ARSENIC, COPPER AND ZINC IN MARINE SEDIMENTS FROM THE PROXIMITY OF THE BRAZILIAN ANTARCTIC BASE, ADMIRALTY BAY, KING GEORGE ISLAND, ANTARTICA

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Abstract: Marine sediments collected, in March/2010, close to the Comandante Ferraz Base, located in Admiralty Bay, Antarctica, were analyzed to determine arsenic (As), copper (Cu) and zinc (Zn) levels, in order to indicate the impact of the Brazilian activities in the study area. Labile concentrations of As ranged from 6 to 10 $\mu\text{g.kg}^{-1}$, Cu and Zn content ranged from 80 to 91 and 50 to 57 $\mu\text{g.kg}^{-1}$, respectively. The preliminary results indicated a slight increase of As with depth. Nonetheless, no relevant trace element inputs were observed, according to the chemical analysis adopted in the present research study.

Keywords: arsenic, metals, sediments, Comandante Ferraz Base-Antarctica

Introduction

Brazilian activities in the Antarctic Continent are coordinated by the Brazilian Antarctic Program (PROANTAR), in which scientific researchers are concentrated at the Brazilian Antarctic Base “Comandante Ferraz” (geographical coordinates of 62° 08' S and 58° 40' W), Admiralty Bay, Peninsula Keller, King George Island, Antarctic Peninsula (Feitosa, 2009).

Antarctica is linked to other regions of the world through the circulation of the atmosphere and the oceans. The huge difference between the Equator distance and the temperature of this Continent drives the poleward heat transport and the general circulation of the air masses, turning Antarctica into the main heat sink of the Southern Hemisphere. Considering the complexity of the air mass circulation, Antarctica plays an impressive role in the global climate system, as well as acts as a sink for persistent

atmospheric pollutants (Bargagli, 2005). Moreover, local emissions from Scientific Stations and tourism also contribute to the dispersing of contaminants, thereby concentrating and accumulating pollutants in sediments.

There are few studies underlying chemical substances and trace elements present in sediments from the proximity of Comandante Ferraz Base. For example, Santos *et al.*, (2005) investigated the heavy metal contamination in 32 sediments and 14 soil samples. Total and bioavailable contents of 16 elements (including Cu and Zn) were determined by ICP OES technique. According to the authors, the results showed an increase of bioavailability of soils in comparison to the sediments, probably due to the different redox properties of soils and sediments. The total average concentrations of metals in the samples presented no important temporal (during the summer

2002/2003) and depth-related variability. Total metals were extracted with an adaptation of methods extensively used in literature, in which the sample is digested with aqua-regia and hydrofluoric acid.

A recent study with five sediment profiles from the Admiralty Bay has suggested a slight increase of As levels, since 1985. According to the authors, the increase of As content may be associated with the Brazilian activities in the bay (Ribeiro *et al.*, 2010). Otherwise, there is no evidence of relevant impact to the ecosystem due to trace element sources in the region (Santos *et al.*, 2005; Martins *et al.*, 2005). Nevertheless, the studies that have been concerned with determining inorganic contaminants, in Antarctica, are still scarce. Accordingly, this work was undertaken to evaluate the real anthropogenic impact of potentially toxic elements (As, Cu and Zn) in the Admiralty Bay, Antarctica.

Materials and Methods

Sampling

Sediment samples were taken using a mini-box corer (MBC), especially designed for sampling soft sediments and benthic macrofauna (Filgueiras *et al.*, 2007). MBC presents 0.0625 m² of sampling area, 25 x 25 x 55 cm box, 55 kg weight (Filgueiras *et al.*, 2007; Martins *et al.*, 2010). Samples were placed into pre-cleaned recipients and stored at -20 °C. Sediments were freeze-dried; further, they were carefully homogenized in mortar and stored in polyethylene bags until laboratory analysis.

ICP OES

Sediment test portions of 500 mg were transferred into 100 mL cleaned glass beakers and chemically digested using the reagent mixture of HNO₃, H₂O₂ and HCl, according to the Method 3050A (USEPA, 1996). Filtered digest solution were analyzed by ICP OES using a Varian spectrometer, model 710ES, for determining As, Cu, and Zn. All reagents were of a comparable pure grade. Geological certified reference materials SCP Science EnviroMat SS-1 and SS-2 were analyzed together the samples to assess the quality of the analytical procedure for the chemical analysis.

