

Metabolic and redox controls on the kinetics and products of microbial Cr(VI) reduction

DANIEL S. ALESSI^{1,2,*}, LEIA V. FALQUET²,
JUSTINE GAY-DES-COMBES², YUHENG WANG²,
DAVID CORDIER², ALEXANDRE BAGNOUD²,
ELENA I. SUVOROVA²,
RIZLAN BERNIER-LATMANI²

¹Department of Earth and Atmospheric Sciences,
University of Alberta, Edmonton, AB, T6G 2E3,
Canada (*presenting author: alessi@ualberta.ca)

²Environmental Microbiology Laboratory, Ecole
Polytechnique Fédérale de Lausanne, CH-1015,
Lausanne, Switzerland

The remediation of hexavalent chromium, Cr(VI), in the subsurface is often achieved by its chemical or biological reduction to Cr(III). Cr(III) is sparingly soluble and is thought to precipitate primarily as mixed Cr(III)-Fe(III) hydroxides [1]. To induce the reducing conditions under which Cr(VI) can be transformed to Cr(III), a solution of electron donor such as lactate, acetate, or molasses can be introduced to the contaminated subsurface zone, increasing activity of microbes indigenous to the aquifer. While some of the Cr(VI) can be directly reduced by these microbes, solid phases including biogenic Fe(II)-bearing minerals are also produced and can chemically reduce Cr(VI). The objectives of this study are to assess the importance of these various electron transfer pathways on the rates and products of Cr(VI) reduction across a range of redox conditions.

Laboratory column reactor studies were conducted using alluvial sediments from a Cr-contaminated aquifer in central Switzerland. We varied the chemical composition of the influent groundwater, the timing of electron donor addition, and the duration of flow in the columns, in order to determine Cr products formed (a) by isolating the enzymatic-only reduction of chromium, (b) during iron reduction, and (c) during sulfate-reduction. Sediments from the columns were characterized using a suite of analytical techniques, including bulk and microprobe X-ray absorption spectroscopy, 16S rRNA microbial community analyses, electron microscopy, and wet chemical analyses. We found that while discrete Fe(III)-Cr(III) precipitates play a key role in sequestering Cr across the range of tested conditions, also present is diffuse Cr(III) which is not colocalized with sediment Fe, and may play a role in overall Cr stability following bioremediation.

[1] Wielinga, B. *et al.* (2001) *Environ. Sci. Technol.* 35(3), 522-527.