Evaluation and recovery of heavy metal polluted coastal lagoon sediments: towards a sustainable remediation.

R. Pacifico, G. Armiento, C. Cremisini, C. Crovato, P. Massanisso, E. Nardi.

ENEA, National Agency for New Technologies, Energy and the Environment, Via Anguillarese, 301 - 00123 Roma (IT).

Phone: + 39-06 30486636
E-mail: renata.pacifico@casaccia.enea.it

Introduction: The "quality" of coastal lagoon sediments (Phlegraean lagoons - Naples, IT), with reference to their heavy metal (HM) pollution levels, has been investigated by an integrated approach with the aim to provide a useful tool for the evaluation of their disposal after dredging.

Applying sequential extraction procedures (SEP) to sediments it is possible to study the distribution of HMs among the different "geochemical phases" and to estimate their potential release as a consequence of a variation of the environmental conditions. Moreover, it is useful to consider also other methods for the estimation of potential metal mobility, taking into account the kinetic aspects of the metal-sediment association and release.

Finally, the information obtained about trace elements mobility are analysed in the perspective of the use of both "red mud" (by-product of alumina production) and "compost" for the dredged sediment remediation and disposal, studying if the utilization of a proper combination of the amendment(s) allows a successive step of phytostabilisation/remediation.

Methods: BCR SEP (Step A, exchangeable and weakly adsorbed fraction; step B, reducibile fraction; step C, oxidable fraction) was applied [1].

Kinetic studies, performed with EDTA, acetic acid and ammonium oxalate, and applying a non-linear equation (pseudo-first order reaction) with one or two components [$y = a(1-e^{-k_1t}) + b(1-e^{-k_2t})$] [2].

Barley plants response was evaluated using three different mixtures: 100% lagoon sediment (S1), 80% sediment plus 20% red mud (S2) and 70% sediment plus 25% compost and 5% red mud (S3).

Results: Considering the total concentration, the surface sediments of lagoon appear to be slightly "polluted", in the following order by As >> Pb > Cu > Zn. SEP results are showed in Fig. 1.
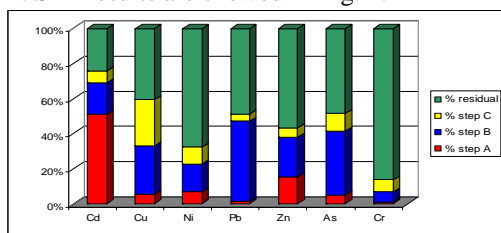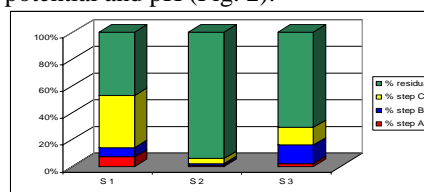

Fig. 1: Distribution of HMs among BCR fractions.

One component kinetic model confirms the data already obtained by application of BCR procedure. Among the used leaching reagents, EDTA appears the most suitable for this kinetic study, and it allows evaluating the available fractions including the labile (a) and the moderately labile fraction (b).

A combination of amendments was also studied with the aim to make possible a successive step of phytostabilisation/remediation.

The mobility assessment was focalized on As, for its quite high (even if "natural") concentration levels in the sediments and its sensitivity to the variation of redox potential and pH (Fig. 2).

Fig. 2: Distribution of As among BCR fractions in the three mixtures.

Discussion: Results of BCR SEP (**A**, **B**, **C** and **Res**) were compared with kinetic parameters obtained (**a**, **b**) for all the elements. The "simplified" correlations found are: "**a**= step **A** + part of step **B**" and "**b**= residual part of step **B** + part of step **C**". Both procedures confirm that the toxicological and environmental risk mainly depends on the eventual occurrence of redox variations, pH changing and organic matter decomposition.

The presence of the amendments modified the amount of As associated to the fractions A, B and C relocating it in the residual fraction. The adding of red mud (S2) produces also a significant improvement in the plant biomass, with an increase of 43% in the protein content after 30 days. The effect due to red mud is predominant with respect to the increase of organic carbon due to compost addition, causing the improvement in the "structure" of the sandy sediment, fundamental for the plant development. "Red mud" proved to be a valid scavenger of HMs and it appears to be a useful tool in the remediation of contaminated sediments.

References: [1] Rauret, G. (1998) *Talanta* 46:449-455; [2] Fangueiro, D. *et al*. (2005) *Talanta* 66:844-857.