Universidad de Huelva

CIMA Centro de Investigação Marinha e Ambiental Universidade do Algarve

Registro sedimentario de la ocupación antrópica en la parte baja de la Cuenca del Guadiana

SEDIMENTARY RECORD OF THE ANTROPIC OCUPPATION ON THE LOW GUADIANA RIVER BASIN

T. Boski, J.M. Nieto, and J. Delgado **GUADHOL / MEGASIGIDT**

Introduction and objetives

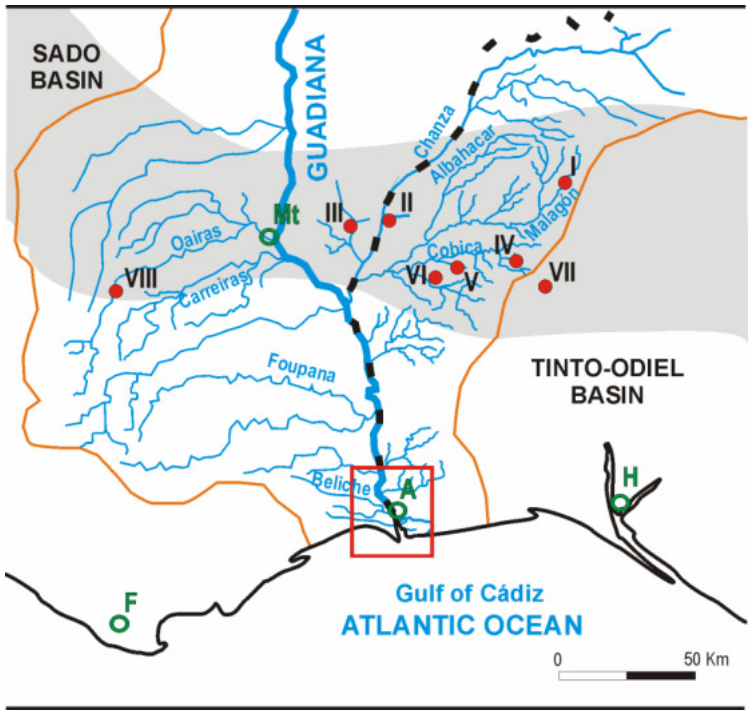
- Guadiana Estuary is a prominent geomorphologic feature in the Gulf of Cadiz and rather unique in terms of the thickness of its infill accumulated in postglacial period. The analysis of sedimentological changes and the geochemical characteristics of that infill have brought a valuable information from the paleoenvironmental point of view, using the trace metals as indicators of the anthropogenic impact.

- The Low Guadiana River drains the western part of the Iberian Pyrite Belt (IPB), one of the most important metallogenetic sulphide provinces of the world (Fig.1), where the exploitation of sulphide deposits dates back to the Third Millennium B.C. Associated with these exploitations, highly polluted acidic leachates with high concentrations of metals, metalloids and sulphates (AMD) are been originated. These leachates are responsible of the pollution and water quality degradation of part of the river basin and, consequently, of the estuarine marshes.

