12th International SedNet Conference (online) 28 June – 2 July 2021

"Sediment Challenges and Opportunities due to Climate Change and Sustainable Development"

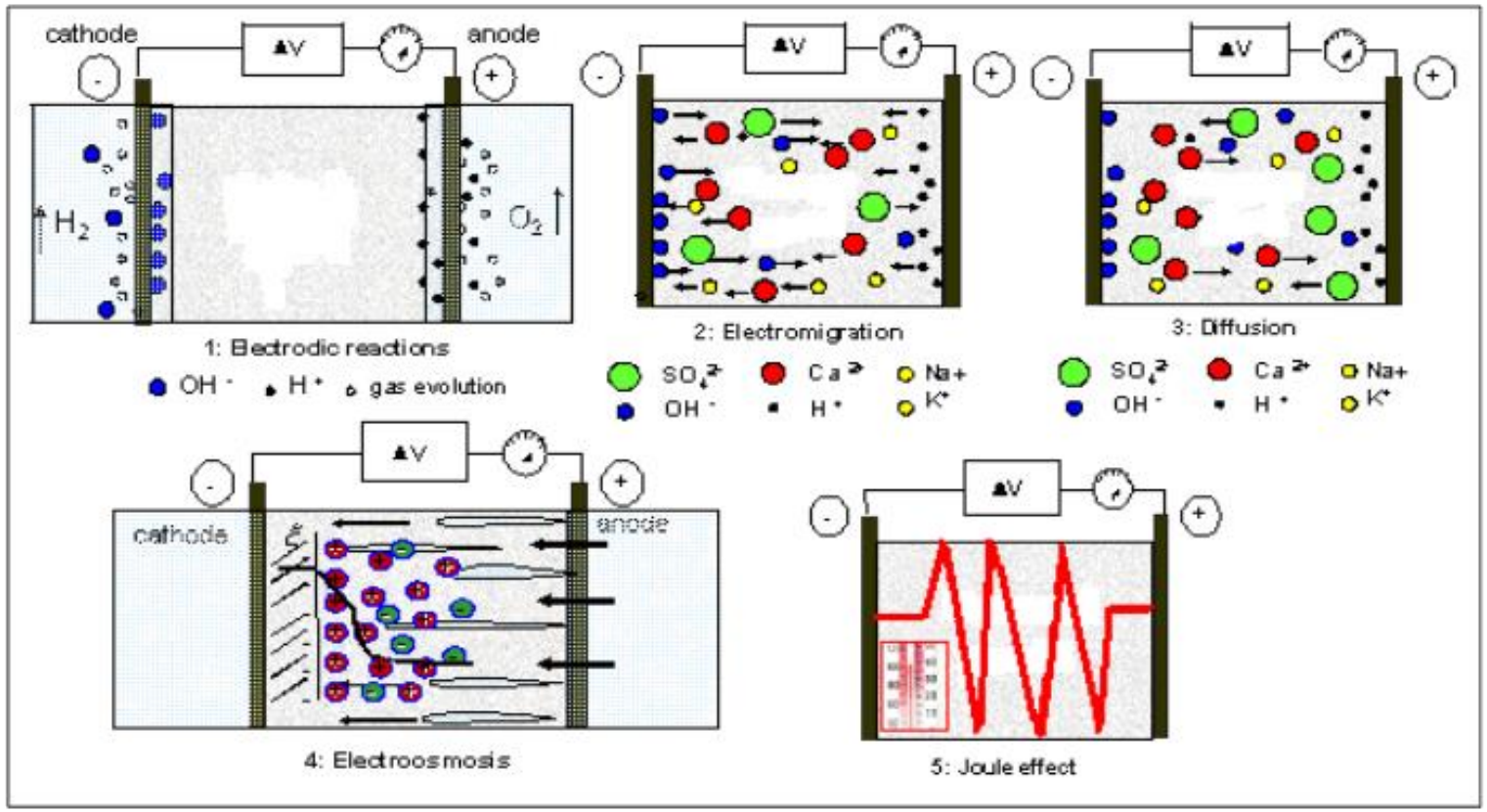
Morphological changes and organic´s removal by electrokinetic remediation of a dredged marine sediment

Marta Castellote

Institute of Construction Science Eduardo Torroja (IETcc-CSIC), Spain

ELECTROKINETICS

FUNDAMENTALS → Aplication of a drop of potential of low intensity directly on the contaminated material



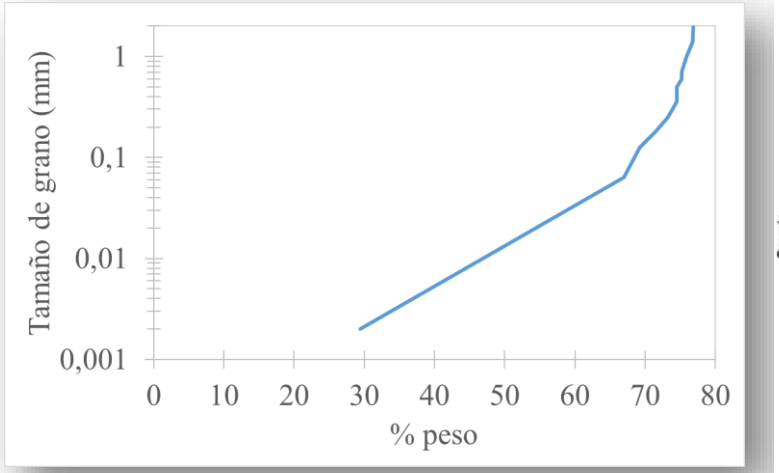
Electrodic Reactions

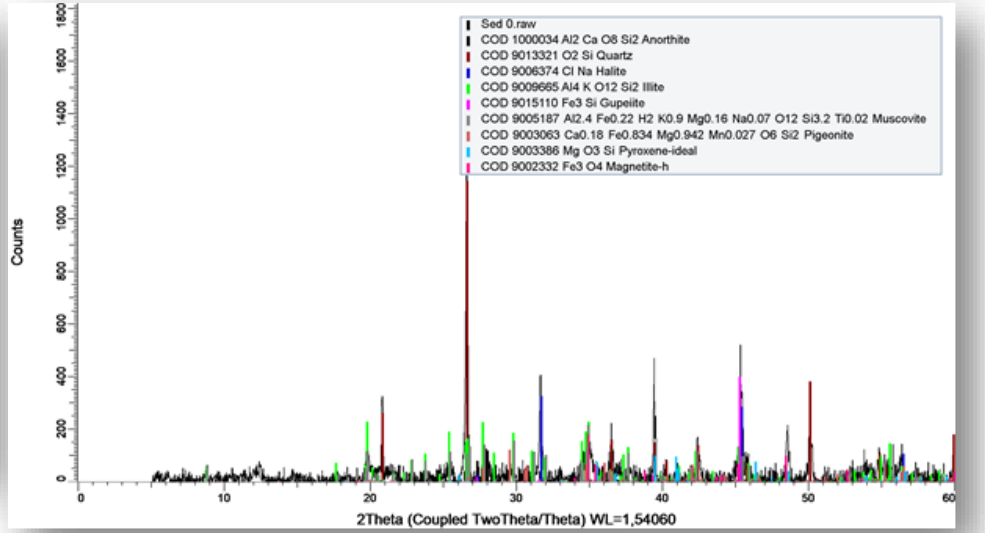
$$H_2O \rightarrow 1/2\ O_2 + 2H^+ + 2e^-$$

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$$

Initial Characterisation

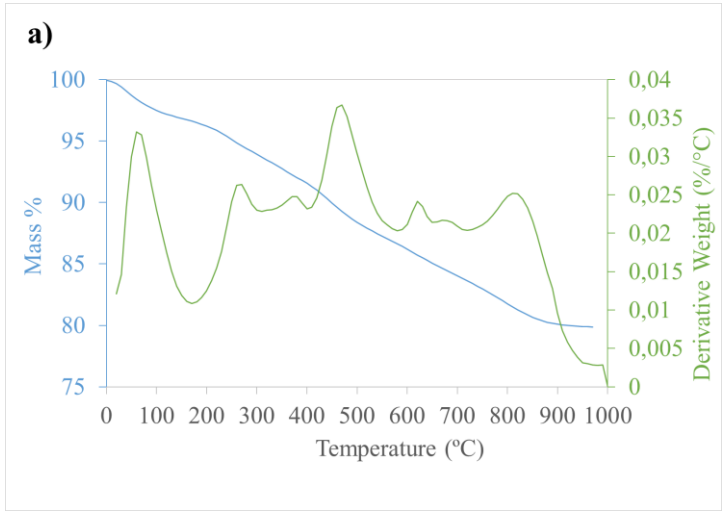
size particle distribution
DRX
FRX
TGA/DTA
Elemental analysis