Results and Discussion

Certified reference materials (CRM)

Experimental data for the CRM presented relative standard deviation lower than 6%. The agreement between the observed and the certified concentrations of As, Cu and Zn were better than 9%*f*, indicating the precision and the accuracy for the methodology employed in the chemical analysis.

Trace elements

Table 1 shows the range contents of As, Cu and Zn determined in 18 samples, representing the sediments collected close to the Comandante Ferraz Base, in Admiralty Bay, King George Island, Antarctic Peninsula. Table 1 also presents the data comparison with literature values available elsewhere for trace elements in Antarctic sediments.

According to the results, the highest concentration values were observed for Cu and Zn (ranging from 80 to 91 and 50 to 57 mg.kg⁻¹, respectively). In fact, high Cu content in Admiralty Bay sediments could be explained by the mineralogy of studied sediments, which were mainly produced by glacier erosion of volcanic rocks such as basalt and andesite. These rocks are respectively composed primarily by olivine and pyroxene and by plagioclase and pyroxene (Fourcade, 1960). Salomons & Förstner (1984)

Table 1. Trace element ranges (mg.kg⁻¹, expressed in dry weight) determined in the Antarctic sediments and compared with literature values.

Site	As	Cu	Zn
Admiralty Bay ¹	6 - 10	80 - 91	50 - 57
Ferraz Station ²	8 - 33	-	87 - 134
Botany Point ²	4 - 6	-	81 - 95
Ferraz Station ³	-	92	89
Admiralty Bay ⁴	2-12	-	-
Mc Murdo Station ⁵	4 - 5	31 - 100	114 - 156
Princess Regnheld Station ⁶	4 - 7	-	26 - 134
Ross Sea ⁷	-	10 - 38	52 - 144
Potter Cove ⁸	-	73 - 156	46 - 63

¹This study; ^{2,3}Santos *et al.* (2007); ⁴Ribeiro *et al.* (2010) ; ⁵Negri *et al.* (2006); ⁶Waheed *et al.* (2001); ⁷Ianni *et al.* (2010); ⁸Andrade *et al.* (2001).

Figure 1. As contents (mg.kg⁻¹) in the sediment from the proximity of Ferraz Station, Admiralty Bay.

have reported that, during magmatic differentiation, Cu is incorporated – among others metals, such as Zn – into olivine, pyroxene and plagioclase. Copper mean concentrations in these mineral are 115 mg.kg⁻¹, 120 mg.kg⁻¹ and 62 mg.kg⁻¹, respectively. According to Machado *et al.* (2001), the high levels of Cu in sediments may be associated with the widespread mineralization of chalcopyrite in the area.

The data comparison with literature indicated that the trace elements levels were in the same order of magnitude of previous contents already obtained in different periods and Antarctic regions. Moreover, contents of As, Cu, and Zn were in conformity with those determined by Santos *et al.* (2005, 2007) in sediments from Admiralty Bay.

Figures 1 to 3 show the mean contents with depth. Likewise previous work (Ribeiro *et al.*, 2010), the results indicated a slight decrease of As with depth (Figure 1), suggesting that the human activities may be contributing to the As enrichment in the study site. The data set suggests the natural sources are the main inputs for Cu and Zn (Figures 2 and 3) in the Antarctic ecosystem. Even though, in order to understand the geochemical distribution of the trace elements in the surface sediments, a study of geochemical partitioning of As, Cu and Zn is necessary and will be developed in the near future.

Figure 2. Cu contents (mg.kg⁻¹) in the sediment from the proximity of Ferraz Station, Admiralty Bay.

Figure 3. Zn contents (mg.kg⁻¹) in the sediment from the proximity of Ferraz Station, Admiralty Bay.

Conclusions

This work presented its preliminary results related to the As, Cu, and Zn in sediments from the proximity of Brazilian Antarctic Base, in the Admiralty Bay. The study provided some baseline information on trace elements of environmental interest for the Antarctic region. In general, chemical composition of sediments was in accordance with the literature values, thereby suggesting a low level of environmental contamination in the areas of human activities in the Admiralty Bay region. Continuous environmental monitoring, determination of baseline levels, chemical speciation methods will be essential for controlling and preventing pollution in the Antarctic Continent.

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