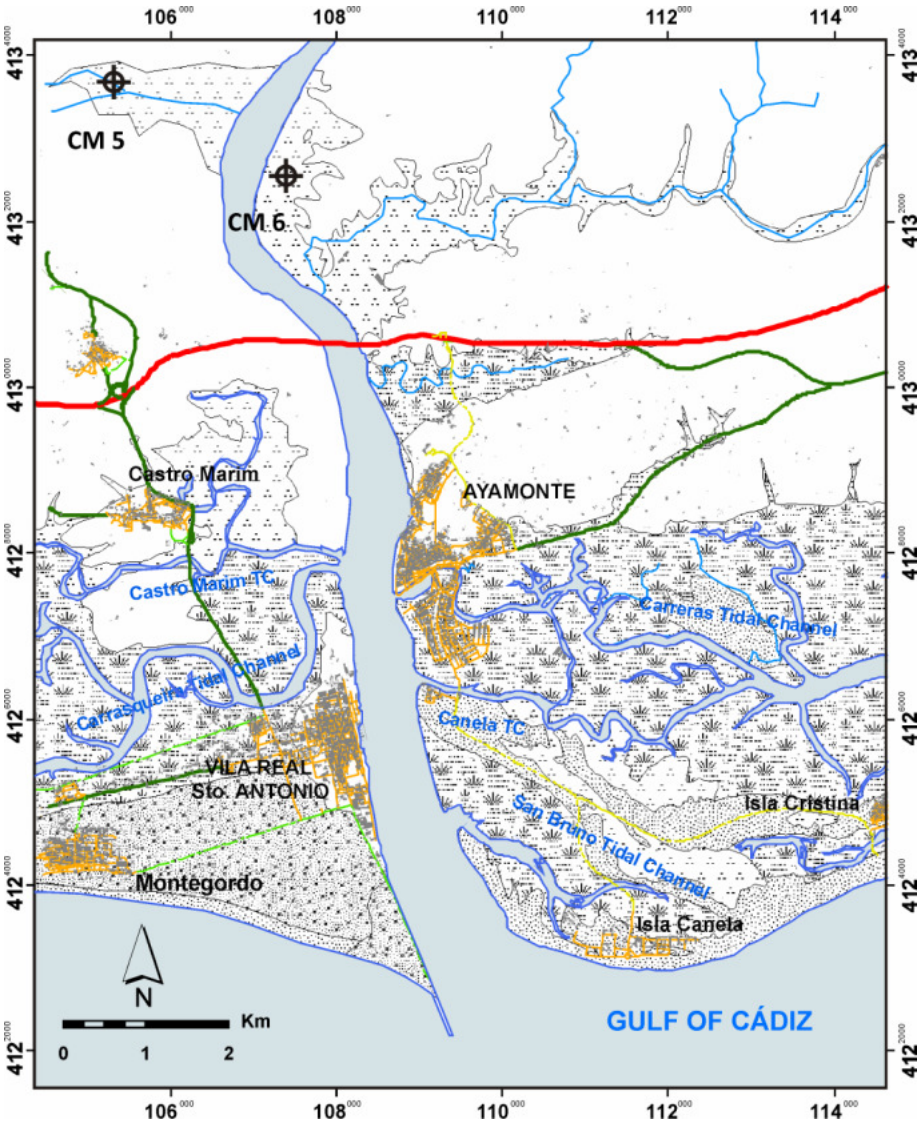
The aims of this work are:

a) Obtained the **regional background** of the Holocene sedimentary infilling to use the trace metal as indicators of the anthropogenic impact.

b) Evaluate the **environmental quality** of the most recent sediments.



