



# A SEQUENTIAL METHOD APPROACH FOR SEDIMENT QUALITY ASSESSMENT

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## **BACKGROUND**

- **Almost lack of geochemical information of marine sediments along the Portuguese shelf;**
- **Contaminated materials have been documented in Portuguese estuaries**  
(Vale, 1990; Dinis, 1996; Araújo et al., 1998; Soares et al., 1999; Mucha et al., 2003; Mucha et al., 2004; among others);
- **Considering contaminant transfer from estuaries to the shelf;**
- **An evaluation of the Portuguese shelf sediment quality is needed to understand the fate of contaminants;**
- **The contaminant loading is often associated with fine-grained components;**
- **Portuguese shelf is largely characterized by high-energy environments and sandy deposits;**
- **Some areas have accumulation of relatively fine-grained sediments.**

# MAIN OBJECTIVES

- ❖ Evaluation of sediments' quality in 3 Portuguese shelf areas, located in the vicinities of four river mouths (Ave-Douro, Lis and Mira);
- ❖ Methodological sequential approach for assessment of heavy metals based on five commonly used evaluation procedures:
  - ◆ Comparison with geochemical thresholds (e.g. NOAA SQG, Portuguese evaluation guidelines for dredged materials – PEC);
  - ◆ Gradient Method (GM);
  - ◆ Normalization using a grain-size proxy;
  - ◆ Regional Geochemical Baseline (RGB);
  - ◆ Enrichment Factors (EF).

# MATERIALS

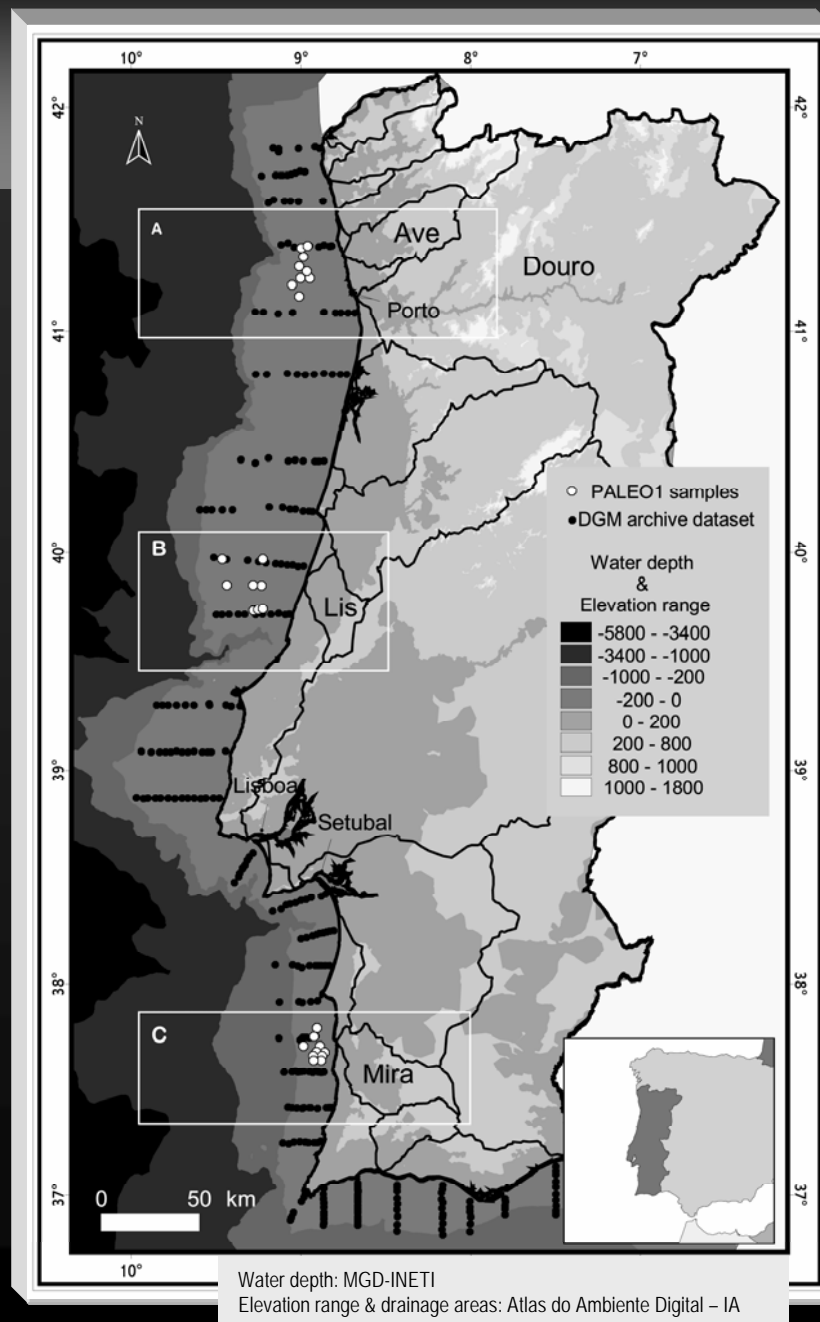
❖ MGD archive dataset (1970's & 1980's)

