Field-scale injection of molasses to stimulate microbially mediated Cr(VI) reduction under fast flow conditions

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In Thun, Switzerland, an alluvial aquifer is heavily contaminated by Cr(VI) due to periodic spillage of chromic acid in the past. The contamination has led to a major groundwater plume with Cr(VI) concentrations up to 3 mg/L, corresponding to a 300-fold violation of the regulatory limit. The site is characterized by oxygen-saturated conditions and high groundwater flow-velocities up to 15 m/day. A previous remediation attempt was carried out by installing a permeable reactive barrier filled with metallic iron shavings. Because most of the Cr(VI) load is bypassing the barrier, the performance of the barrier is limited [1] and additional remediation measures are required.

In this study, we performed a controlled injection of sterile, diluted sugar beet molasses into the hotspot of the contamination to stimulate microbially-mediated Cr(VI) reduction. In total, around 100 kg of molasses were delivered over a period of 4 months. After 1 month, the injection well became anoxic and Cr(VI) was quantitatively removed. Once the injection stopped, anoxic conditions prevailed for about 5 months before turning oxic again and the Cr(VI) concentration returned to pre-injection values. In one monitoring well located 170 m downstream of the injection point, the Cr(VI) concentration and O_2 saturation decreased by about 50% during injection, and both parameters quickly returned to pre-injection values after the injection stopped. These observations suggest that Cr(VI) reduction was successfully stimulated for a substantial portion of the aquifer, which is also consistent with Cr isotope analyses. All other monitoring wells did not show any indications of O_2 or Cr(VI) reduction, demonstrating that strong preferential flow paths are occurring within the aquifer. This presents a challenge for distributing molasses or other electron donors over the entire contaminated aquifer, which is relevant for future site-scale bioremediation attempts.

[1] Wanner et al. (2013), Applied Geochemistry 37, 125-133.