1 Introduction

Problems:
1) Conventional remediation techniques are not effective for fine-grained soils and sediments.
2) High spatial and temporal resolution mapping techniques are required for in situ monitoring of remediation processes.

Objectives of this study:
1) To evaluate Electrokinetic Remediation (EKR) for the treatment of polluted marine sediments, investigating the influence of the experimental parameters of the treatment, including different enhancing electrolytes, on the efficiency of the process.
2) To determine whether Spectral Induced Polarization (SIP) could be used to monitor geochemical processes occurring during EKR treatments.

2 EKR test conditions

- Contaminated material: Marine sediments dredged from a harbour in northern Sardinia (Italy).
- Investigated contaminants: Zn (273 mg/kg), Pb (145 mg/kg), V (12 mg/kg), Ni (16 mg/kg), Cu (92 mg/kg).
- 3 experimental tests: EXP1, EXP2, EXP3.

3 Experimental setup

- Sediment compartment dimensions: 30 x 15 x 15 cm
  Volume: 6.75 dm³
- Anode and cathode electrodes: Graphite plates (20 x 15 x 0.4 cm)
- Electrolytic compartment volume: 2.25 dm³, reservoirs: 4 dm³, recirculation with peristaltic pumps.

4 Electric current

Addition of EDTA (EXP1) → sustained electric current due to the presence of NaCl (Because of NaClH used for the preparation of the EDTA solution).

6 pH, electroosmotic flow

pH in EXP1 (data) and EXP2 (data) with time.

5 CaCO₃ and hydroxides precipitation

5.2 pH of CaCO₃ and hydroxides precipitation:
- Exp1: pH: 8.4
- Exp2: pH: 8.6
- Exp3: pH: 8.0

7 Results

Retention efficiency (%)

8 SIP data acquisition

Complex resistivity (SIP) measurements were performed on sediment samples collected from the electrokinetic cell after the EKR treatments at low frequencies (from 10⁻¹ to 10⁻⁵ Hz).

- Sample holder: acrylic cylinder (L = 200 mm, η = 36 mm)
- A, B: energizing electrodes (stainless-steel plates)
- M, N: potential electrodes (silver rings, d = 70 mm)
- Y: measured voltage across potential electrodes (Y)
- I: measured electric current (A)

9 Data inversion

Frequency (Hz)

10 SIP spectra

Complex resistivity (2D):

11 m-pH relationship

Linear relationship between chargeability (m) and pH: such a relationship has potential value for the interpretation of SIP data, encouraging the field-scale engineering implementation of the SIP method for monitoring EKR processes.

12 Conclusions

1) EDTA was the most effective electrolyte solution since the dominant mechanism of removal was the electroosmotic flow.
2) Resistivity monitoring: abrupt local increase of resistivity over time correlates to carbonate and metal hydroxide precipitation phenomena.
3) SIP: a linear correlation exists between the pH and the electric chargeability of the material subjected to EKR.

References

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LABORATORY SCALE ELECTROKINETIC REMEDIATION AND GEOPHYSICAL MONITORING OF METAL-CONTAMINATED MARINE SEDIMENTS

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