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Laboratory scale electrokinetic remediation and geophysical monitoring of metal-contaminated marine sediments

Matteo Masi (1), Veronica Pazzi (2), and Gabriella Losito (1)

(1) Department of Civil and Environmental Engineering, University of Florence, Florence, Italy, (2) Department of Earth Sciences, University of Florence, Florence, Italy

Electrokinetic remediation is an emerging technology that can be used to remove contaminants from soils and sediments. This technique relies on the application of a low-intensity electric field to extract heavy metals, radionuclides and some organic compounds. When the electric field is applied three main transport processes occur in the porous medium: electromigration, electroosmosis and electrophoresis.
Monitoring of electrokinetic processes in laboratory and field is usually conducted by means of point measurements and by collecting samples from discrete locations. Geophysical methods can be very effective in obtaining high spatial and temporal resolution mapping for an adequate control of the electrokinetic processes.
This study investigates the suitability of electrokinetic remediation for extracting heavy metals from dredged marine sediments and the possibility of using geophysical methods to monitor the remediation process. Among the geophysical methods, the spectral induced polarization technique was selected because of its capability to provide valuable information about the physico-chemical characteristics of the porous medium.
Electrokinetic remediation experiments in laboratory scale were made under different operating conditions, obtained by varying the strength of the applied electric field and the type of conditioning agent used at the electrode compartments in each experiment. Tap water, 0.1M citric acid and 0.1M ethylenediamine tetraacetic acid (EDTA) solutions were used respectively as processing fluids. Metal removal was relevant when EDTA was used as conditioning agent and the electric potential was increased, as these two factors promoted the electroosmotic flow which is considered to be the key transport mechanism. The removal efficiencies ranged from 9.5% to 27% depending on the contaminant concerned. These percentages are likely to be raised by a further increase of the applied electric field.
Furthermore, spectral induced polarization measurements were performed on the sediments before and after the treatment in order to correlate the measured electrical parameters with the geochemical processes occurring during electrokinetic remediation. A linear relationship was found between chargeability and pH. This result opens the door to the use of spectral induced polarization method to monitor electrokinetic processes in the field.