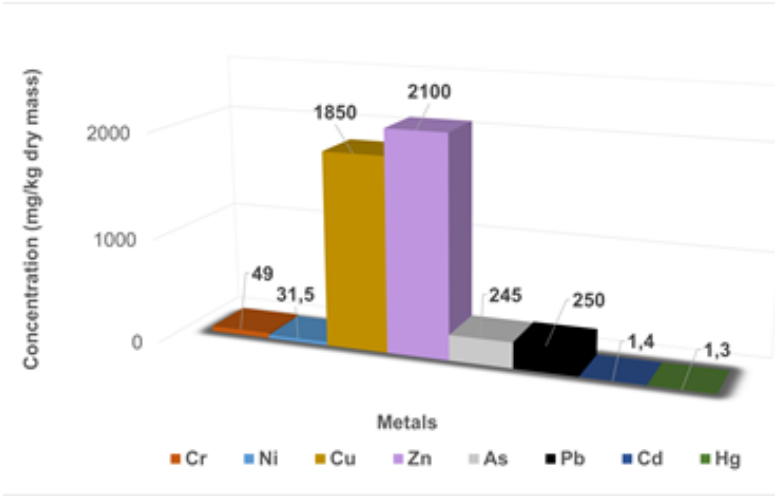




The main mineral phase was quartz (SiO_2) followed by silicates as muscovite, clay minerals such as illite, Iron-containing minerals and halite (NaCl) were also found.

Sediment composed mainly of clays and silts: 67% weight fraction < 63 µm:

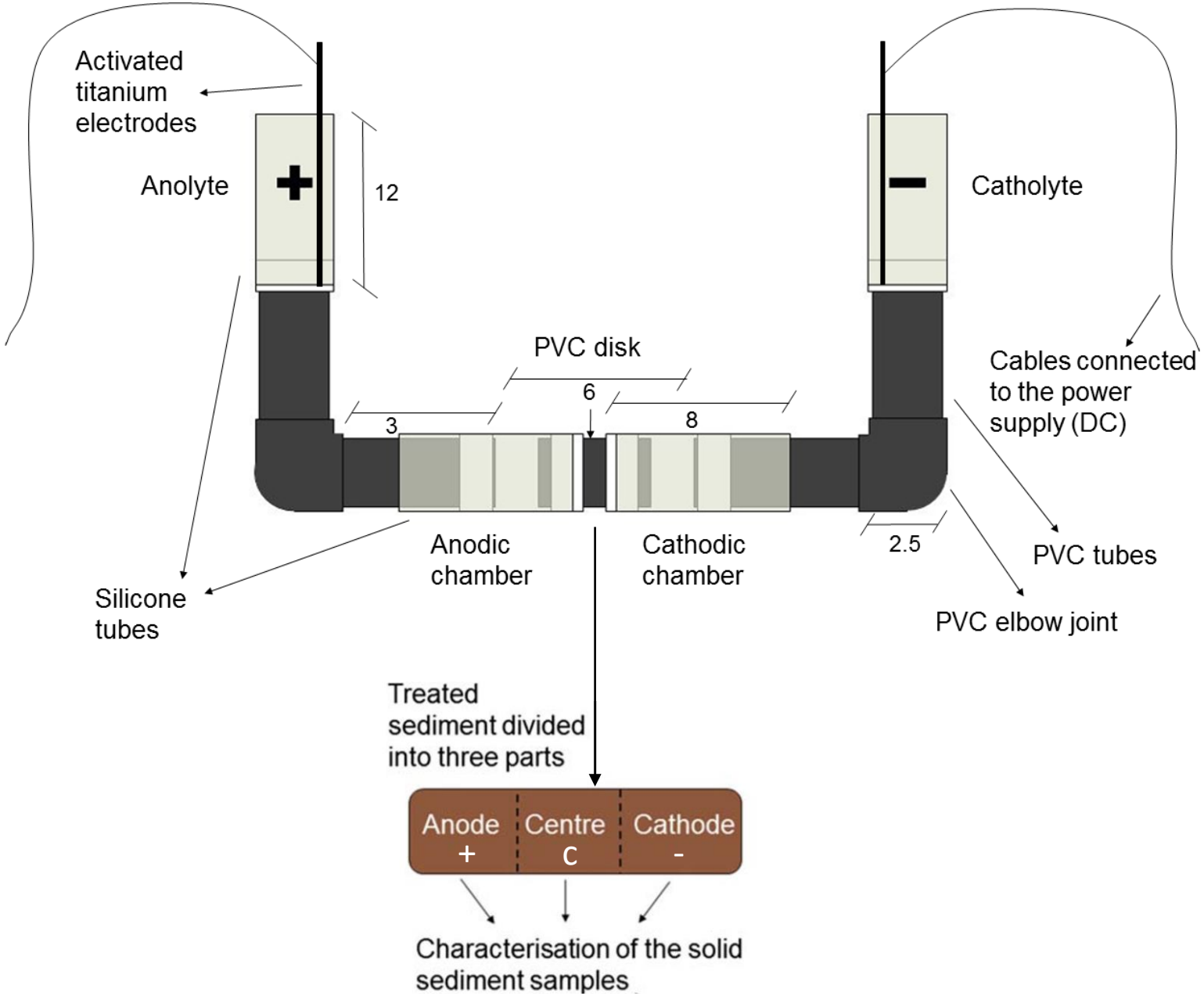




Characterisation of the raw, natural sediment

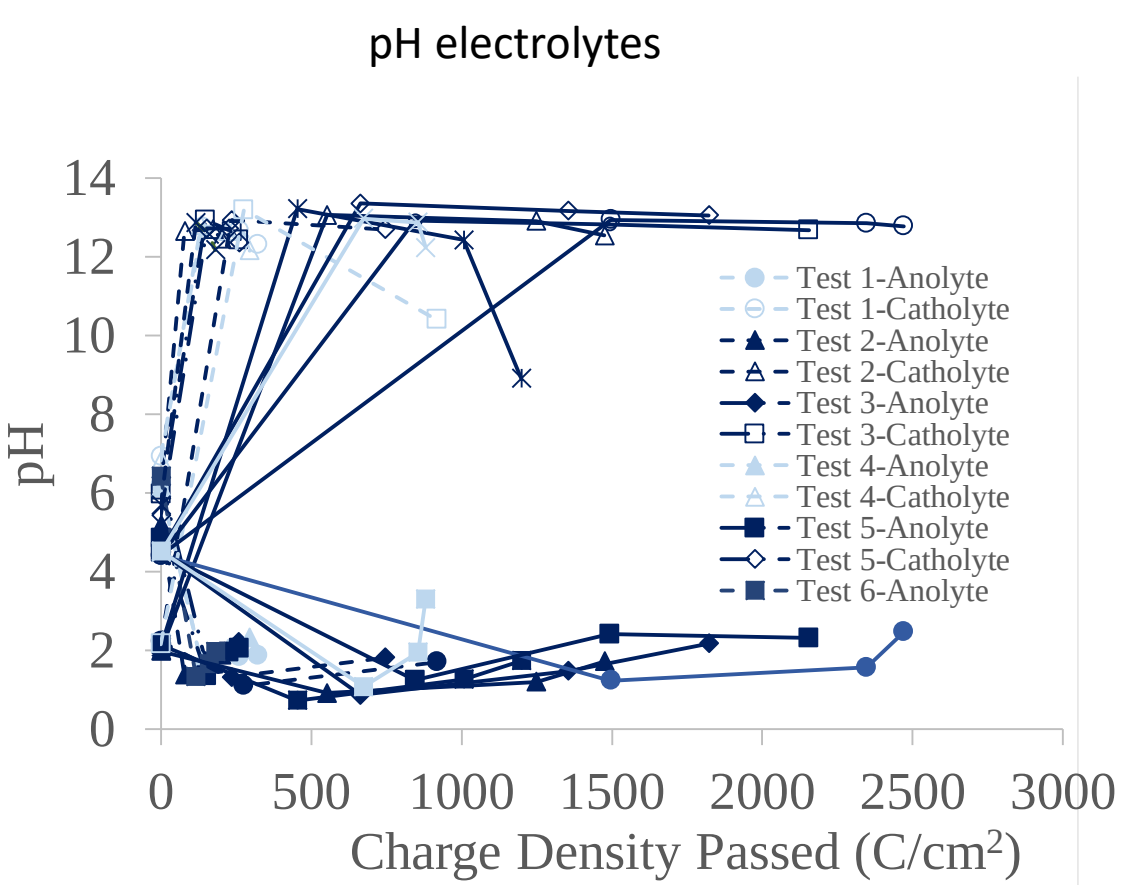
	(mg/kg dry mass)
TOC	21.000 (2.1%)
$CaCO_3$	10.200 (1.02%)
TPH C10-C12	< 5.5
TPH C12-C16	< 8
TPH C16-C21	15.5
TPH C21-C40	51
∑ TPH	70
Monobutyltin (MBT)	< 2.2
Dibutyltin (DBT)	< 27
Tributyltin (TBT)	57 microg/kg
Total PAH	< 0.30
∑ PCB	< 0.007

