

ASSESSMENT OF HISTORICAL TRACE METALS CONTAMINATION ALONG A RIVER-ESTUARINE-COASTAL GRADIENT IN SEDIMENT CORES FROM THE GARONNE-GIRONDE SYSTEM (FRANCE)

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Introduction

The Garonne-Gironde Estuarine System is one of the largest European estuaries. Since the late 19th century, erosion of smelting wastes of a former Zn ore smelting factory and mining activities located about 200 km upstream contributed to trace metal contamination (Zn, Cd, Pb, Hg) of the river/estuarine system (e.g. Audry et al., 2004; Larrosse et al., 2010; Schäfer, et al., 2002). Furthermore, agricultural (e.g. Cu used in vineyards) and urban sources (e.g. Ag due to Bordeaux urban area) have impacted sediment quality. Understanding how historic contamination has been preserved along the river/estuary gradient allows predicting long-term effects caused by old contaminant mobilization. However, to quantify the anthropogenic contribution of trace metals in sediment cores, concentrations need to be compared with a regional geochemical background, representing the non-contaminated concentrations (Reimann and Garret, 2005). In this study two sediment cores collected in the central estuary were analyzed for trace metal concentrations and ²¹⁰Pb and ¹³⁷Cs geochronology with the aims of 1) Finding a regional geochemical background for the Garonne-Gironde System; 2) Assessing the historical contamination at the studied site; 3) Quantifying the spatial depositional variability of trace metal contamination along the river-estuarine gradient.

Methods

Two sediment cores (GirHistoII and III; 450 cm long) were collected in the central Gironde Estuary (Macau Inlet). Along the two cores ²¹⁰Pb and ¹³⁷Cs radionuclides were determined. Sediments were analyzed for grain size, total organic carbon (TOC), total trace metals (Cd, Zn, Pb, Cu, Ag, Th, Hg). Enrichment Factors (EF) and geoaccumulation index (Igeo) were used to assess metal contamination. Additionally, metal spatial distribution along the river-estuarine-coastal (REC) gradient was investigated,

by comparison with published trace metal records obtained in the Garonne-Gironde system (e.g. Audry et al. 2004; Grousset et al., 1999; Larrose et al., 2010).

Results

Activities of ²¹⁰Pb and ¹³⁷Cs showed sediments below 300 cm were deposited at least before ~ 1900 and sediments below 390 cm were assumed as pre-industrial regional geochemical background levels (RGB) for the Garonne-Gironde System (Zn/Th=11.9; Cd/Th=0.02; Cu/Th=2.07 Pb/Th=3.39; Ag/Th=0.04; Hg/Th=0.005). Similar marked increasing metal trends towards the surface sediments were correlated with historical contamination in the area. Compared with RGB levels, Cd and Hg were identified as the elements of highest enrichment (EF up to 20 and 6 respectively), followed by Zn (EF up to 5), Pb (EF up to 4), and Cu and Ag (EF up to 2). Based on the Igeo sediments were classified as strongly polluted in Hg, moderately to extremely polluted in Cd and unpolluted to moderately polluted in Pb, Zn, Cu and Ag. Along the REC gradient, metals enrichment decreased from the upstream highly contaminated fluvial site (Cajarc; e.g. EF Zn=40; EF Cd=500) to the poorly polluted coastal site (West Gironde Mud Patch; EF Zn and Cd=1.5), suggesting a consistent metal dilution and/or significant biogeochemical processes in the physico-chemical gradient.

Conclusion

This work has shown that historically contaminated sediments can be preserved also in estuaries with strong tidal flow. In the Gironde Estuary sediment cores have recorded the increase in trace metal contamination since the beginning of the century and a geochemical background representative of the mid estuary concentrations was calculated. In such estuarine environment characterized by complex hydrodynamics, highly contaminated sediments can be remobilized resulting in the contamination of the aquatic system. Data from this work can be used to help in the evaluation of the effects of past human activities along the Garonne-Gironde System for the development of management strategies for present contamination reduction in the upstream sediments.

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