Impact of competitive adsorption on microbial arsenate reduction at the water-goethite interface

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Competitive adsorption between arsenate, extracellular polymeric substances (EPS), phosphate and sulphate and resulting impacts on microbial arsenate reduction was investigated at the water-goethite interface at 10 μM arsenate with Shewanella putrefaciens strain CN-32 at pH 7. Addition of phosphate and S. putrefaciens EPS to 2 g L$-$1 goethite suspensions increased dissolved arsenate concentrations and enhanced arsenate reduction rates. The half-life of first order kinetics was 343 h without competitive species, whereas adding 50–500 μM phosphate and 0.28 g L$-$1 EPS decreased half-lives to 141–177 and 223 h, respectively. Phosphate and EPS addition did not increase arsenate reduction rates at 10 and 0.4 L$-$1 goethite, reflecting stronger effect of arsenate mobilisation induced by microbe-mineral interaction than competitive adsorption, respectively. Addition of 100 μM sulphate did not accelerate arsenate reduction, reflecting its weak competitive adsorption. Moreover, phosphate may slow down but EPS accelerate arsenate reduction in solution. Addition of 300–700 μM phosphate increased half-life of dissolved arsenate reduction in solution from 21.3 to 29.4–32.2 h but the presence of 1.4 g L$-$1 EPS decreased half-life to 2.2 h. Depending on surface coverage and the nature and concentrations of competitive species, competitive adsorption may enhance arsenate reduction kinetics and cause arsenic mobilisation.

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