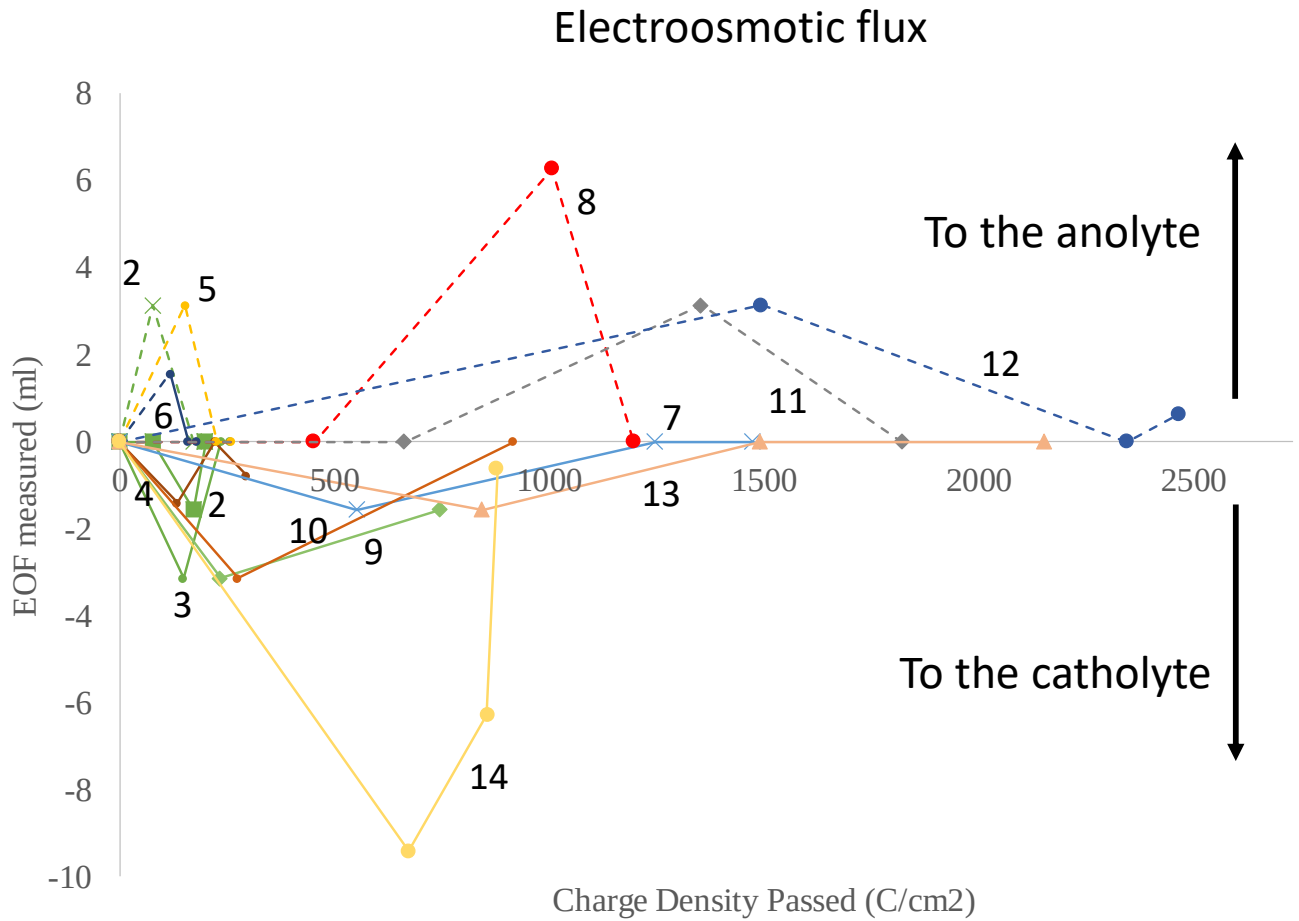
Cell device used for the electrokinetic experiments



Experiment	Anolyte (+)	Catholyte (-)	Voltage (V)	Duration (hours)
Test 1	Surfactant A	Deionized water	30	65
Test 2	Surfactant B	Deionized water	30	65
Test 3	Deionized water	Surfactant A	40	66
Test 4	Deionized water	Surfactant B	40	73
Test 5	Deionized water	Surfactant C	40	71
Test 6	Deionized water	Surfactant D	40	71
Test 7	0.1 M Citric acid + Surfactant A		40	66
Test 8	0.1 M Citric acid + Surfactant B		40	66
Test 9	0.1 M Citric acid + Surfactant C		40	67
Test 10	0.1 M Citric acid + Surfactant D		40	67
Test 11	0.1 M EDTA + Surfactant A		40	65
Test 12	0.1 M EDTA + Surfactant B		40	71
Test 13	0.1 M EDTA + Surfactant C		40	71
Test 14	0.1 M EDTA + Surfactant D		40	71