❖ 267 surface samples (black dots)

❖ PALEO1 samples (2002)

❖ 29 surface samples (white rings)

Major & trace elements, organic carbon, carbonate & grain-size contents were measured



# NORMALIZATION OF GEOCHEMICAL DATA

Different oceanographic & inland characteristics



Distinct sediment compositions

Comparison of total metal contents between areas not allows evaluate the existence of contamination

variability of sediment geochemistry

interaction of elements with



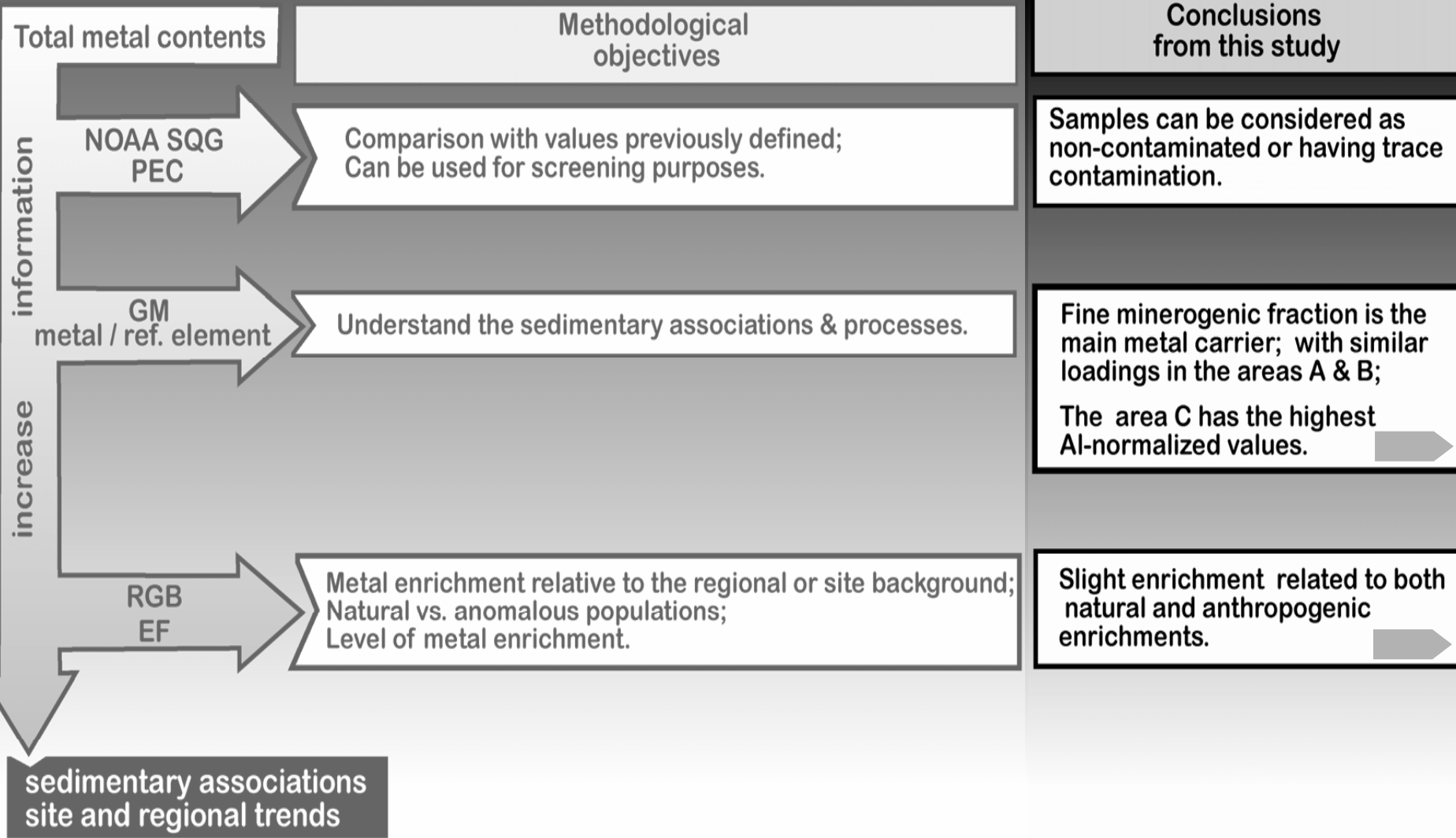
organic carbon  
grain size  
mineralogy

