

HEAVY METAL DISTRIBUTION IN BOTTOM SEDIMENTS FROM THE CEARÁ BASIN, NE BRAZILIAN CONTINENTAL SHELF UNDER THE INFLUENCE OF OFFSHORE OIL EXPLORATION



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1. INTRODUCTION

Most anthropogenic environmental impacts on marine areas are limited to coastal sites such as bays and estuaries. It is believed that open continental shelves are hardly affected by land-based pollutants sources. Exceptionally, offshore oil exploration is considered a potential source of pollutants to continental shelf environments (Rezende et al. 2002). Whereas hydrocarbons released by offshore oil exploration affect water masses for a varying time depending on their degradability, heavy metals, that are ubiquitous components in these effluents, are non-degradable and may accumulate in abiotic and biotic compartments reaching potentially toxic concentrations particularly in bottom sediments (Rezende et al. 2002). The large metal accumulating capacity of fine bottom sediments of continental shelves (Muller et al. 1999) and the low mobility of the benthic communities may maximize exposure and make possible deleterious effects upon the biota. Although effects upon shelf biota are difficult to detect and monitor, the importance of shelf resources and the possibility of fisheries contamination by long-lasting contaminants such as heavy metals call for detailed studies in areas affected by oil exploration. The PETROBRAS Company, which runs the Ceará offshore oil field, started an environmental monitoring program to investigate potential contamination of the local environment, in particular by heavy metals (PETROBRAS 2001). As an output of that program this study shows the distribution and geochemical association of heavy metals in bottom sediments from the Ceará Basin, NE Brazil.

2. EXPERIMENTAL

Sampling campaigns occurred during December 2003. Three samples of surface sediments (0-10 cm of depth) were collected in 28 stations using a box corer. In the laboratory samples were sieved (< 1.0 mm) to avoid dilution due to larger sand grains and debris and dried (60°C for 72 h). Total heavy metals content was determined by Atomic Absorption Spectrophotometry after total digestion of 2g of dry sediment with a nitric-fluoridric solution. Hg was determined in 4g samples, after digestion with 50% HCl:HNO₃ (1:3). Details on the chemical procedures used can be found in Marins et al. (1998). Simultaneous analysis of reference standard material (NIST 1646a, Estuarine Sediment) using the same procedure, reached a good agreement between certified and measured concentrations within 80% to 95% recuperation.

3. RESULTS AND DISCUSSION

Metals concentrations in sediments of the Ceará Basin continental shelf are presented in table 1. Concentrations order followed: Al>Fe>Ba>Mn>V>Pb> Ni>Cr>Zn>Cu>Cd>Hg and are within the range reported for shelf sediments from other sectors of the northeastern Brazilian coast, but are in general lower than those reported for the southeastern coast. The difference between northeastern and southeastern shelf sediments is probably due to large contribution from continental sources, higher accumulation capacity of the dominant clay minerals and lower carbonate content in the SE sediments (Muller et al., 1999). A

correlation coefficients analysis showed two distinct groups of elements. A first group of continental origin significantly correlated with Al and the clay content of sediments and including Al, Fe, Mn, Cr, V e Zn and to a lesser extent Hg. A second group, which mobilization is strongly influenced by carbonates and to a lesser extent organic carbon, includes Cd, Pb, Cu e Ni and to a lesser extent Ba, Cr and Zn. An analysis of the spatial distribution of the elements showed the two groups with different distribution. Figure 2 and 3, shows typical examples of the spatial distribution of continental influenced metals (Cr, Fig. 2) and of those influenced by the geochemistry of carbonates (Cu, Fig. 3). The elements with stronger continental influence show highest concentrations close to river discharge areas, whereas the carbonate-influenced group shows spots of high concentrations scattered through the area sampled following the carbonate content of sediments.

Table 1. Metal concentrations ($\mu\text{g.g}^{-1}$) in bottom sediments of the Ceará Basin, Fe and Al in %.