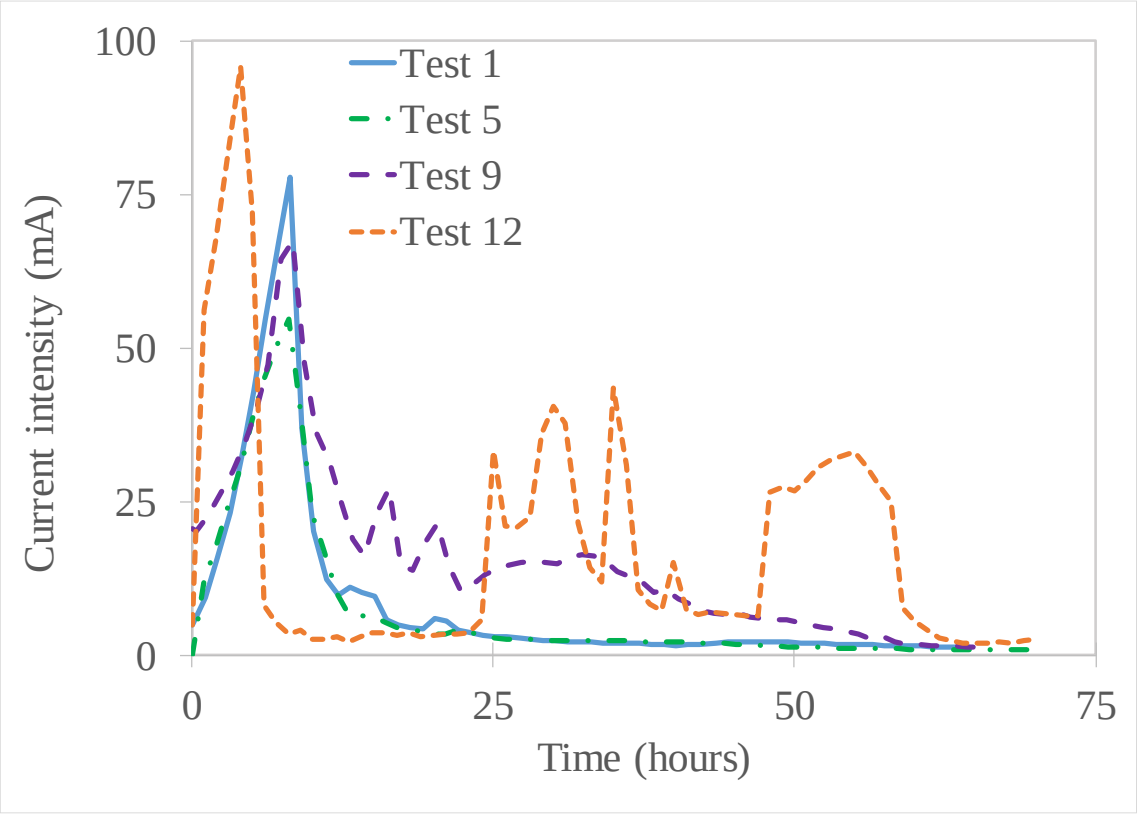
Results

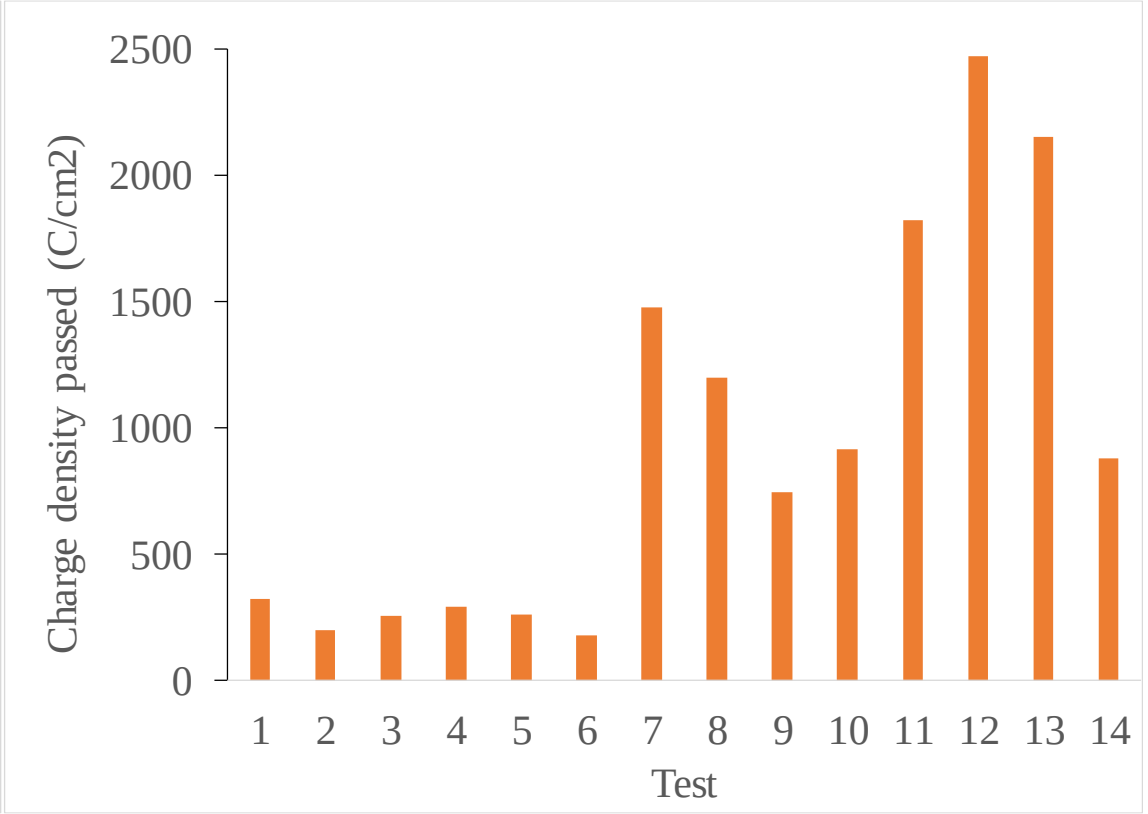




						CA				EDTA			
Surf	**B**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
To +	2			5	6		8			11	12		
To -	2	3	4			7		9	10			13	14