Methods



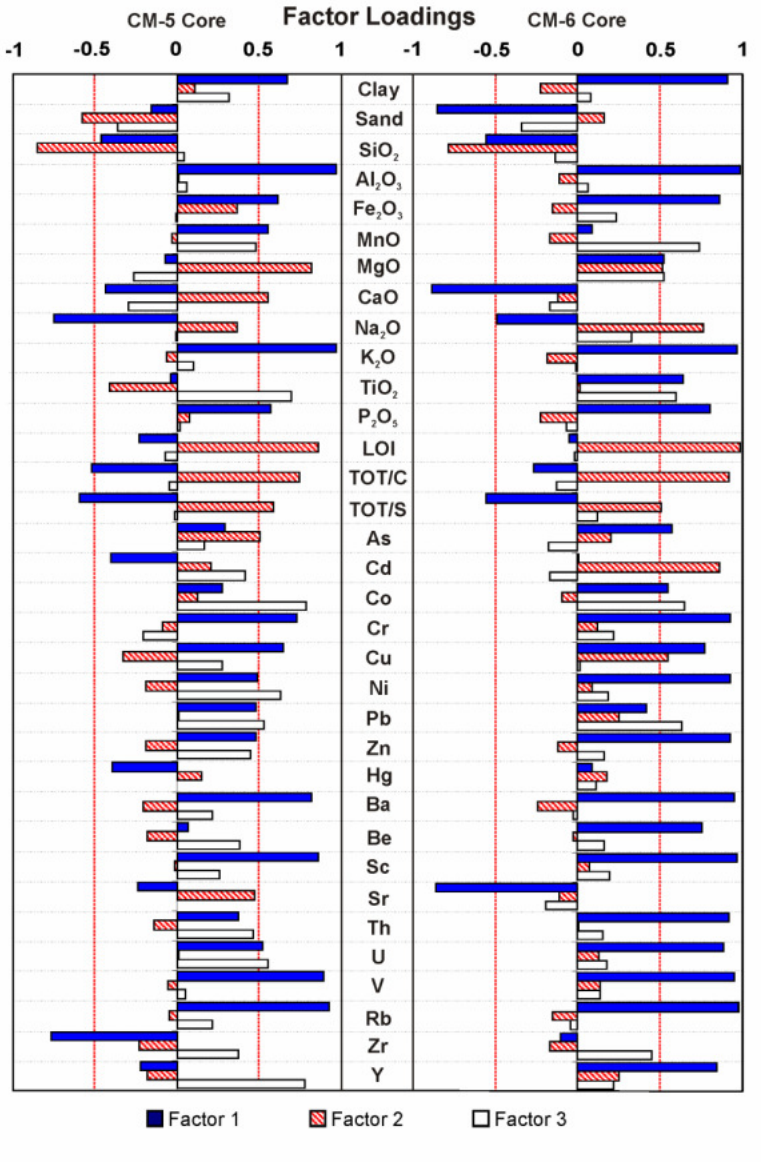
- Two deep sediment cores CM-5 (51m deep) and CM-6 (63m deep), were recovered in the floodplain of the estuary.
- the ***sampling frequency*** (Based on a chronostratigraphic model established by Boski et al. (2008)):

  first 6m, samples were collected every 20cm.

  from 6-12m, the samples were taken every 50cm.

  below 12m, samples were collected every 2m.
- The samples were dried at temperature below 40ºC and subject to **analyses** of **foraminefera fauna, granulometric and chemical composition**.
- The major and trace elements were analyzed by ICP-AES/MS in the Acme Analytical Laboratories Ltd (Vancouver, Canada).

Results and discussion



- **Factorial analysis (FA)** of the principal components was applied to determine the sources of metals.

Factor I is characterized by high positive loadings (> 0.5) of major and trace elements to **clay %.**

Factor II shows a clear association with elements of **biogenic origin** such as LOI, TC, Ca, and Sr in addition to carbonate minerals (Ca, Mg, Na, and Fe) which can incorporate metal such as As, Cd, and Cu.

Factor III shows high positive loadings between **Mn – Ti, Cd, Co, Ni, Pb, Cu and Zn**.

- **Factor Scores** show the vertical (temporal) distribution of principal components.

Factor I profile presents a strong similarity with clay content indicate that represents mainly material coming from **soil and mother rock erosion**.

Factor II profile reflect clearly the increse of **bioclastic** content in the vertical and **carbonates minerals** .

Factor III reflects elements strongly associated with **human activity** in recent times.

Results and discussion

- The M/Al ratio (normalised metal with respect to Al) may be a parameter revealing valuable data on natural changes or influenced by human activity which have left evidence in the Holocene record.

