Biogeochemical cycling of arsenic and phosphorus in shallow submarine hydrothermal sediments

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Milos Island (Greece), located on the Hellenic Volcanic Arc, harbour several shallow hydrothermal systems on its coastal area. Unique characteristics of the vented hydrothermal fluids are high arsenic contents reaching up to 3900 times above seawater levels and, gas discharge predominated by CO_2 that affects sediment and seawater chemistry. Despite our awareness on the impact of arsenic on phosphate bioavailability, there is a scarcity of information on the relationship between arsenotrophy and the distribution of phosphate uptake genes in arsenic-rich hydrothermal sediments. Here, two hydrothermal sediments capped by visually distinct white and brown deposits and a distal environment composed mainly of sand (reference sediment) were sampled at Milos to investigate the relationship between arsenotrophy, detoxification and phosphate metabolism by quantifying key genes involved in arsenotrophy and in the regulation of phosphate uptake into cells. Quantitative PCR data, coupled to sediment geochemistry highlights a situation where arsenotrophy and arsenic detoxification covary with high affinity phosphate uptake genes as a function of the degree of hydrothermal influence. The As/P ratio impacts the metabolism and further suggest that a hydrothermally active sediment, covered by the deposits with high arsenic emissions, provides a relatively habitable environment for life, with respect to arsenic toxicity and phosphate stress, compared to zones lacking visible mat cover (reference sediments).