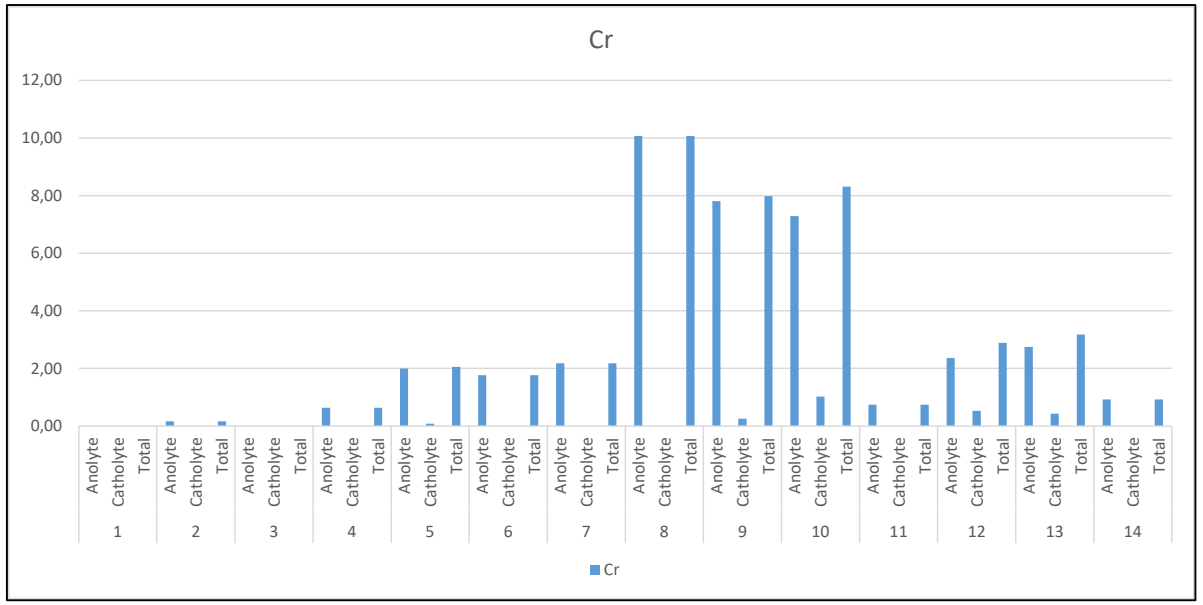
Electrical Current

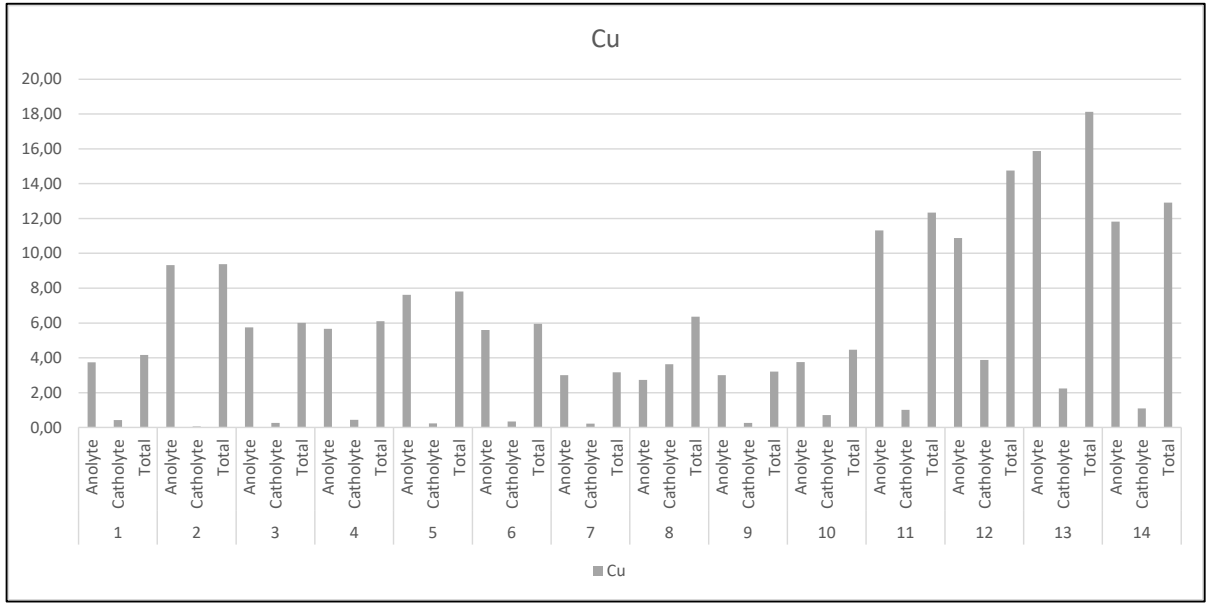


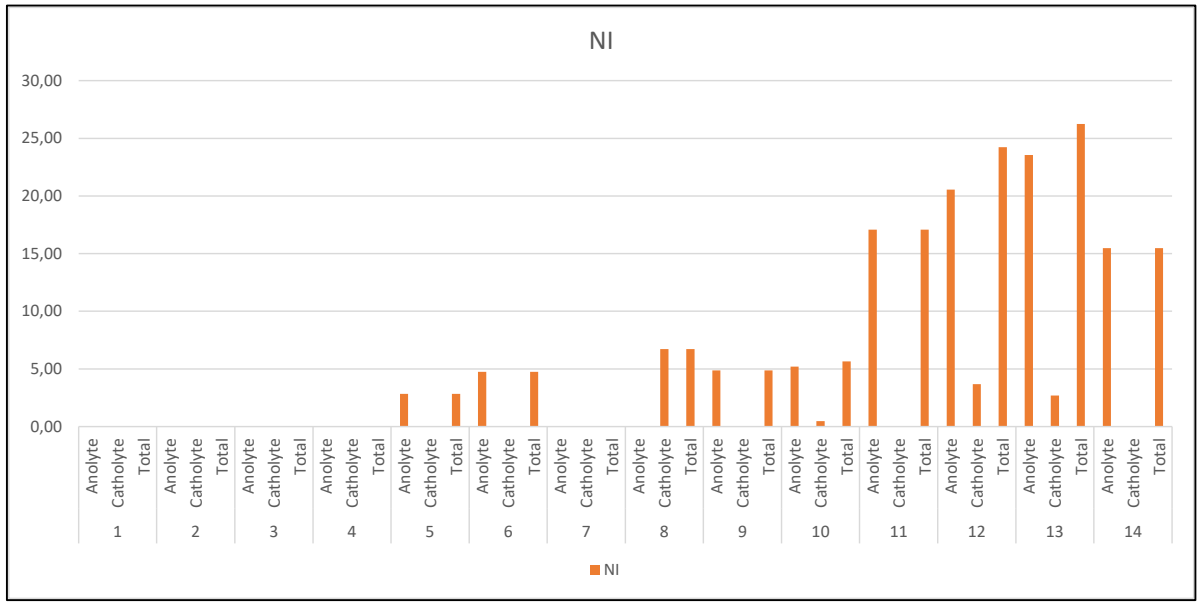


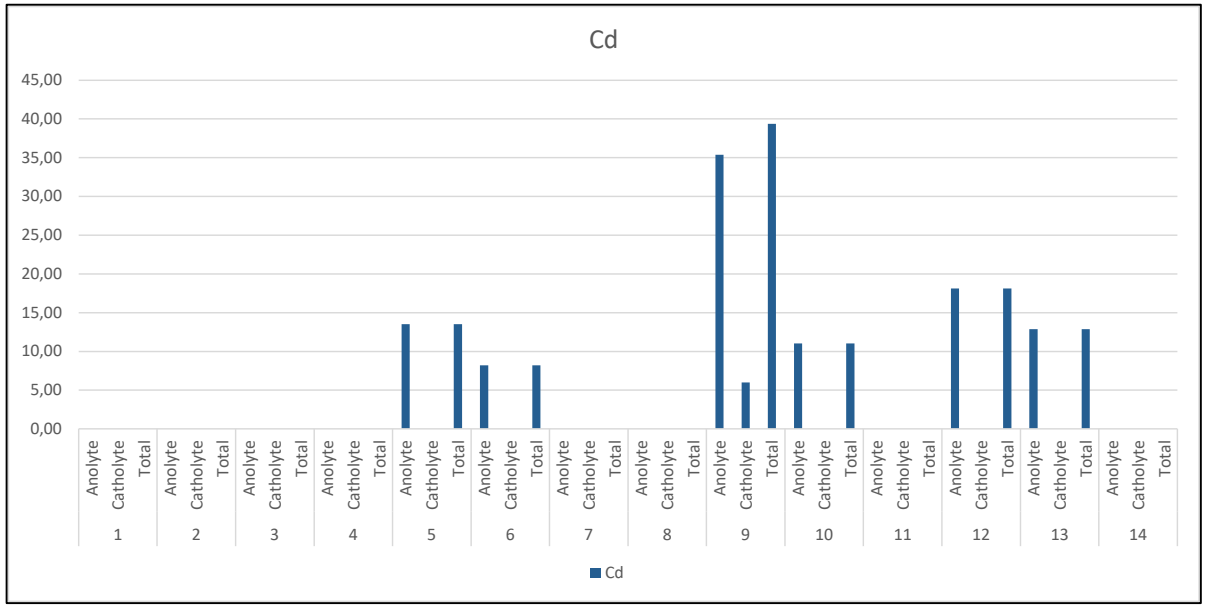
DRX: significant changes

Metal´s removal (ICP)