Metal	Hg	Cd	Ni	Pb	Cu	Zn	Mn	Cr	V	Ba	Fe	Al
Average	0.002	0.9	12.1	18.5	1.6	2.4	86.5	11.3	31.5	427	0.28	1.13
Minimum	<0.1	<0.5	<3.0	<5	<1.0	<1.2	8.7	<4.5	<12.5	52	<0.01	<0.06
Maximum	0.013	3.1	28.9	42.3	7.7	16.9	461	23.5	70.7	811	0.99	1.97

The special distribution of concentrations showed no evidence of the influence of the offshore oil exploration, but reflected the input from continental sources, in particular from rivers outflows and the presence of high concentrations of authigenic carbonates. Therefore, to proper characterize any effect on offshore oil exploration activities it is of significant importance to dimension the influence from continental sources and the geochemical processes governing the accumulation of clay and carbonate sediments in the coastal shelf.

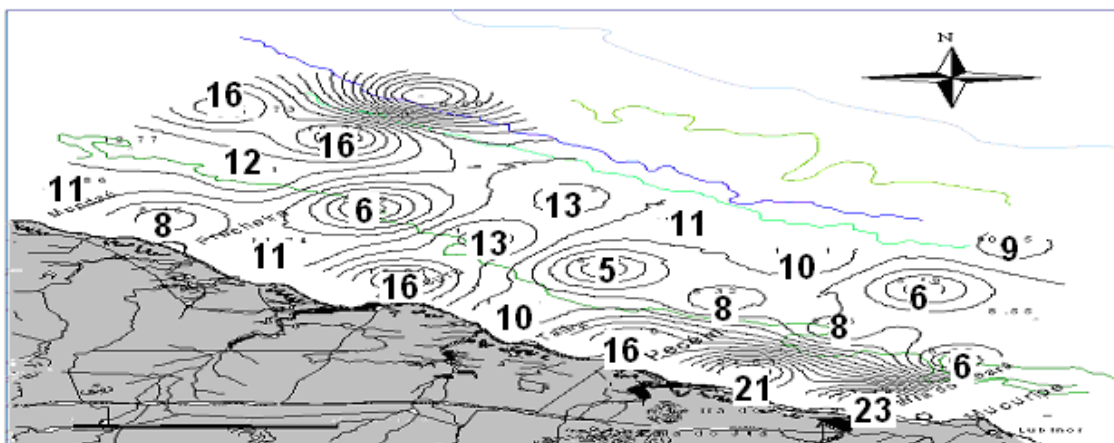


Figure 2. Cr concentrations ($\mu\text{g.g}^{-1}$) in bottom sediments of the Ceará Basin continental shelf.



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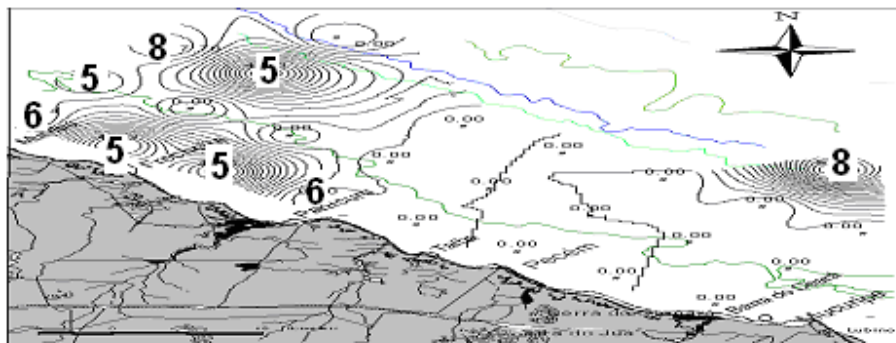


Figure 3. Cu concentrations ($\mu\text{g.g}^{-1}$) in bottom sediments of the Ceará Basin continental shelf.

4. ACKNOWLEDGEMENTS

To PETROBRAS/CENPES and M.F. Rocha and G.H. Cavalcanti through the Ceará Basin Environmental Assessment Project, T.M.C. Lotufo (UFC) and CNPq.

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