Lithotrophic nitrate reduction under high-pressure conditions at deep-sea vents

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From the variety of bioavailable electron acceptors at deep-sea vents the role of seawater NO3- in supporting lithotrophic production has not been fully explored. Mixing between seawater and high-T hydrothermal fluids results in diffuse-flow fluids being enriched in NO3- while maintaining reducing conditions due to the sluggish kinetics of H2-O2 equilibria at low temperatures (<100 °C). To better constrain the extent and nature of subsurface biosphere, culture-based studies need to address the metabolic activity and the rates of chemosynthetic primary productivity at in-situ pressures, temperatures and substrate conditions. A key parameter that has been very poorly explored is the effect of pressure on the metabolic activities and function of deep-sea bacterial communities. To address this knowledge gap, we have conducted a series of high-pressure culturing experiments to determine the pressure adaptation of a strictly anaerobic, thermophilic Epsilonproteobacterium (Nautilia strain PV-1) that we recently isolated from diffuse-flow fluids discharged at East Pacific Rise. The organism utilizes NO3- through the DNRA metabolic pathway. In these experiments we utilized a novel high-pressure/temperature bioreactor that allows for continuous culturing at 25-120 °C and pressures as high as 690 bars. Results from our experiments show that this strain is a novel piezophilic Epsilonproteobacterium with a doubling time of ~16 min at 200 bars, 55 °C. This organism is the only piezophilic Epsilonproteobacterium ever isolated, and it exhibits the highest growth efficiency of all the known piezophilic organisms. Here, we will present a comparative analysis on the metabolic activity, proteome expression and growth efficiency of the PV-1 strain under ambient and high pressure conditions.