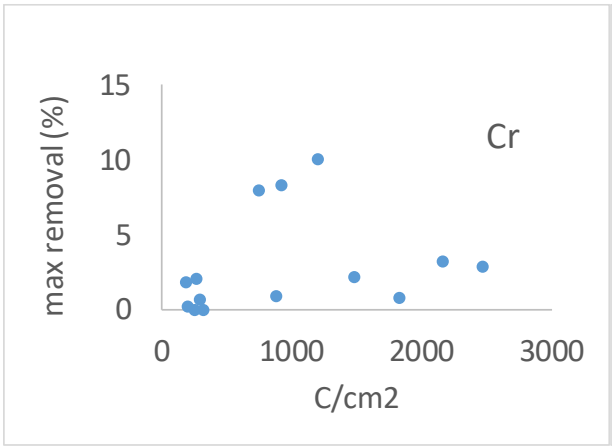


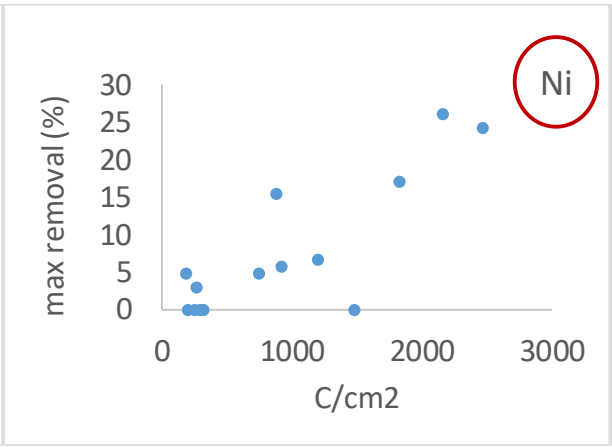


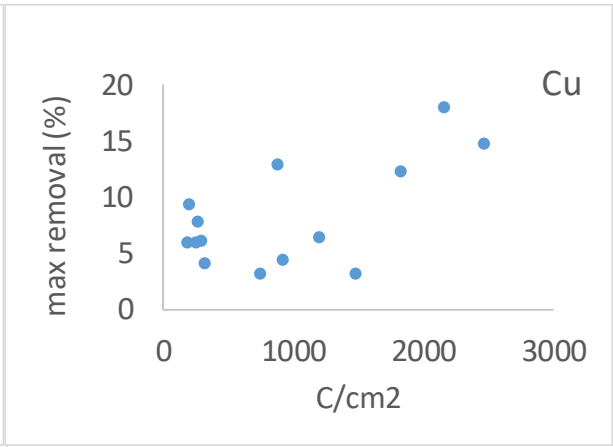


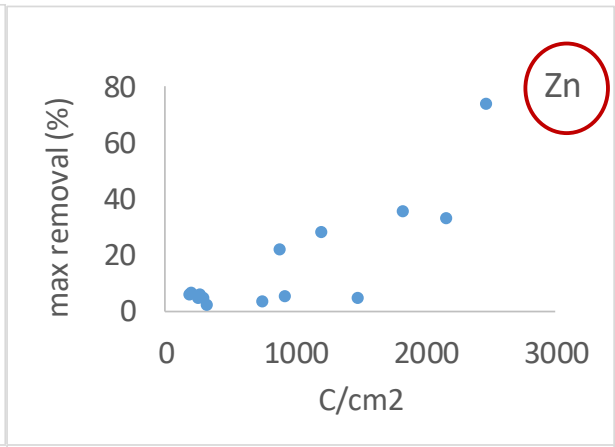


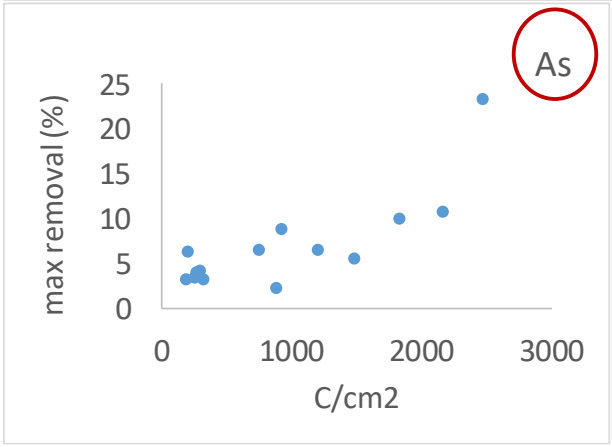
Maximum Metal´s removal (ICP)

