

## Removal of As(V) by Formation of Arsenic Trisulfide by *Shewanella* sp. HN-41

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### Abstract

Despite intensive study in recent years, quantitative biogeochemical models that explain and predict conditions controlling the uptake or release of dissolved arsenic in groundwaters remain incomplete, due partly to a lack of knowledge of arsenic speciation in subsurface sediments. Accumulation of arsenic at redox boundaries in natural sediments has been documented and association with sulfide has been observed under very reduced conditions<sup>1-4</sup>. Biogenic precipitation of arsenic sulfide has been reported under sulfate reducing environments developed by sulfate-reducing bacteria<sup>5,6</sup>. But here we used a dissimilatory iron-reducing bacterium to precipitate arsenic sulfide by the reduction of arsenate and thiosulfate. To remove arsenate [As(V)] from the solution, we selected the way to make As(V) to be insoluble inorganic material. *Shewanella* sp. HN-41 was used to precipitate As(V) by making sulfide mineral. Strain HN-41 reduced both of As(V) and  $S_2O_3^{2-}$  in the same incubation to As(III) and  $S^{2-}$  to produce arsenic sulfide mineral. As(V) was reduced to As(III) by *Shewanella* sp. HN-41. Concentration of As(V) decreased over time, and correspondingly the concentration of As(III) showed increase. But the amounts of increased As(III) were not suitable for the amounts of decreased As(V), which means the precipitation of As(III) by forming arsenic sulfide. We could also observe that sulfide increased first, and then decreased, which explains the participation of sulfide in the precipitation of yellow colored-arsenic sulfide. The X-ray diffraction (XRD) pattern of the yellow precipitate, arsenic sulfide is similar to that of mineral orpiment ( $As_2S_3$ ). The color was appropriate for orpiment mineral, but the shapes were needle-like, which has not been reported before with regard to arsenic sulfide and therefore could be a characteristic of biogenic arsenic sulfide. Therefore we

could infer the precipitate is close to orpiment. Then it is likely that the arsenic sulfide is composed of As(III) from the reduction of As(V) and  $S^{2-}$  from reduction of  $S_2O_3^{2-}$  by *Shewanella* sp. HN-41, because there is no apparent chemical reductions of the oxidized forms of As(V) and  $S_2O_3^{2-}$  as in uninoculated controls. The precipitated materials were characterized by using scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX), and X-ray absorption spectroscopy.

### References

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