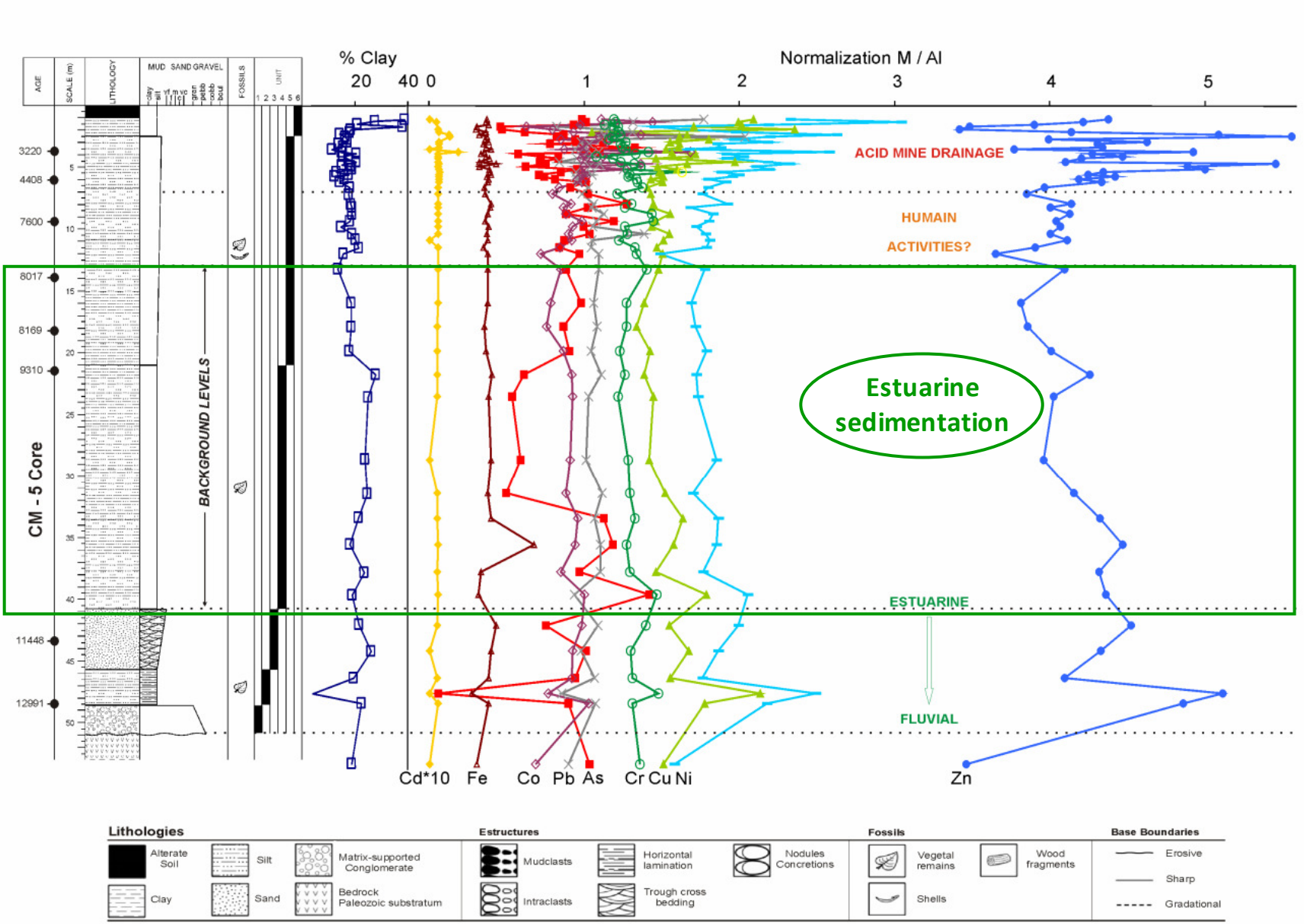
- The study of variations with depth of the M/Al ratio and of the lithological characteristics of the continuous Holocene sedimentation record (ca. 13000 years) have allowed discriminate three sedimentary environment:

  - Units I, II, and III in both cores (upwards of 41m depth for CM-5 and 47.5m for CM-6) correspond to the initial stage of the Holocene in the Iberian Peninsula (ca. 11000 years cal. BP) → **marine-fluvial transition stage.**