Compensate for sedimentary variability

Geochemical procedures  
(interpretative tools)

- ◆ Gradient Method (GM);
- ◆ Normalization using a grain-size proxy (Al);
- ◆ Regional Geochemical Baseline (RGB);
- ◆ Enrichment Factors (EF).

# SEQUENTIAL METHODOLOGY & EXEMPLIFIED CONCLUSIONS



# CONCLUSIONS

- ◆ Sediment metal composition largely have a natural origin;
  - ◆ There is little evidence of human impact on the studied sediments;
  - ◆ Slight metal enrichments reflect both a natural and an anthropogenic origin;
  - ◆ The weak anthropogenic signal can be explained by an effective trapping in the estuaries, or by mixing processes on the shelf (waves, coastal currents, downwelling and upwelling) and dilution by biogenic coarse materials.
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- ◆ Natural variability should be considered in the evaluation of sediment quality;
  - ◆ Combination of different methods strength the quality of results obtained individually;
  - ◆ The integration of the results can be justified by reduction of costs associated with a coherent selection of samples for detailed analyses (e.g. sequential extractions, toxicity tests).

## **Aknowledgments:**

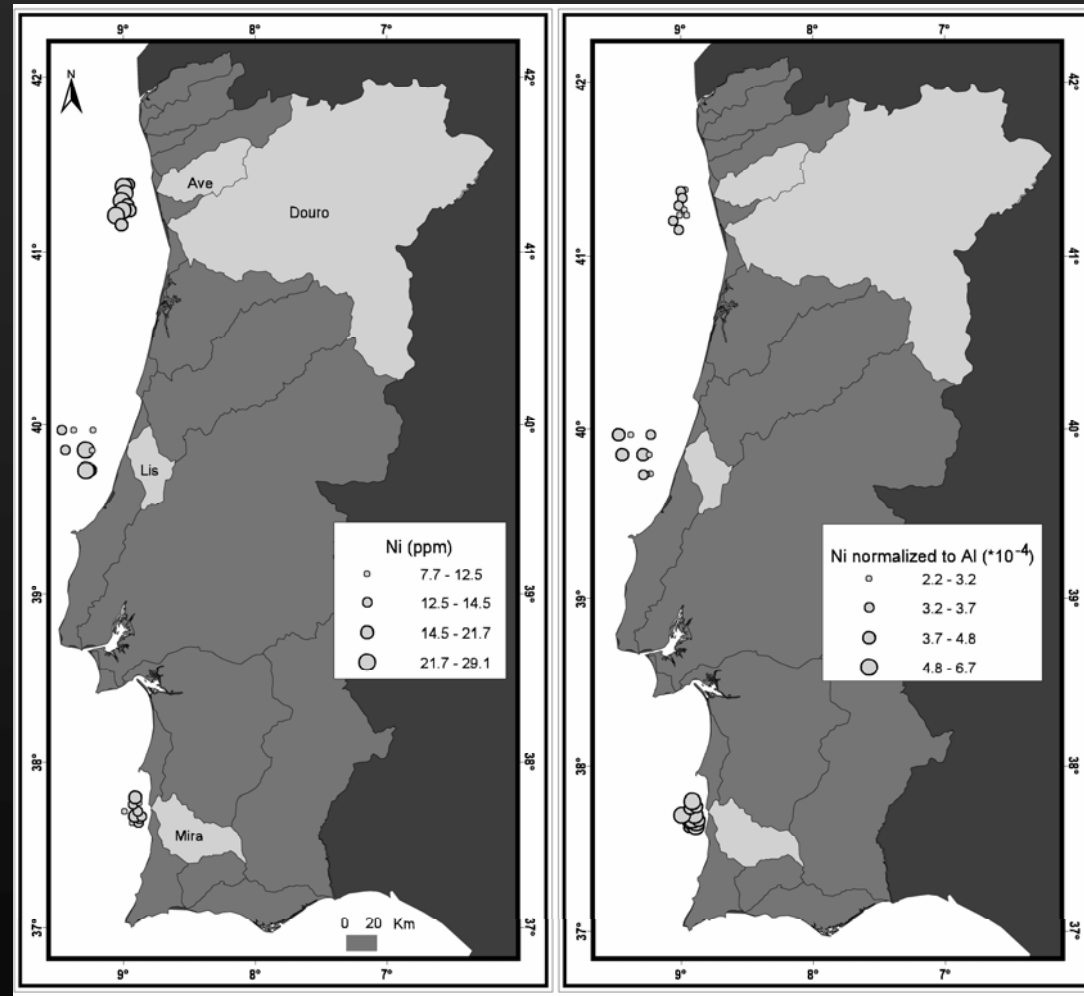
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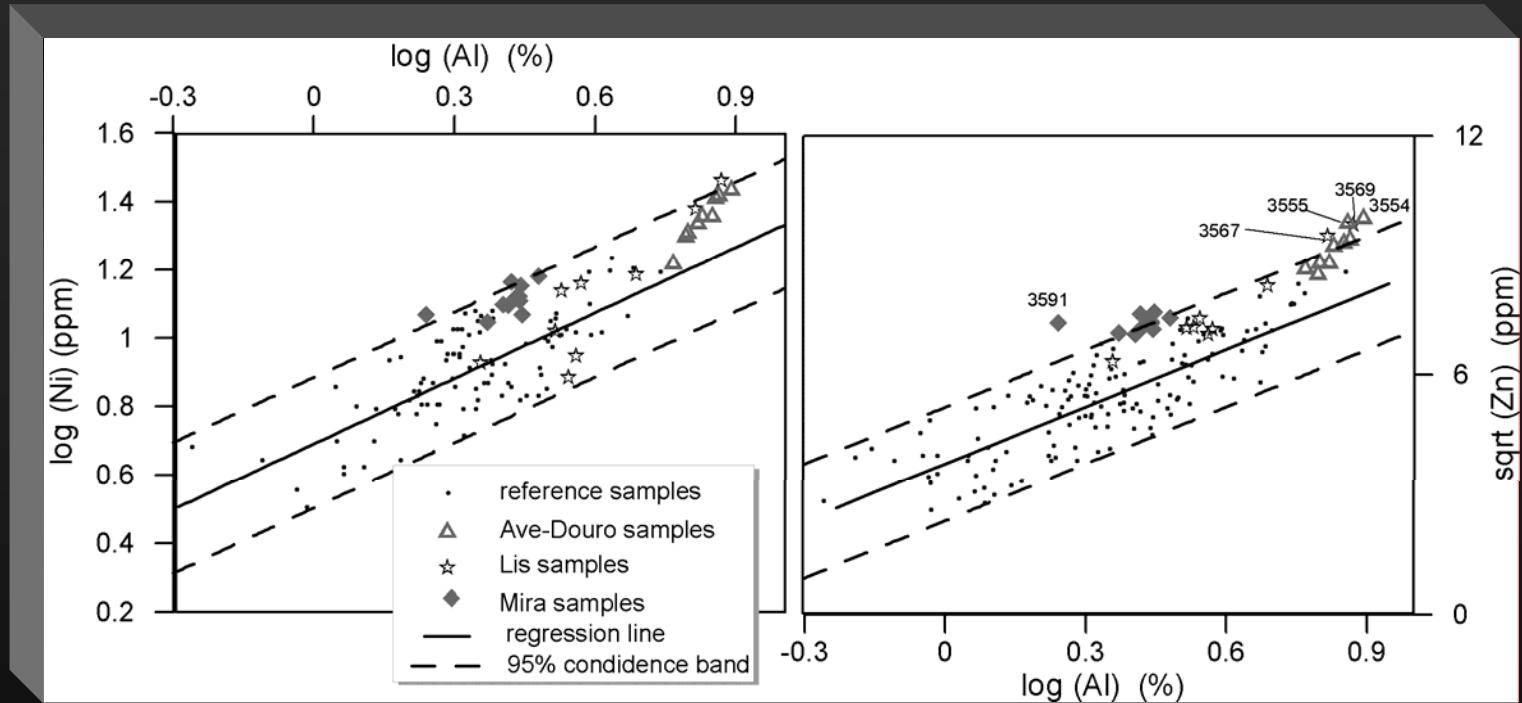


