Use of microscopic and spectroscopic techniques and kinetic models to understand the role of clay minerals in the microbial reduction of chromium(VI) by *Pseudomonas aeruginosa*

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The potential role of clay minerals, widely dispersed in soil and other biosphere, in the microbial reduction of hexavalentchromium(Cr(VI)) has not been well documented. In this study, we reported that *Pseudomonas aeruginosa* CCTCC AB93066 along with glucose and clay minerals (kaolinite and vermiculite) reduced Cr(VI). The results showed that the addition of clay minerals improved the consumption rate of glucose, stimulated the growth and propagation of *Pseudomonas aeruginosa*, and thus enhanced the efficiency of microbial Cr(VI) reduction. Cr(VI) bioreduction by both cells and clay minerals-amended cells followed the pseudo-first-order kinetic model. In this system, *Pseudomonas aeruginosa* was the biological reductant, glucose was an electron donor, and the clay minerals acted as an accelerator for both the reductant and electron donor. The mass balance analyses and X-ray photoelectron spectroscopy (XPS) analysis found that Cr(VI) was reduced to Cr(III), which might mainly exist as soluble organo-Cr(III) products. Atomic force microscopy (AFM) revealed that the addition of clay minerals (e.g. vermiculite) decreased the surface roughness of Cr(VI)-laden cells and changed the cell morphology and dimension. Fourier transform infrared spectroscopy (FTIR) revealed that organic matters such as aliphatic species and/or proteins played an important role in the combination of cells and clay minerals. Scanning electron microscopy (SEM) confirmed the attachment of cells on the surface of clay minerals, indicating that clay minerals could provide a microenvironment to protect cells from Cr(VI) toxicity and serve as growth-supporting materials. These findings manifested the underlying influence of clay minerals on microbial reduction of Cr(VI) and gave an understanding of the interaction between pollutants, the environment and the biota.