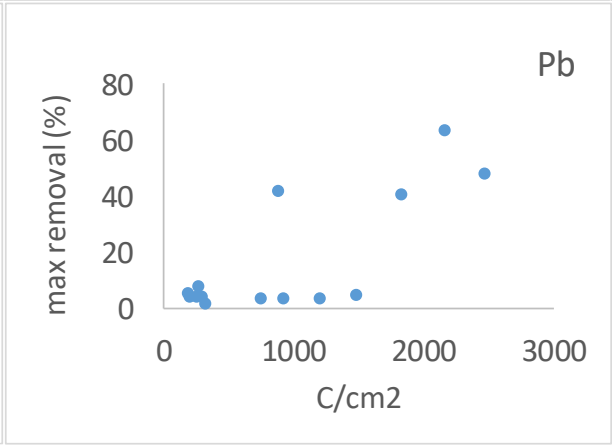


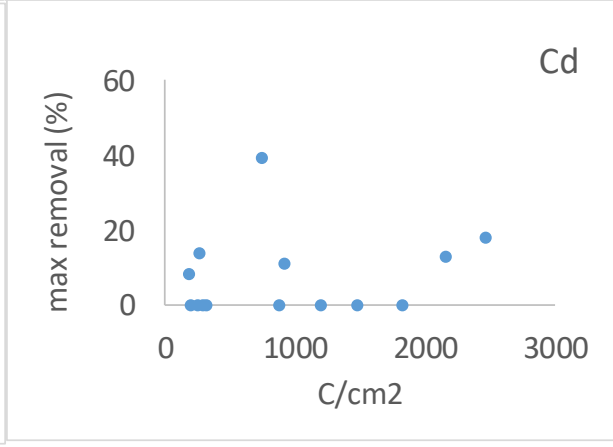


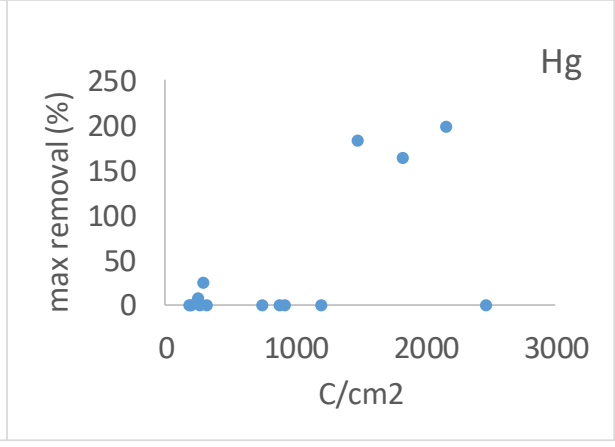




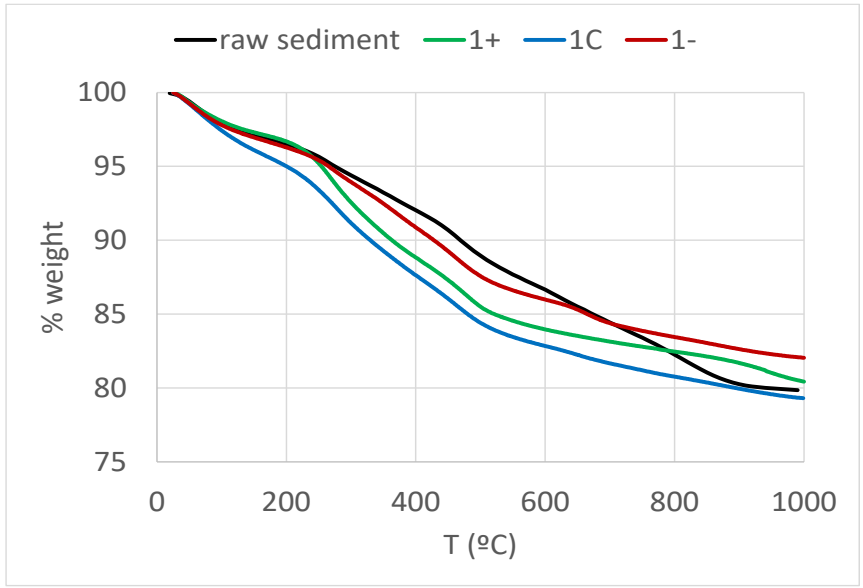


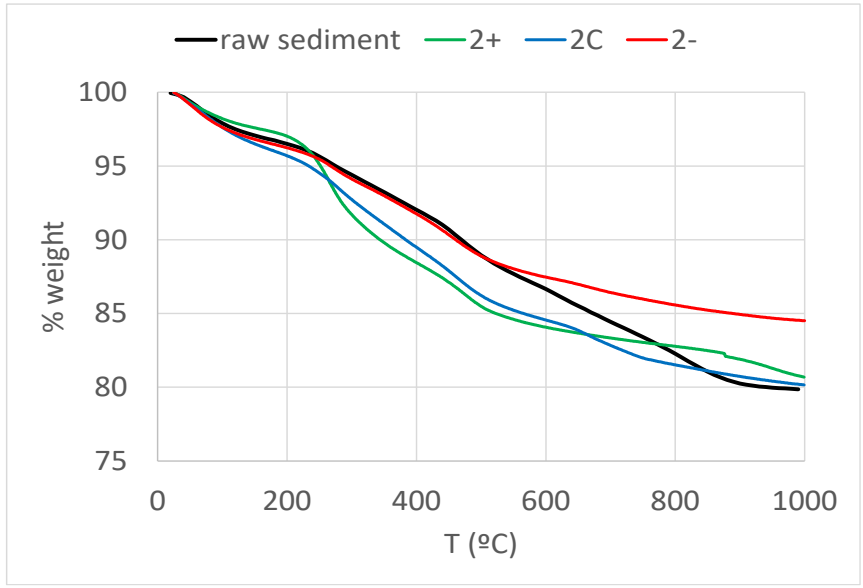


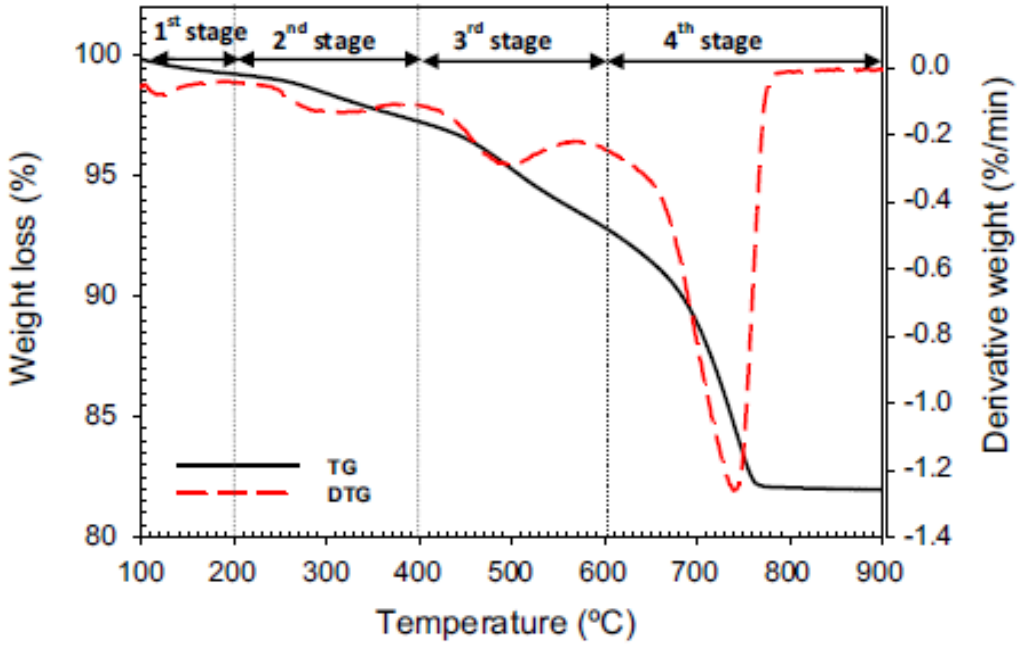




TGA-DTG



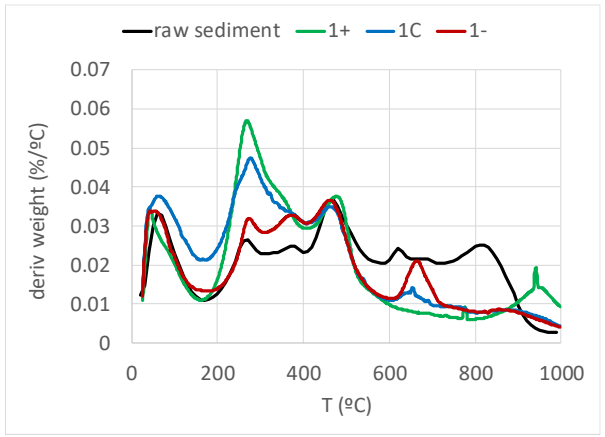


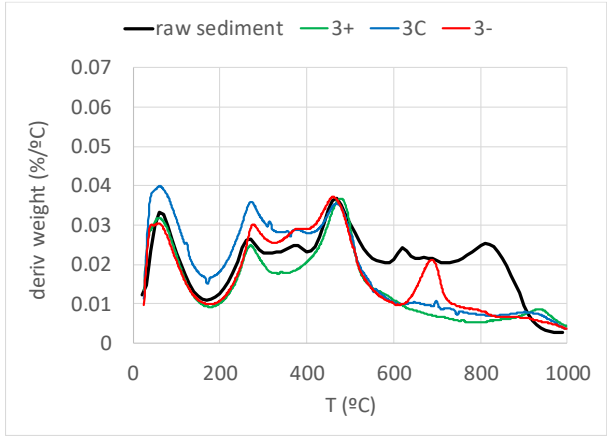


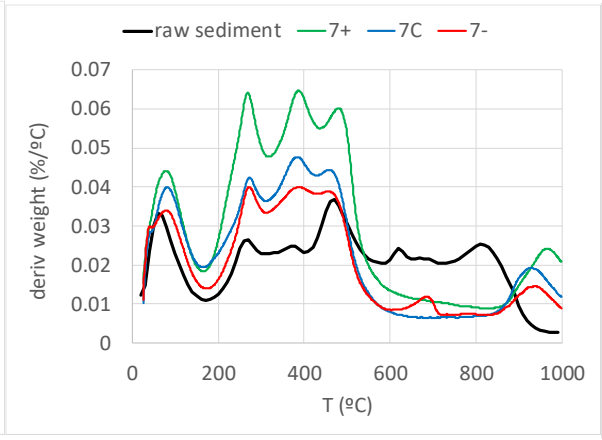
From Oudghiri, F., J.L. García-Morales, and M.R. Rodríguez-Barroso, *Novel use of TGA–FTIR technique to predict the pollution degree in marine sediments.* Infrared Physics & Technology, 2015. **72**: p. 52-57.

