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**TRACE ELEMENTS AND RADIONUCLIDES IN BRAZILIAN ENVIRONMENTAL
SAMPLES**

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INTRODUCTION

In the last years there has been an increasing interest in various elements present in the environment and their possible effects on human health due to the increase of pollutant emissions from fuel combustion, automobile exhaust and industrial activities.

The pollutants can be transported across long distances from their emission source, removed from the atmosphere and deposited in the biosphere and hydrosphere by a number of mechanisms. They can get into the human body by means of ingestion of contaminated food, air inhaling or by direct absorption from the biosphere.

Artificial radionuclides, such as cesium-137 and strontium-90 are produced regularly in nuclear power plants and reach the environment by means of effluent discharges, nuclear weapons tests and from accidental releases as the Chernobyl accident. These two radionuclides are important due to their nuclear and chemical characteristics. They have long physical half lives and high fission yields. Besides they have physiological and chemical behaviour similar to K and Ca, respectively, that are important elements from the biological point of view. These radionuclides can enter the human population by several pathways and one of them is the marine environment.

Considering these problems and the lack of information concerning our country, it is relevant to investigate the trace element contents as well as radionuclide levels in environmental samples, such as aerosol and marine samples.

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EXPERIMENTAL

Aerosol samples were collected in the city of São Paulo, 1.5m above ground level, using a Dichotomous Sampler that fractionates suspended particles into two size fractions, 2.5 to 10 μ m and less than 2.5 μ m on two 37mm teflon membrane filters with a flow rate of 1m³h⁻¹. The collection time was 24h. Aluminium, Br, Ca, Ce, Cl, Co, Cr, Fe, K, La, Mn, Na, P, S, Sb, Sc, Se, Si, Sm, Th, V, and Zn contents were determined by ED-XRF and INAA.

In order to determine the radionuclide levels in our country, marine samples (seawater and fish) are being monthly collected from 7 points of the Brazilian coast from State of Rio Grande do Sul (southern coast, 32° 11'S) to State of Para (northern coast, 00° 26'S).

For seawater analysis, cesium-137 was preconcentrated from 100L of sample using ammonium phosphomolybdate (AMP) and determined by gamma spectrometry(1,2).

For fish analysis, the edible part (2kg) was weighed and dried at 110°C for one week and later on the temperature was gradually increased up to 450°C until ashes were obtained. Ashes were counted in polyethylene pots in hyperpure Ge detector to determine Cs-137 contents.

The main fish species consumed by our population, such as sardine, ballistes, weak fish, dog fish, mullet, saw fish, red mackerel scad, Brazilian croakar and white grunt were analysed.

RESULTS AND DISCUSSION

The elemental concentration data of aerosols were analysed by means of linear correlation coefficients, enrichment factor, principal factor analysis(3,4),PFA, and absolute principal component analysis(5),APCA.

The results of correlation coefficients showed that Al, Ce, Fe, La, Sc, Si, Sm and Th have high correlation in the coarse fraction, while Br, P, S, Sb and V in the fine fraction. This seems to indicate a common origin of certain elements.

To evaluate the contribution of anthropogenic aerosol sources for each element, the enrichment factor was evaluated and the reference element utilized in this study was Fe. The results showed that Al, Ca, Ce, K, La, Mn, Rb, Sc, Sm are typical elements of natural origin, while Br, Pb, S, V and Zn are representative of anthropogenic sources in the expected predominance of small particles.

Hereby Fe concentration was used as a normalizing factor, assuming that all of the Fe is derived from soil. This assumption is not strictly correct. Several activities may emit important quantities Fe. Moreover many emissions have soil like compositions. Thus, the enrichment factor represents at most the maximum enrichment versus the soil composition and should not be used as an indicator for the anthropogenic or natural source of an element.

In order to identify pollution sources and to determine their relative contribution PFA and APCA was used. PFA give the number of emissions sources responsible for aerosol chemical composition, without a priori knowledge of these sources(6,7).

For coarse particles six factors explained 89% of the data variance. All elements presented high communality. The first factor was responsible for 31,8% of the variance and had high loadings for Al, Fe, Sc, Th, V and rare earths. It seems to represent the contribution from the resuspend soil. The second factor represented a high correlation with Ca, K, P, S and Si, whose presence was attributed to a fertilizer plant located 4km away from the sampling site. Only Cl and Na were separated in the third factor, which was clearly associated with marine aerosol. The fourth factor was associated with Br and Sb and seemed to represent emissions from high temperature processes. Refuse incineration, a source known to be enriched in Zn, appeared to be represented in the fifth factor, seemed to be reasonable since had a municipal incinerator in operation near the sampling site during sample collection. The sixth factor had high loading for Cr and Pb and was attributed to emissions from industrial processes.

For fine particle matter, five factors were responsible for 83.2% of the total variance. In general the interpretation

of many of these factors was similar to that of the coarse particles. The influence of phosphatic rocks and refuse incineration appeared in the first factor.

With APCA is possible to know the source, the source profile and the relative contributions of each source to the atmospheric elemental concentrations. The relative contribution of each source were calculated as percentages of the observed average concentrations, and the results are shown in Tables 1 and 2.

Cesium-137 levels in seawater range from 0.5 to 2.2Bq m⁻³ and in fish vary from 0.1 to 0.4Bqkg⁻¹. This radioactivity present in marine samples correspond to typical values due to fallout deposition in the southern hemisphere and can be considered reference levels to our country. Cesium-137 has been monitored by most member states of the European communities and the Gesamp Report(8) gathered data relative to the levels of this radionuclide. Cesium-137 measurements in seawater and fish over the period 1980 to 1985 were performed. The cesium-137 levels in Portuguese waters are low (<20Bqm⁻³) and include a significant contribution due to the fallout from nuclear weapons testes. Areas like northwest coast of Scotland and northern Ireland are influenced by input from Sellafield (cesium-137 levels 10-200Bqm⁻³) and the Irish Sea contains the highest concentrations determined (>200Bqm⁻³).

Cesium-137 concentrations in fish range from about 0.3 to 3.0Bqkg⁻¹ (wet) with the higher levels being found in the Baltic Sea.

Bettencourt et al(9) performed cesium-137 measurements in fish collected in Portuguese oceanic waters. From the artificial radionuclides analysed, Cs-137 is the most significant contributor for the dose to man through fish consumption. The cesium-137 concentrations in fish muscle range from 0.1 to 1.7 Bqkg⁻¹.

In this work, cesium-137 levels obtained for marine samples are in agreement to the published values in the literature and they can be considered reference levels to our country. Any increase in these levels could be attributed to some possible future contamination.

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Table 1

Contribution from the various sources for coarse elemental concentration data, in %.

Element	Component					
	1	2	3	4	5	6
	soil	fertilizer	marine	high temp	refuse in	industrial
	plant			processes	cineration	processes
Al	78					
Br				51		
Ca		80				
Ce	94					
Cl			22			
Cr						46
Fe	69					
K		50				
La	71					
Mn					80	
Na			34			
P		49				
Pb						49
S		80				
Sb				57		
Sc	97					
Si	60	42				
Sm	83					
V	62					
Zn					63	

Table 2

Contribution from the various sources for fine elemental concentration data, in %.

Element	Component				
	1	2	3	4	5
	phosp. rock ref. inciner.		high temp. processes	industrial	soil
Al					26
Br		91			
Ca				3	
Cl			92		
Cr				15	
Fe		47			
K	59				
La	21	40			
Na	98				
P	51				
Pb	44	49			
S	64				
Sb	39				
Se			36		
Si	45				15
V		69			