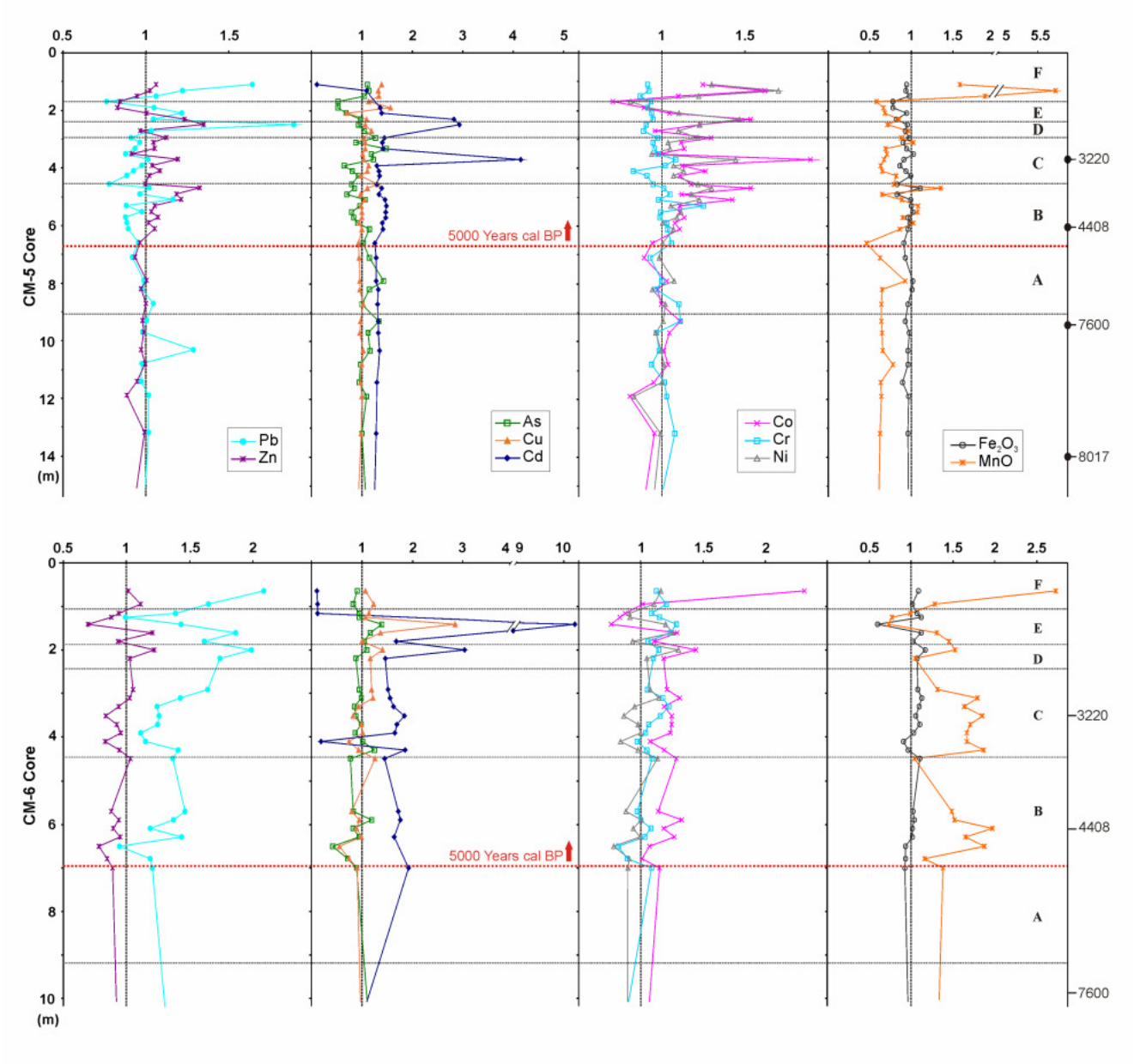
  - Units IV and V (12-41m in core CM-5 and 13-47.5m in core CM-6) have proved to be associated with a clearly estuarine, quite homogeneous, sedimentation unaffected by human activities. Selected to estimate the **background or natural metal concentrations**.

  - Upwards of 12m depth in both cores, corresponding to ca. 7800 cal. BP, a wide variation associated with **anthropic activity in the Guadiana basin** in element concentrations is observed.

Results and discussion



Results and discussion



In order to analyse the impact of human activities in the last 5000 years, the **metal enrichment factor** (EF) was determined:

EF = ([M] / [N]) sample / ([M] / [N]) background

Where: [M] sample = metal concentration for the studied sample, [M] background = regional Background, [N] sample = concentration of the normalising element for each sample, and [N] background = value of the normalising element in the background.

