

Uranium adsorption by *Shewanella oneidensis* MR-1 in the presence of NaHCO_3

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There have been several previous studies that have measured the adsorption behavior of U(VI) onto non-metabolizing bacteria in experiments either devoid of dissolved CO_2 or in systems open to the atmosphere. There is considerable evidence for extensive adsorption of U(VI) above pH 6-7 where the aqueous uranyl-tricarbonate aqueous complex dominates the aqueous budget of uranium. However, there is considerable uncertainty regarding the identity and thermodynamic stability of the bacterial surface complexes that cause this adsorption. It is particularly important to determine these parameters in order to model the effect of bacterial adsorption of U(VI) in a range of natural or engineered carbonate-bearing aqueous systems.

In order to constrain the stoichiometry and stability of the important U(VI)-bacterial surface complexes, we measured the adsorption of 60 ppm aqueous U(VI) as a function of NaHCO_3 concentration in solution from 0.0 to 30.0 mM. Experiments were conducted in 0.1 NaClO_4 to buffer ionic strength, and pH was varied from 3 to 9 in order to vary the extent of protonation of bacterial surface sites so that the sites that are important in U(VI) binding could be identified. All the experiments were conducted open to the atmosphere. The observed extents of U(VI) adsorption are independent of NaHCO_3 concentration in the system below pH 5. Above pH 5, the extent of adsorption decreases with increasing NaHCO_3 concentration, but the observed extent of adsorption in each case is greater than that predicted assuming only aqueous uranyl-carbonate complexation and neglecting ternary uranyl-carbonate-bacterial complexation.

We used a non-electrostatic surface complexation approach to model the adsorption data. The data require the existence of at least two uranyl-carbonate-bacterial surface complexes, and we use the observed adsorption measurements to constrain values for the stability constants for each of these complexes. The modeling results suggest the presence of additional uranyl-carbonate bacterial surface complexes than have been previously identified under conditions with elevated carbonate concentrations. These complexes can control the U(VI) adsorption behavior in systems with high carbonate concentrations and hence our results can be used to predict the extent of U(VI) adsorption onto bacteria in a range of natural and engineered systems.

Environmental monitoring of tungsten in Fallon, Nevada

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Environmental Monitoring in Fallon

Fallon, Nevada, USA, experienced a cluster of childhood leukemia beginning in 1997 [1]. Extensive research was conducted in Fallon by multiple entities to determine what might have caused this childhood leukemia cluster. For our part, we employed multiple techniques of environmental monitoring for metals in Fallon, including chemistry of airborne dust, lichens, surface dust, surfaces of tree leaves, and tree rings [2].

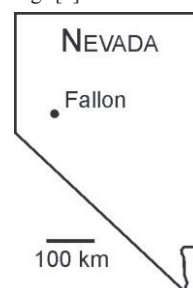


Figure 1: Map showing location of Fallon, Nevada, USA

Results

Tungsten and cobalt were elevated in airborne dust of Fallon relative to comparison towns. Tungsten and cobalt were elevated in lichen tissues within Fallon relative to desert sites outside of town. Surface dust showed tungsten and cobalt concentrations peaking just northwest of the center of Fallon relative to the outskirts of town. Leaf surfaces confirmed this spatial pattern of tungsten and cobalt peaking just northwest of the center of Fallon. Tree rings, a technique that emphasizes temporal resolvability, showed tungsten increasing in central Fallon by the mid to late 1990s, coinciding roughly with the onset of the cluster of childhood leukemia. Tree rings also showed high inter-tree variability in tungsten and cobalt across sampled trees within Fallon relative to comparison towns.

Conclusion

Fallon is distinctive by experiencing a cluster of childhood leukemia and having elevated airborne tungsten and cobalt. Linkage between a disease and an environmental condition cannot be made from environmental data alone. However, the co-occurrence in Fallon of elevated airborne tungsten and cobalt and a cluster of childhood leukemia logically should prompt biomedical research to evaluate the potential linkage between leukemia and the combined exposure to airborne tungsten and cobalt.

[1] Steinmaus et al. (2004) *Environmental Health Perspectives* **112**, pp. 766-771. [2] Sheppard, Ridenour, & Witten (2009) pp. 141-156 in *Airborne Particulates*, Cheng & Liu (Eds.), Nova Science Publishers, New York.