# NORMALIZATION USING A GRAIN-SIZE PROXY

- Assuming that the Al normalization accounts for grain-size variation, the high non-normalized metal values are interpreted to be largely related to the fine fraction;
- The relatively high Al-normalized values in the area C are probably associated with the drainage of the IPB mineralized formations. The fine fraction itself may have a higher metal concentration in this area.



# ESTIMATION OF A REGIONAL GEOCHEMICAL BASELINES (RGB)

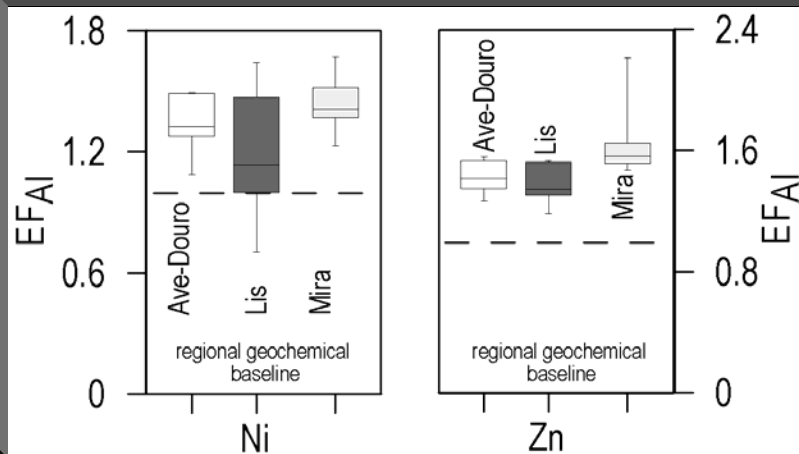


# ENRICHMENT FACTORS (EF)

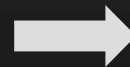
EF was obtained by comparison with background values:



Regional Geochemical Baselines

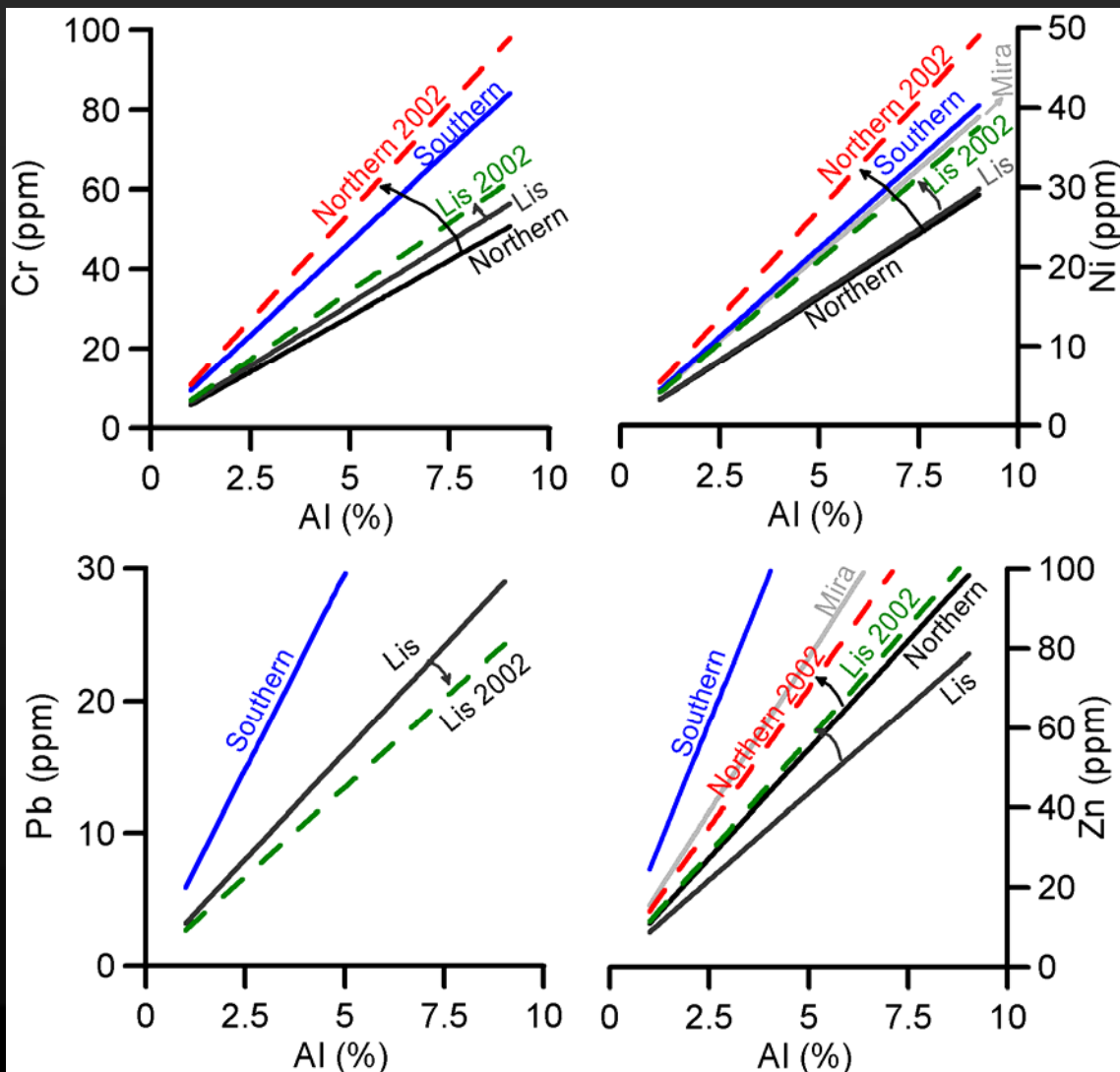


$EF \approx 1$

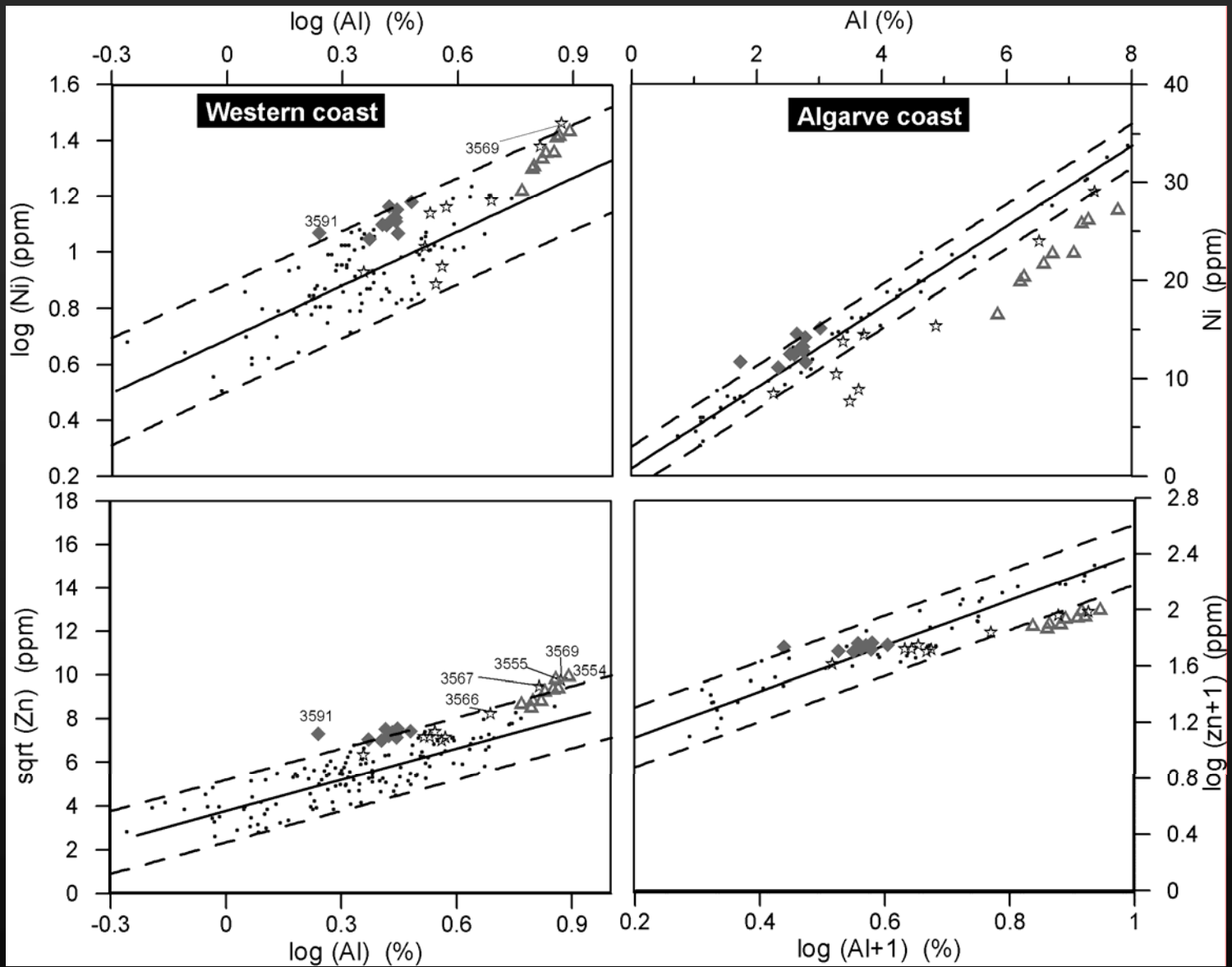


EF slightly greater than 1 suggesting some metal enrichment relative to the RGB

# GRADIENT METHOD

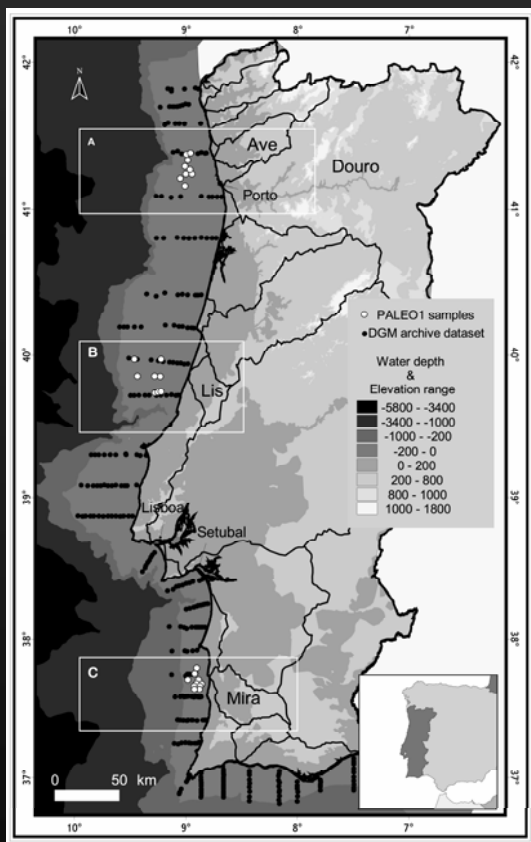


- Southern and Mira areas have the steepest metal gradients possibly indicate the drainage of mineralized areas of the Iberian Pyrite Belt
- Cr, Ni and Zn have an increased gradient in PALEO1 samples from the Ave-Douro (Northern2002) and Lis (Lis2002) areas;
- may reflect the anthropogenic inputs from the diverse industries of both drainage areas
- Pb has lower loadings relative to Al in the recent samples from the Lis area;
- can be attributed to the drop of lead emissions associated with the burn of unleaded fuel