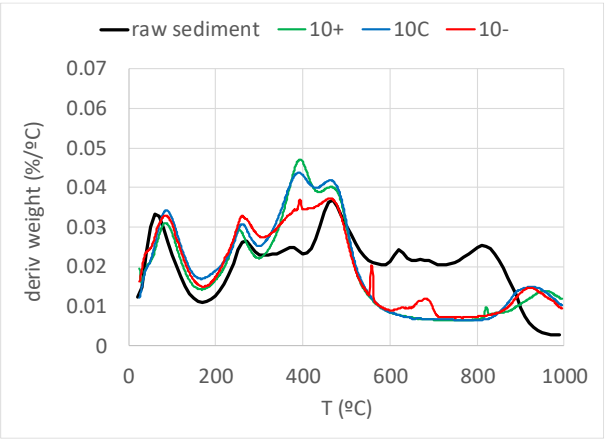
TGA/DTG

Surfactant A

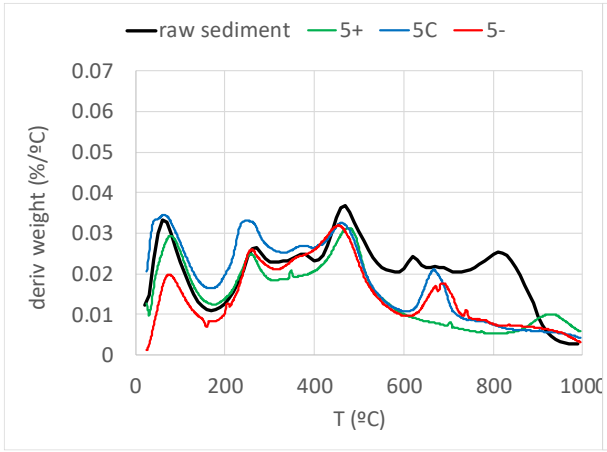


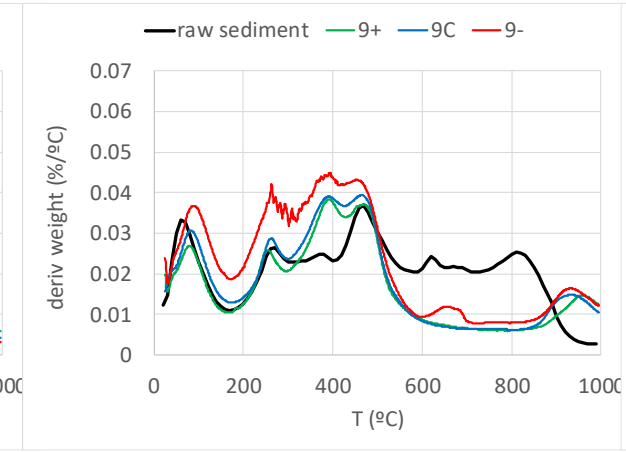


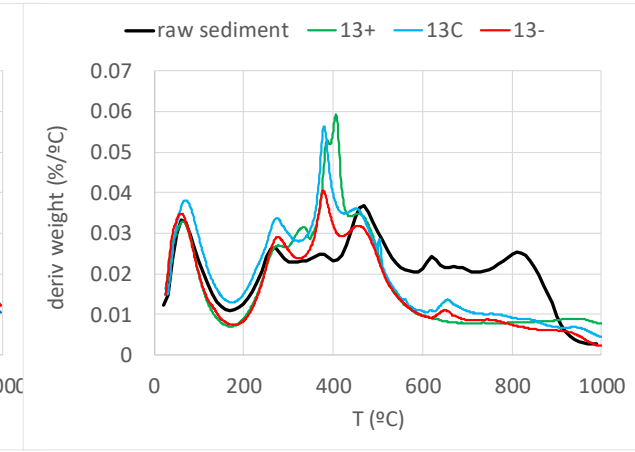




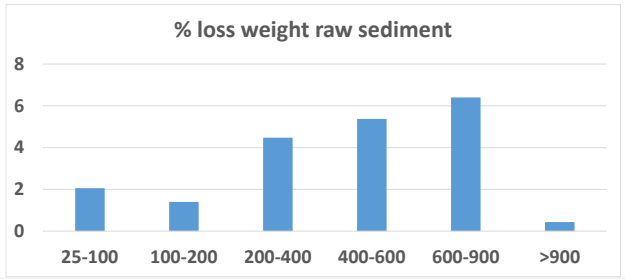
Surfactant C

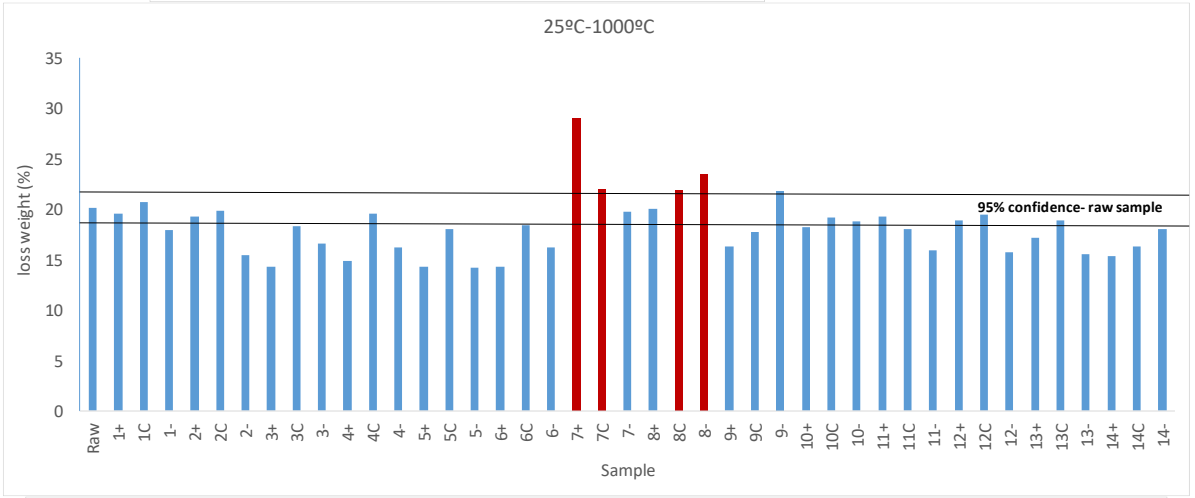


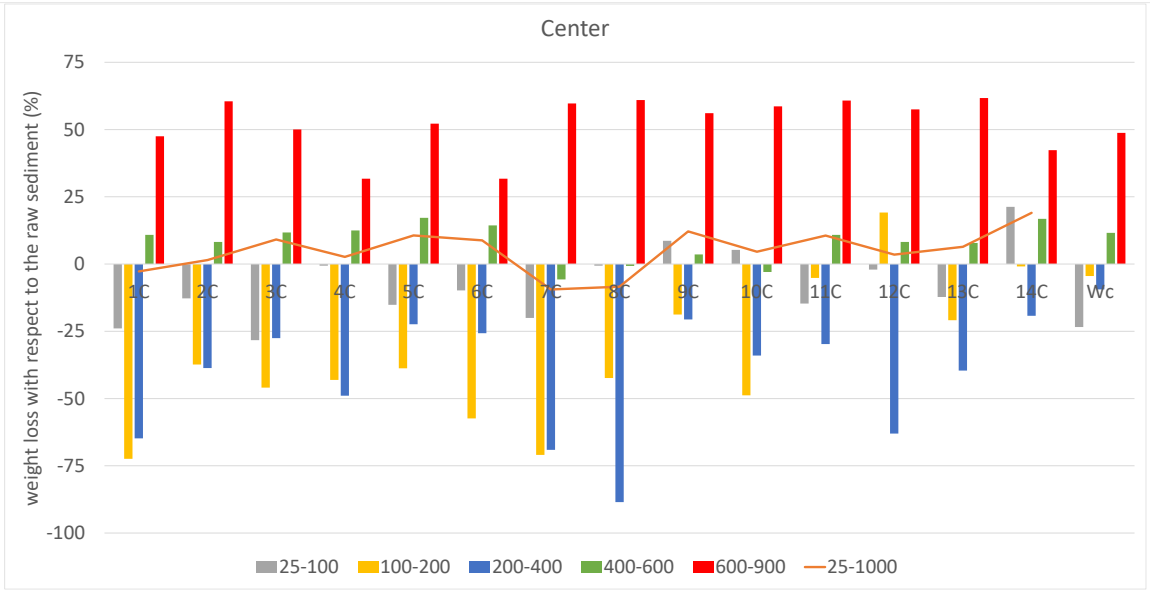


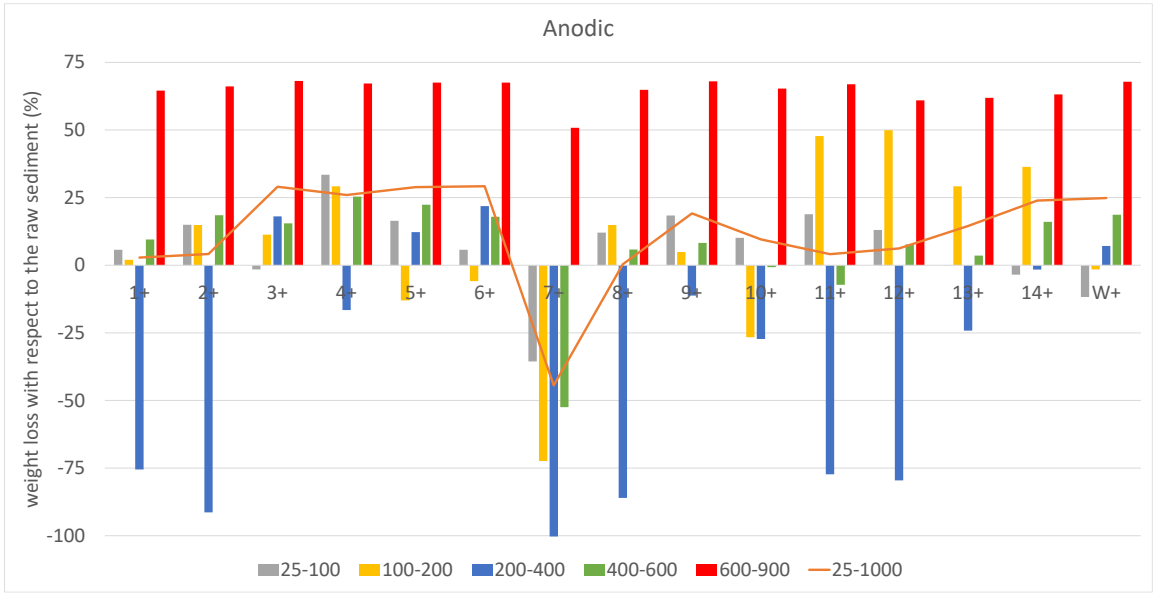


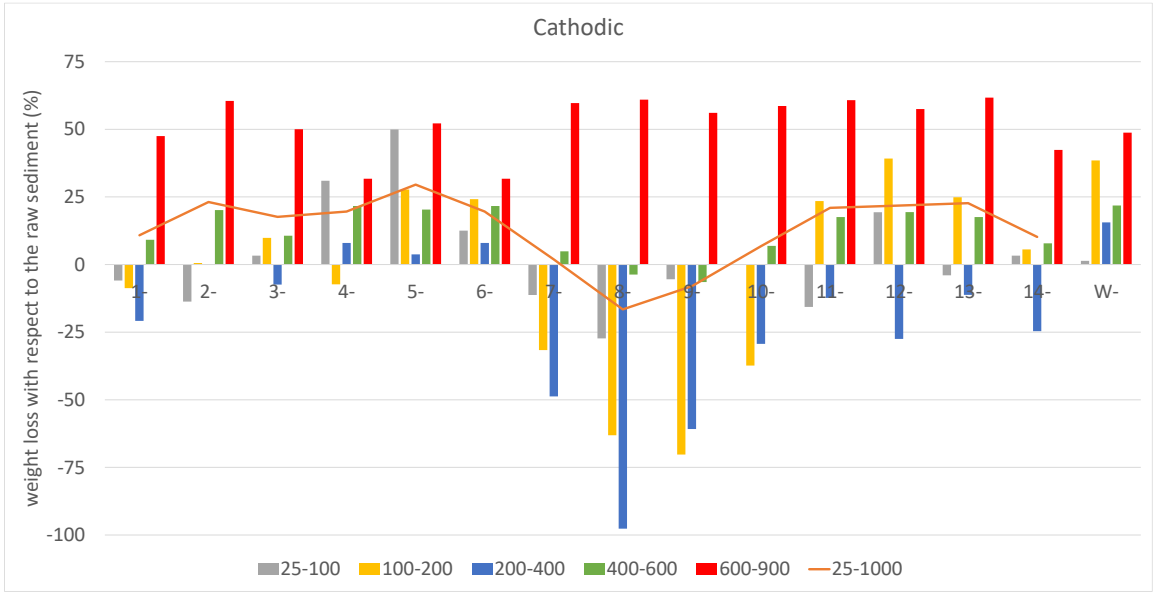
TG analysis


% loss weight raw sediment
8
6
4
2
0
25-100
100-200
200-400
400-600
600-900
>900


25ºC-1000ºC
loss weight (%)
95% confidence- raw sample
Sample


Center
weight loss with respect to the raw sediment (%)
25-100
100-200
200-400
400-600
600-900
25-1000


Anodic
weight loss with respect to the raw sediment (%)
25-100
100-200
200-400
400-600
600-900
25-1000


Cathodic
weight loss with respect to the raw sediment (%)
25-100
100-200
200-400
400-600
600-900
25-1000

Summary

- Electrokinetic tests combined with enhancing solutions (surfactants/chelants) present a high potential to remove not only charged species, as metals but also organic pollutants.

- It is necessary to design the optimum experimental setup in function of the species we want to remove.