Anthropic activities have been recorded in the sediments of the Guadiana Estuary starting around 5000 years ago (**since the Copper Age**).

Mining activities developed and became particularly intensive between the late Bronze Age and the Roman period (3000-1500 cal. yr. BP.), with the highest recorded enrichments being: EFPb ≈ 2, EFCd > 10, EFCr ≈ 2, EFCu ≈ 3, and EFZn = 1.4.

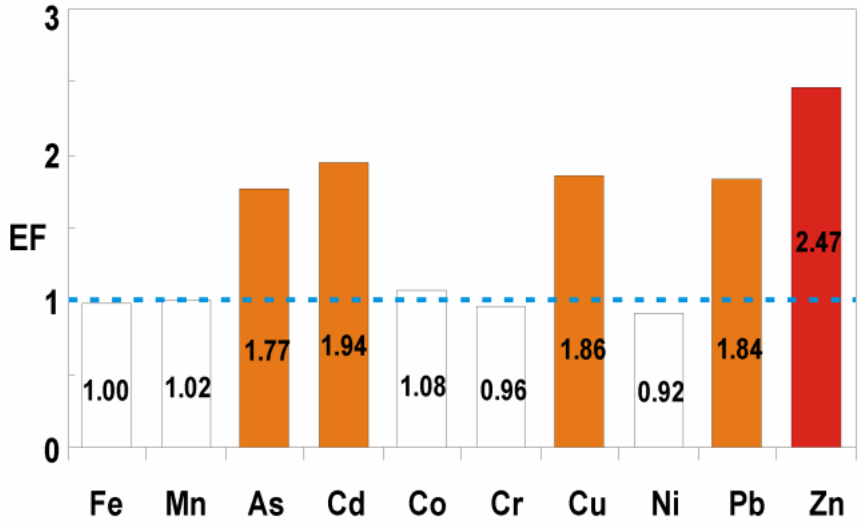
Results and discussion

Environmental quality of the Estuary

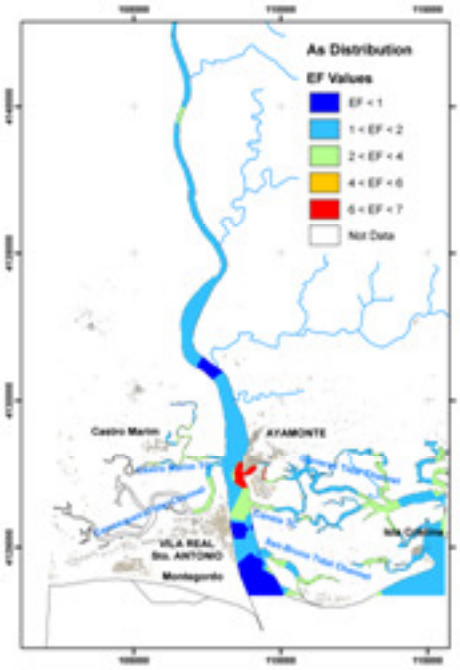
- The background established has allowed to estimate the **environmental quality** of the estuary by mean of the calculated EF (189 surficial samples).

  EF distribution maps were generated by krigeage geostatistical method using ArcGis software, to identify sites of environmental vulnerability in the Guadiana river estuary.

  – The distribution of the EF for the elements within the estuary suggests the existence of a **diffuse historical mining pollution (Cu, Pb, Zn)** associated with the AMD forming processes in the Guadiana watershed.



  – Other **local sources** of metallic pollution have been found near the villages of Ayamonte (Spain) and Villa Real de Sto. Antonio (Portugal) showing high EF values for **As, Cd, Zn**.


