# Cd adsorption onto *Bacillus subtilis* bacterial cell walls: Integrating isotherm and EXAFS studies

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Cadmium, a toxic heavy metal, has become a significant contaminant in many soil and groundwater systems. Understanding the processes that control the mobility and bioavailability of cadmium in the environment is thus becoming increasingly important. To this end, Cd adsorption to isolated cell walls of commonly occurring Gram positive bacteria, *Bacillius subtilis,* was studied as a function of Cd loading at pH 5.9.

ICP-AES was used to measure Cd adsorption to 10g/L (wet weight) of *B. Subtilis* over three orders of magnitude of metal concentration (0.5 ppm to 200 ppm) at pH 5.9. Thermodynamic equilibrium modeling was used to predict the stoichiometry of the reaction using FITEQL. The adsorption data was best modeled with a Cd:carboxyl binding site stoichiometry of 1:1; however a combination of binding sites could not be unequivocally excluded. To better understand the molecular-scale adsorption mechanisms and to determine whether the adsorption mechanism changes as a function of Cd loading onto the cell wall, we conducted X-ray Absorption Fine Structure (XAFS) measurements of 4 different Cd concentrations (3.0, 10, 30, 200 ppm) with a fixed bacterial concentration of 10g/L. Cd speciation as derived by XAFS will be discussed and compared to that predicted at the bulk scale. This study demonstrates that bulk adsorption and XAFS measurements are complementary and that the combined approach is especially powerful for determining metal speciation and distribution in metal-microbe systems.

# Stimulation of cell-surface catalysed Cr(VI) reduction by DOC during microbial cell lysis

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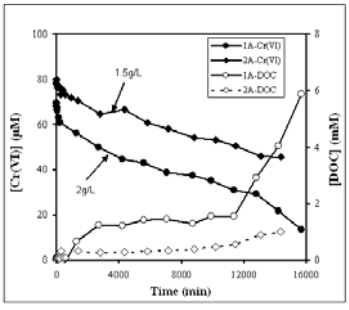
Microbial reduction of the mutagenic, carcinogenic and highly mobile Cr(VI) to Cr(III) has widely been promoted as a potential method for reducing chromium toxicity and bioavailability. While a large number of strains of bacteria capable of reducing Cr(VI) to Cr(III) have been isolated, questions remain about the exact mechanism for non-metabolic Cr(VI) reduction by microbial cells, particularly with respect to the relative roles of the cell surface and external electron donors (Fein et al., 2002). Prompted by preliminary data showing that cells lyse during incubation, Cr(VI) reduction experiments were conducted with a gram-negative, heat-inactivated aerobic strain of *Enterobacteriacea* at pH 2.5 in order to investigate the impact of cell lysis on the reduction rate. Incubations were maintained for up to 250 hours and sampled regularly for total Cr by GFAAS, Cr(VI) by the s-diphenylcarbazide method and DOC using a Shimadzu TOC-TN analyzer.

Results are summarized in the graph for two runs with different biomass, and show that while removal of Cr(VI) can occur in the presence of microbial cells, the removal rate is higher when dissolved organic carbon starts to increase dramatically (Run 1A) as cells begin to lyse around 200 hrs. Analysis of total Cr indicates that removal is due to reduction to Cr(III). Comparison with Run 2A suggests a threshold DOC content is required to stimulate reduction, perhaps through DOC acting as an external electron donor or as a ligand for solution complexation of Cr(III). These observations imply that the fate of Cr(VI) may be closely coupled to the cycling and re-mineralisation of bacterial biomass in the environment.




## Reference

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