Geochemical and ecotoxicological evolution of a dredged sediment submitted to three protocols simulating ageing under oxidation conditions

P. Bataillard [1], J. F. Masfaraud [2], S. Piou [2], C. Mouvet [1]

[1]Brgm; Environment and Processes Division, Avenue C. Guillemin, BP 36009, F-45060 Orléans Cédex 2

Phone: +00-(33)-(0)2 38 64 39 08
p.bataillard@brgm.fr

[2]Université Paul Verlaine – Metz, Ecotoxicity and Environmental Health, Campus Bridoux, F-57070 Metz

Introduction: Various prospective scenarios of sustainable development (*e. g.* the 2008 French “Le Grenelle de l’Environnement”) include the promotion of marine and fluvial transport. The resulting increase of depth required in waterways and harbors will produce vast amounts of dredged sediments**.** Yet, the geochemical and ecotoxicological evolution over time of dredged sediments contaminated by heavy remains unsufficiently known. The work presented here focus on the geochemical and ecotoxicological evolution during and after the oxidation of a dredged sediment contaminated by trace elements, notably Zn.

Methods: The sediment was collected in the Scarpe canal (Nord-Pas-de-Calais region, France), manually homogenised and sieved at 6mm under nitrogen to prevent oxidation. The silty sediment contained Zn, Cd and Pb total concentrations of 3203, 115 and 353 mg/kg, respectively.

For the 133 days artificial evolution generated in the laboratory, the sediment was either maintained close to the water holding capacity (protocol 1, P1, control), or gently acidified (P2: 0.05 M H_2SO_4), or submitted to cycles of wetting with deionised water / drying (P3). Every week (including t0), sediment pH and CEC were determined, and sequential extractions [1] were conducted.

Ecotoxicological characterization of the sediment leachates was conducted with the bacterial Microtox® biotest, the *Pseudokirschneriella subcapitata* algae growth inhibition test, and the rotifer *Brachionus calyciflorus* reproduction test.

Results and discussion: The maximum decrease in pH, 1.2 unit (probably buffered by the dissolution of calcite) was observed for P2 and P3. The maximum decrease in CEC was 22 meq/100g (observed for P3). The maximum increase in sulfate and calcium concentrations in leachates were 1600 and 600 mg/L, respectively (Fig. 1). The highest increase in Zn water extractability resulted from P3. All these geochemical changes are coherent with the oxidation of the sediment and the dissolution of sulphides as being the key driving processes.

The greatest toxicity was observed with P3, the EC 20 decreasing to 5 mg sediment/L within 35 days of ageing, whereas the toxicity of the control was 60 mg sediment/L. The correlation between the inhibition of algae growth and the Zn^{2+} concentration in the soluble water fraction of sediment submitted to P3 was highly significant (p= 0.0006).

Conclusion: Based on physico-chemical and biological parameters, the ageing protocol using drying and wetting cycles in the laboratory appears a good simulation of the natural evolution of dredged sediment deposited on land.

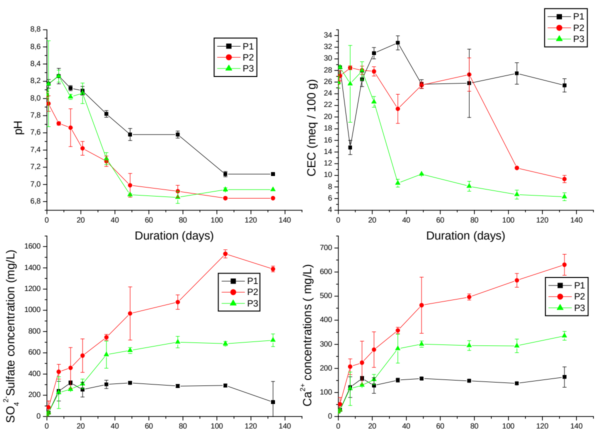

Fig. 1: Evolution over time of pH, CEC, Ca^{2+} and SO_4^{2-} according to the ageing protocol.

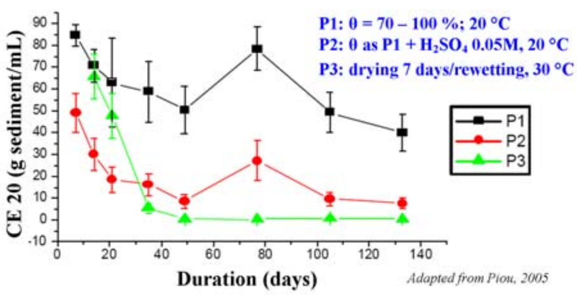

Fig. 2: Evolution over time of toxicity towards *Pseudokirschneriella subcapitata* of the sediment aged in the laboratory according to the 3 protocols.

References: [1] Gomez-Ariza *et al.*, *Anal. Chim. Acta* 2000; **414**, 1-2, 151 - 164.