquely suited as a natural laboratory to study interactions between the geosphere and the biosphere.