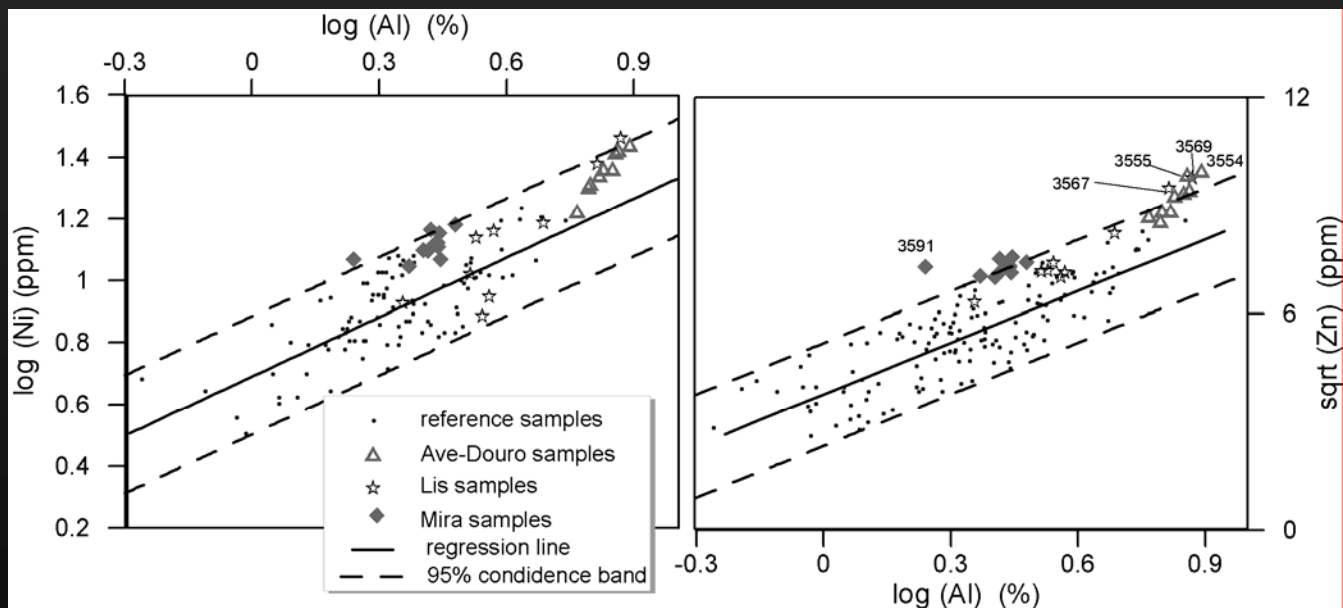


Importance of the sediment natural variability in the definition of the regional geochemical baseline

# ESTIMATION OF A REGIONAL GEOCHEMICAL BASELINES (RGB)



- ✱ 200 surface samples from the DGM archive dataset (western coast);
- ✱ facilitate the distinction between natural and anthropogenically induced variability of metal contents.



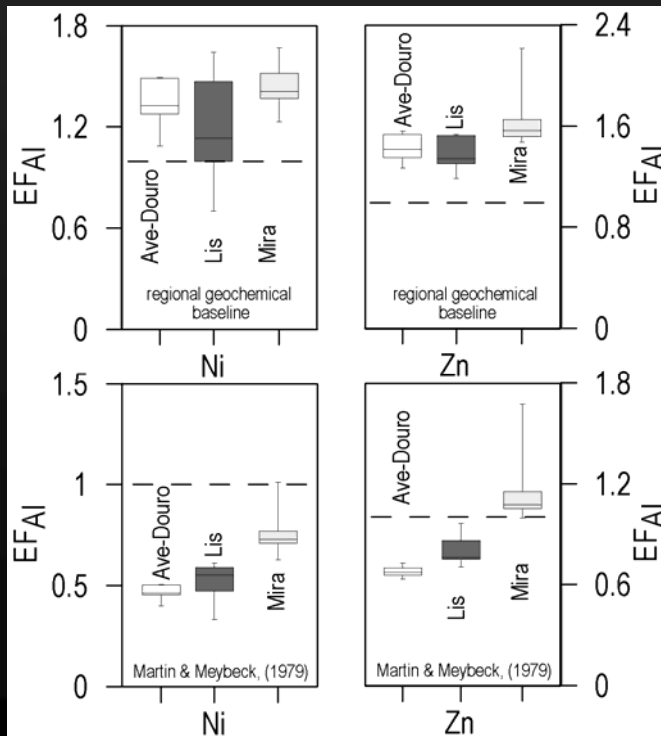
- High Ni and Zn contents from the Ave-Douro and Lis areas are very close to the upper limit of the confidence band indicate a slight anthropogenic or natural enrichment relative to Al variations;
- Enriched values in the Mira area reflect material derived from the Iberian Pyrite Belt.

# ENRICHMENT FACTORS (EF)

EF was obtained by comparison with background values:

global average composition (Martin & Meybeck, 1979)

RGB



- Same relative EF trends
- a more specific evaluation of contamination levels should be possible with a selection of an appropriate baseline
- RGB accounts with regional variability

$EF \approx 1$

largely natural origin