# TEMPORAL CHANGES OF METAL CONTAMINATION OF MARINE SEDIMENTS DUE TO AN INDUSTRIAL PLANT

**Elena Romano, L. Bergamin, M. Celia Magno, F. Venti and A. Ausili**

***ISPRA. Institute for Environmental Protection and Research, Rome, Italy*** *elena.romano@isprambiente.it*

**Keywords:** Marine sediments; Steel plant; Metals and trace elements; Enrichment Factor

## Introduction

For almost one century an important steel plant was active in the industrial area facing on the coastal marine area of the Bagnoli Gulf (Naples, Italy). An extensive environmental characterization was carried out and the results showed a contamination mainly due to Polycyclic Aromatic Hydrocarbons (PAHs) and metals, such as Pb, Zn, Cd, Cu and Hg, closely correlated to the steel activity, up to 2 meters in depth, only close to the piers of the plant (Fig. 1). Aim of this work is to investigate the temporal changes of heavy metal contamination in the marine coastal area, through the study of sediment cores, taking into account the reference condition recovered in the uncontaminated levels.

## Methods

Three sediment cores (BA39, BA78, BA95) were collected by means of vibrocorer in March 2005 in the marine area facing the industrial plant of Bagnoli, in the Bay of Nisida at south and in the northern area, not influenced by industrial activity, respectively. The total sediment recovery was of 494 cm, 416 cm, and 370 cm, respectively. Each core was subsampled using 2 cm thick levels for a total of 142 levels. Sediment samples were used for grain size (Romano et al., 2004) and chemical analyses. Metals and trace elements (Al, As, Be, Cd, Co, Fe, Mn, Ni, Pb, Sn, V, and Zn) were analyzed according to EPA 3052, using an AAS and ICP-AES; for Hg analysis a Direct Mercury Analyzer (DMA-80, FKV) instrument was used, according to EPA 7473. The results were analyzed by statistical approach.

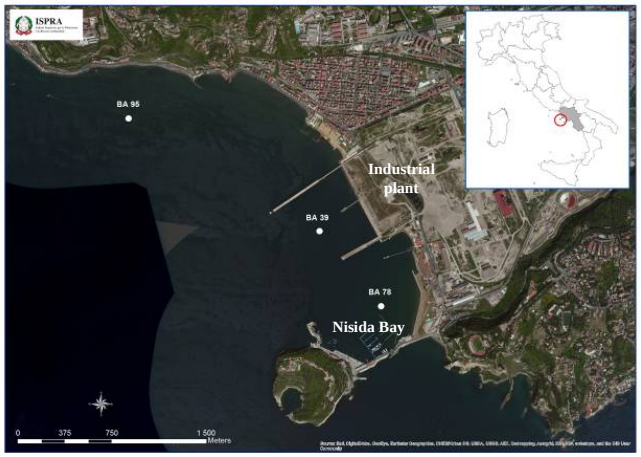



**Figure 1.** Study area and sampling stations.

## Results

The analytical results showed a prevalence of sandy sediments in all the cores, with an increase of pelitic fraction in the bottom, superficial and middle core levels in BA95, BA39 and BA78 respectively. In the cores BA39 and BA78, the chemical results highlight higher values of several elements, like as Cd, Cu,

Hg, Ni, Pb and Zn, in the upper 60 cm of the cores. Instead, the core BA95, located in the northern sector of the study area, shows lower values of the analyzed parameters.

The Principal Component Analysis (PCA) demonstrated that all metals and trace elements, except Al, are correlated among themselves and associated to the upper levels (0-59 cm) of core BA39 (Fig. 2).

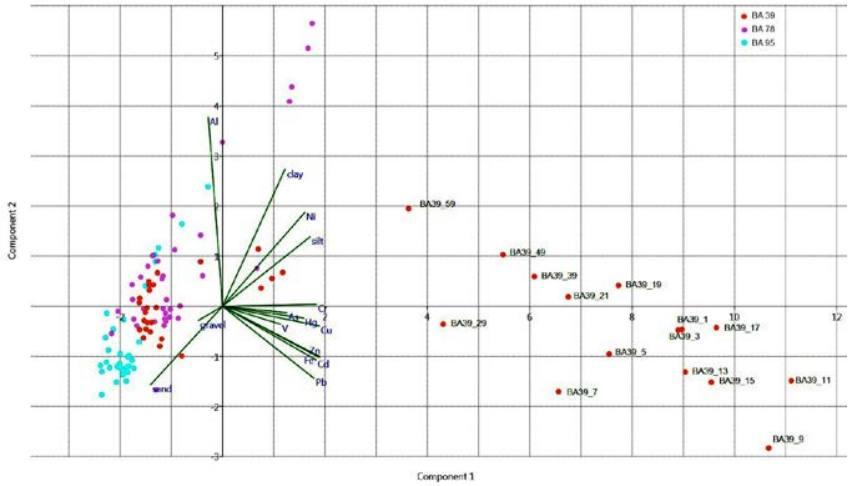
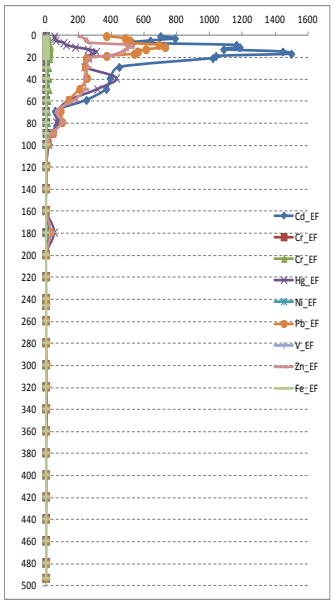



**Figure 2.** PCA on analytical data. PC1 and PC2 account for 62%, and 10% of variance, respectively.

The Enrichment Factor (EF) of metals and trace elements was determined according to Tanner et al. (2000) while mean crustal concentrations were considered as background values (Turekian and Wedepohl, 1961). Considerable EFs were determined, mainly in core BA39, for Hg, Zn, Pb and Cd. The significant enrichments started at -59 cm for all of them, but with the highest values at different depths: Hg has the highest value at -39 cm, Cd at -17 cm, Pb at -11 cm and Zn at -9 cm. Above this level a general decrease of EFs is observed, although they are still high in the top level.




## Conclusion

The statistical correlation of metals and trace elements, together with the concurrent event of metal enrichment, suggest a common origin. The earliest enrichment may be attributed to the start of the industrial activities in the early 20th century, while the general decrease is related to the closing of steel plant. The high metal enrichment which characterizes the most superficial level of sediments indicates that at, the moment of sampling, the industrial area still contributed to the contamination of the marine coastal area.

**Figure 3.** Core BA39: plot of Enrichment Factor along core depth.

## References

Romano, E.; Ausili, A.; Zharova, N.; Celia Magno, M.; Pavoni, B.; Gabellini, M. (2004). Marine sediment contamination of an industrial site al Port of Bagnoli, Gulf of Naples, Southern Italy. *Mar. Poll. Bull.*, 49, 487-495.

Tanner, P.A.; Leong, L.S.; Pan, S.M. (2000). Contamination of heavy metals in marine sediment cores from Victoria Harbour, Hong Kong. *Mar. Poll. Bull.*, 40, 769-779.

Turekian, K.K.; Wedepohl, K.H. (1961). Distribution of the elements in some major units of the earth's crust. *Geological Society of America Bulletin*, 72, 175-192.