



Hydrogen thresholds and bioenergetics of microbial As(V) and Fe(III) respiration

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Molecular hydrogen (H_2) is a key intermediate in anaerobic degradation of complex organic matter. H_2 is not only a common product of many fermentation reactions, but also the ultimate electron donor with the highest turnover and shortest residence time in anoxic sediments (1). Consequently, aqueous H_2 concentrations in aquifers tend to be very low, often at nanomolar or subnanomolar levels making H_2 an excellent parameter to evaluate the redox state of anoxic environments. However, to date nothing is known about H_2 levels during respiratory reduction of arsenate (As(V)), a process that together with dissimilatory Fe(III) reduction is believed to favor arsenic mobilization in Southeast Asian aquifers (2).

H_2 thresholds for microbial respiration of arsenate (As(V)) were studied in a pure culture of *Sulfurospirillum arsenophilum*, a microbe growing by reduction of As(V) to As(III). The H_2 thresholds (0.03-0.09 nmol/L) for this culture are among the lowest values measured so far compared with other terminal electronaccepting processes (TEAPs). Similarly, sediment microcosm from an arseniccontaminated aquifer in Vietnam showed rapid reduction of As(V) to As(III) accompanied by comparatively low steady state H_2 levels.

We also looked at H_2 thresholds for iron reduction by *Geobacter sulfurreducens*, a wellcharacterized key metalreducing organism. H_2 thresholds for a set of different synthetic iron oxides covering a wide range of variation in crystallinity, surface area, and reactivity, ranged from 0.05 to 0.11 nmol/L. Collectively, these data suggest that

microbial As(V) reduction, a suspected culprit for arsenic contamination of groundwater, is a highly competitive TEAP in terms of substrate utilization and H₂ uptake. In addition, H₂ levels associated with microbial respiration of As(V) and Fe(III) do not appear to be limited by thermodynamic constraints in the same way as sulfate reduction and methanogenesis.

References

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