TRACE METAL POLLUTION IN SEDIMENTS OF THE CATALAN COAST (NORTHWESTERN MEDITERRANEAN)

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Abstract
A survey along the Catalan coast was carried out in 2007 to assess trace metals in sediments with a homogenous sampling and analytical strategy. The nine prodeltaic systems and adjacent areas of this coast were studied as sinks of polluted sediments in the continental shelf. Results show that North part of the coast presents background levels or low isolated alterations. South part of the coast, including the Ebro, Besòs and Llobregat prodeltas, presents high enrichment factors for several elements. Cadmium, and specially Mercury, presents very high enrichment factors around the metropolitan areas of Barcelona and Tarragona.
Keywords: Trace Elements, Pollution, Ebro Delta, Sediments, Mercury

Introduction
The irregular regime of the small rivers discharging in the Catalan coast and also uncontrolled pollutant dumpings result in sporadic pollution. This produces anomalous trace metal contents in bottom sediments of active prodeltaic accumulation areas that are indicative of sedimentary systems affected by pollution.
Studies about trace metals in sediments of the Catalan coast have been carried out mainly in specifics areas, in different years and following different sampling strategies and analytical methods (Palanques et al. 1994). The present study provides homogeneity in sampling and analytical procedures in the study of trace metals in the sediments of the Catalan coast.

Material and methods
A total of 118 samples of surface sediment (first centimeter) were taken in the 9 prodeltas and adjacent areas of the Catalan coast (Figure 1). Transects of five stations perpendicular to the bathymetric isolines were established, taking surface sediment samples at 10, 20, 30, 40 and 50 meters depth.

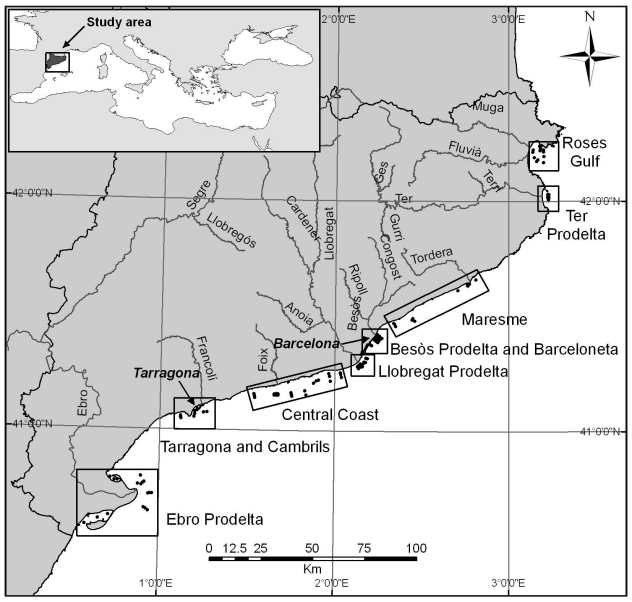

Fig. 1. Study area with samples in black dots grouped in zones.

Grain size of all samples was determined by a sedigraph (fine fraction) and a settling tube (coarse fraction) according to Giró et al. (1985). For geochemical analysis, a total digestion technique was carried out, according to Querol et al. (1996). Pb, Cr, Cu, Cd, Ni and Zn content was determined by ICP-MS, Fe and Al content by ICP-OES and Hg content by a specific mercury analyzer.
GIS analysis and representation of data were performed with ESRI ArcGIS 9.3.

Results and discussion
To obtain the enrichment factors (EF), samples were normalized by Al content. Results for every metal were compared to unpolluted samples of previous studies, including pre-industrial samples from sediment cores. Table 1 summarizes EF ranges for every area (Figure 1).
Samples from the northern of Barcelona metropolitan coastal area (Northern Maresme, Ter prodelta and Roses Gulf) presented natural or near natural EF, with some isolated pollution signals.
General high EF were present in the Barcelona metropolitan coastal area (Southern Maresme, Besòs and Llobregat prodeltas and Northern Central Coast), an area heavily populated and industrialized (4.9 million inhab.). In general, maximum EF were founded in Besòs prodelta, up to 38 for Hg (up to 2.5 µg/g), up to 10 for Cd (1.4 µg/g), up to 6.4 for Cu (up to 137 µg/g), up to 7 for Pb (173 µg/g), up to 4.9 for Cr (251 µg/g) and up to 5.7 for Zn (450 µg/g). In this area, pollution is associated to sewers and the Besòs and Llobregat rivers. Tarragona area, which hosts petrochemical industry facilities, showed the highest EF for Hg in the Catalan Coast (EF 126, 4.6 µg/g). Hg pollution is associated to the several sewers in the area. Rest of metals showed natural levels (Ni and Pb) or EF below 3 (Cd, Cr and Zn).
The Ebro prodelta, the larger system, showed significant EF only near the river mouth (Hg up to 8) and in its Bays (Cd up to 3), probably due to retention of polluted sediment in the numerous dams throughout its basin and also to the higher dilution of polluted particles in a river with high water discharge.

Tab. 1. Enrichment factor (EF) ranges for every area (Natural EF=1).

Area	Hg	Cd	Ni	Cu	Pb	Cr	Zn
Roses	0.6-1.6	0.8-1.6	0.0-1.0	0.6-1.8	0.6-1.3	0.8-1.7	0.8-1.6
Ter	0.5-25.7	1.1-2.1	0.8-1.0	0.8-1.2	0.7-1.7	0.9-1.1	1.2-1.5
Maresme	0.3-8.39	0.2-1.1	0.0-0.5	0.1-1.2	1.3-2.9	0.0-1.0	0.2-1.7
Besòs	4.8-37.6	2.1-10.0	0.6-1.1	2.0-6.4	1.2-7.1	1.5-4.9	2.1-5.7
Llobregat	2.0-8.7	1.8-3.8	0.9-1.2	1.6-2.8	0.6-1.5	1.4-2.0	1.5-2.4
Central Coast	0.4-14.3	0.2-3.6	0.5-1.2	0.4-3.4	0.9-2.0	0.4-2.8	0.4-2.8
Tarragona	4.3-126.3	1.0-2.5	0.5-1.2	0.7-2.3	0.8-1.1	0.6-1.4	0.8-2.0
Ebro	0.8-8.1	1.1-2.9	0.9-1.2	0.5-1.4	0.4-0.9	0.9-1.4	0.6-1.4

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