Monitor Cr toxicity and remediation process - Combining a whole-cell bioreporter and Cr isotope techniques

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Cr concentrations are very variable in different environments. It is between 0.025 to 5 mg/L in rivers and lakes, and is about 5 to 900 ng/L in seawaters. In contaminated sites, it can be 30 mg/L or higher. The toxicity of Cr is dependent on its concentration and speciation. Bacterial Cr reduction can immobilise the toxic Cr (VI) to a less toxic Cr (III) form. Whole cell bioreporters enable a rapid and sensitive detection of bioavailability and toxicity of contaminants, while isotopes can be used to trace the migration and reduction process of them, and here we report a novel combination of the two of these to monitor bacterial responses reducing Cr at sites of elevated Cr. In this study, a whole cell bioreporter *Acinetobacter baylyi* ADP-recA-lux was applied to indicate the toxicity of different species of Cr, over a range of initial concentrations. Cr isotope techniques were also employed to study the impact of Cr toxicity on microbial Cr reduction processes. The whole cell bioreporter *Acinetobacter baylyi* ADP-recA-lux was efficient in indicating the genotoxicity of Cr (VI) at low concentration levels (< 5mg/L) and cytotoxicity at high concentration levels (100 mg/L). Compared with Cr_2O_7, CrO_4 was more toxic as indicated by the bioreporter. High concentration (100 mg/L) of Cr (III) could also strongly induce the bioluminence in the bioreporter, indicating it could also cause DNA damage at such concentration levels. *Pseudomonas fluorescens* LB 300 was found to be effective in reducing Cr (VI) even when the concentration was high; however, complete Cr (VI) reduction was only observed at low concentration levels (5 mg/L), reflecting that the toxicity of high concentrations of Cr (VI) impact Cr reduction processes by the bacteria. With its reduction, Cr isotopes fractionated and the $\delta^{53}Cr$ value increased in Cr (VI) species, indicating a lighter isotope composition in the products. The calculated fractionation factor by the bacterial Cr (VI) reduction process was 3.1 ‰ when its initial concentration was low, and was 2.6 ‰ when the Cr (VI) concentration was high. The small variation of the fractionation factors indicated that the Cr isotope signature caused by the bacterial reduction was independent of initial Cr concentrations, and that it can be used to indicate bacterial reduction during bioremediation of Cr (VI) over a wide range of concentrations.