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Reactive transport modeling of the release and mobility of hexavalent chromium in a contaminated soil

ELINA CEBALLOS[1], **JORDI CAMA**[2] AND JOSEP M. SOLER[2]

[1]Institute of Environmental Assessment and Water Research (IDAEA, CSIC)

[2]Institute of Environmental Assessment and Water Research (IDAEA)

Presenting Author: jordi.cama@idaea.csic.es

Chromium-containing solid waste generated by tanning industries is an important source of hexavalent chromium (Cr(VI)) in soil and groundwater. The objective of this study is to quantify the leaching of Cr(VI) from a soil, resulting in groundwater contamination.

Experiments were performed using representative soil samples obtained from the contaminated site (industrial area of the Matanza-Riachuelo basin, Argentina). A series of flow-through tests was conducted to evaluate the processes responsible for Cr(VI) release. Additionally, a column experiment allowed the study of Cr(VI) mobility along the soil profile. The experiments were performed by injecting Milli-Q water to emulate rain water under atmospheric conditions (415 ppm $CO_{2(g)}$ and 21% $O_{2(g)}$).

The variations in pH and in the concentrations of Cr(VI), Ca, S, Si and Mg with time (flow-through experiments) and with time and space (column experiment) were used to quantify the geochemical processes responsible for the mobility of Cr(VI) along the soil profile. One-dimensional (1D) numerical simulations using CrunchFlow [1] reproduced the release of Cr(VI) in the flow-through experiments and its mobility in the column experiment. Simulations indicate that dissolution of less than 3 wt% of Na_2CrO_4 and Cr(VI)-bearing hydrocalumite is necessary to reproduce the largest concentration of Cr(VI). Moreover, dissolution of Cr(VI)-rich ettringite, which was identified in the solid waste, contributes less Cr(VI) to the water. Furthermore, the processes of reduction and adsorption of Cr(VI) did not take place along the column.

[1] Steefel, Appelo, Arora, Jacques, Kalbacher, Kolditz, Lagneau, Lichtner, Mayer, Meeussen, Molins, Moulton, Shao, Simunek, Spycher, Yabusaki, Yeh (2015), Computational Geosciences 19, 445–478.