As Distribution
EF Values
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2 < EF < 4
4 < EF < 6
6 < EF < 7
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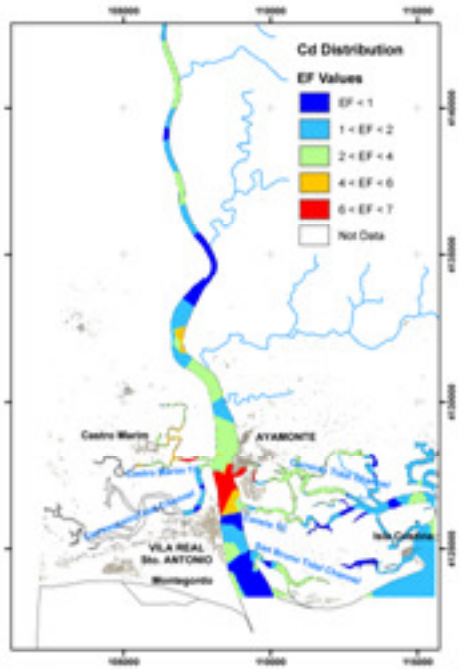
Cd Distribution
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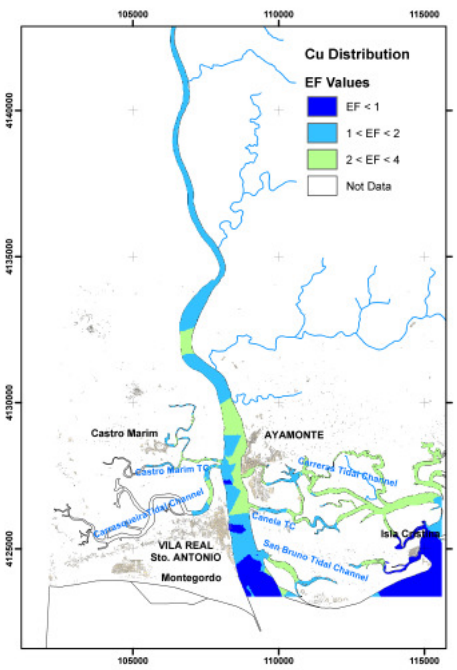
Cu Distribution
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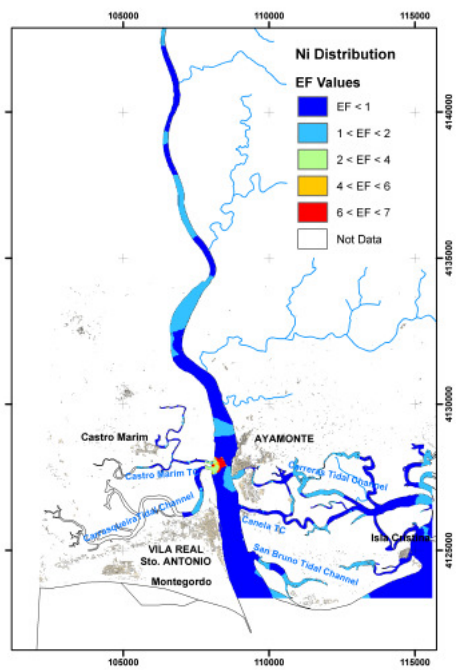
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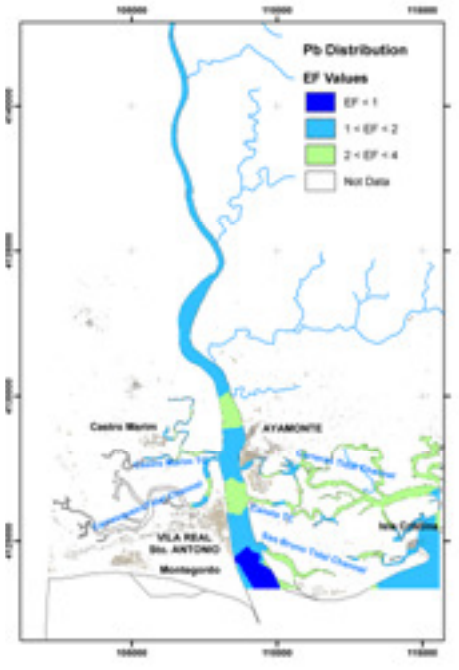
Pb Distribution
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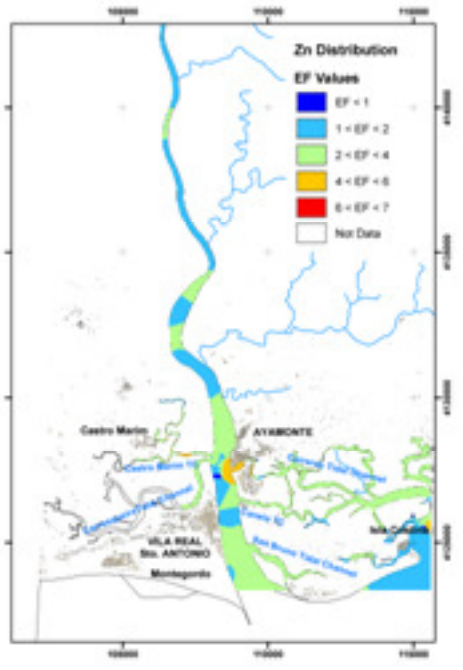
Zn Distribution
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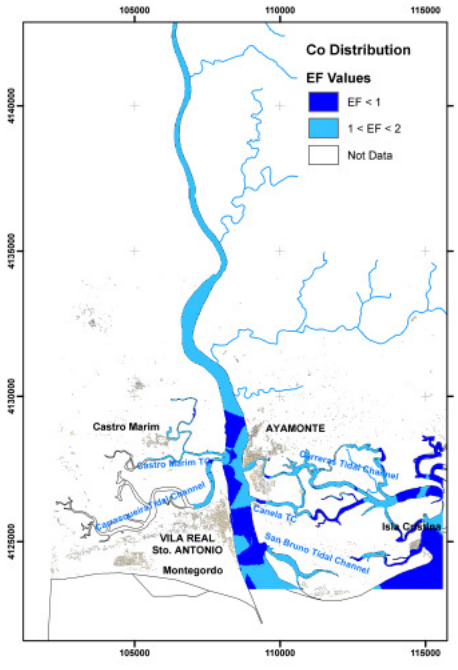
Co Distribution
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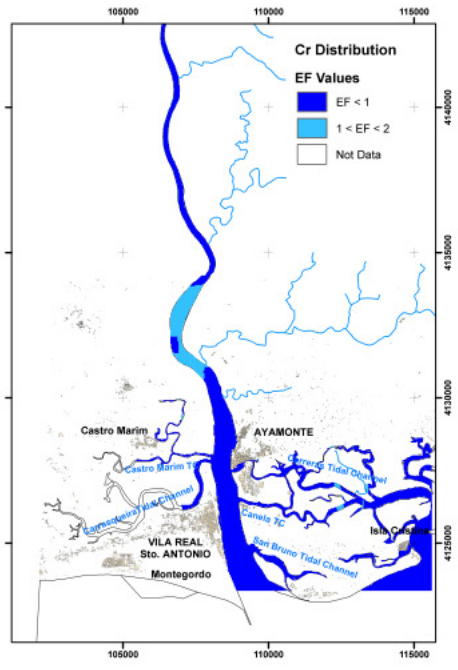
Cr Distribution
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The present…

- Diffusion of the results

Delgado, J; Nieto, J.M; Boski, T. **Analysis Of The Spatial Variation Of Heavy Metals In The Guadiana Estuary Sediments (SW Iberian Peninsula) Based On GIS-Mapping Techniques.** (2010). Estuarine, Coastal and Shelf Science, 88: DOI: Pág. 71-83. 10.1016/j.ecss.2010.03.011.

Delgado, J; Nieto, J.M; Boski, T & Moura, D.. **Geochemical paleo-markers to discriminate between changes induced by natural causes and antropic activities in the Holocene: a case of study, the Guadiana estuary (SW iberian pyrite belt).** Quaternary science reviews (Submitted).

The future…

- RISE II??

The future research work proposed by the collaboration group are:

SEP (sequential extraction procedure) → to study the metal fractionation in the core and superficial sediments to distinguish the bioavailability of the elements that can involve a environmental risk to the ecosystem.

Pb Isotopes analyses → to distinguish the source of metal content in the surficial and core sediments

THANKS FOR YOUR ATTENTION!