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Controls on Sulfate Reduction in Shallow Submarine Hydrothermal CO_2 - Venting Sediments (Milos Island, Greece)

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Microbial sulfate reduction is the dominant process in the anaerobic mineralization of organic matter in continental margin sediments (Jørgensen, 1982). While sulfate-reducing bacteria (SRB) are generally accepted to occur in environments of pH 6 – 8 (Widdel, 1988), recent studies have demonstrated sulfate reduction in low pH habitats like acidic lakes and rivers, areas of acid mine drainage, and CO_2-discharging hydrothermal vents. The latter are of particular interest, representing a system in which the degassing-effects of previously sequestered CO_2 can be investigated.

Incubation experiments were conducted on sediments from the low pH shallow-sea hydrothermal vent system of Palaeochori Bay, Milos Island, Greece. Abundant gas venting of CO_2 occurs throughout this bay, which lowers the pH of pore fluids adjacent to gas venting to values of ca. 5 – 6. The objective for this research was to investigate how changing pH and pCO_2 affect sulfate reduction rates in a system in which the pH is naturally reduced. The sediment in close proximity to the gas vent had an *in-situ* temperature of $75\,^{\circ}C$ (in 10 cm depth) and was covered with whitish precipitates. This sediment was compared to 1) sediment from the transition zone characterized by decreasing temperature, precipitates and increasing pH and 2) to ambient sediment showing no irregularities in terms of temperature, pH and content of precipitates.

To test the effect of pH on bulk sulfate reduction in these sediments, incubations at pH values of 3, 4, 5, 6 and 7 were performed by adjusting the pH of SRB media with 1 M phosphoric acid or $NaHCO_3$. In addition, the effect of CO_2-overpressure on the sulfate reduction rate was tested with respect to changing substrate. Different substrates, including H_2 and volatile fatty acids (VFA) mix which contained acetate, lactate, formate, succinate, butyrate and propionate, were added to slurries of sediment and medium (1:1.5 v/v) and sulfate reduction rates measured. Sediments not amended with external substrates showed increasing sulfate reduction rates with greater distance from the vent site. The pH optimum for sulfate reduction during 16 hours incubation at $40\,^{\circ}C$ exhibited different pH responses. Incubations of unamended transition zone sediment showed the highest rates of sulfate reduction (14 nmol cm^{-3} day^{-1}) being measured at pH 6, whereas incubation with the mixture of VFA electron donors resulted in the highest measured sulfate reduction rate being 10 nmol cm^{-3} day^{-1} at pH 5. This may suggest that VFA electron donors stimulate a more acid-tolerant SRB population. The effects of changing CO_2 are currently being evaluated.

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F. Widdel. Microbiology and ecology of sulfate- and sulfur-reducing bacteria. *In: A.J.B. Zehnder, Editor, Biology of Anaerobic Microorganisms, Wiley, New York, NY*, (1988), pp. 469-585.