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TRACE ELEMENTS IN THE URBAN AEROSOL OF SÃO PAULO

by

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" Trace-Elements in the Urban Aerosol of São Paulo "(*) (**)

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* This paper was presented at a panel by the Group for Air Pollution Studies of the IFUSP, in the 6th World Congress for the Air Quality, which was held on May 16-20, 1983, at the "Palais des Congres" in Paris, France.

The meeting, sponsored tri-annually by the International Union of Air Pollution Prevention Associations (IUAPPA) is considered the biggest international event on air pollution and related problems. In this 6th Congress 43 countries have been represented through the 309 papers and 161 posters presented at the 10 daily simultaneous sessions, on the following themes: The physics, chemistry and measurement of Pollutants; Atmospheric pollution and health; Olfactive nuisances ; Atmospheric pollution and plants; atmospheric pollution and materials; meteorology and atmospheric physics; the reliability and safety of installations--economic evaluation; the control of radioactivity; automotive pollution; pollution caused by replacement energies.

This poster was the only South-american work brought to the meeting, a fact that shows the poor condition of these matters in South-America, in spite of its great importance to the improuvment of our life-quality.

Resolution approved by the international comittee of IUAPPA during the Congress has determined that the 3 next meetings will be held, respectively, in: Sidney, Australia(1986); Netherlands(1989); São Paulo, Brazil(1992). In Brazil, the IUAPPA is represented by the "Associação Brasileira de Prevenção à Poluição do Ar" (ABPPOLAR).

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INTRODUCTION

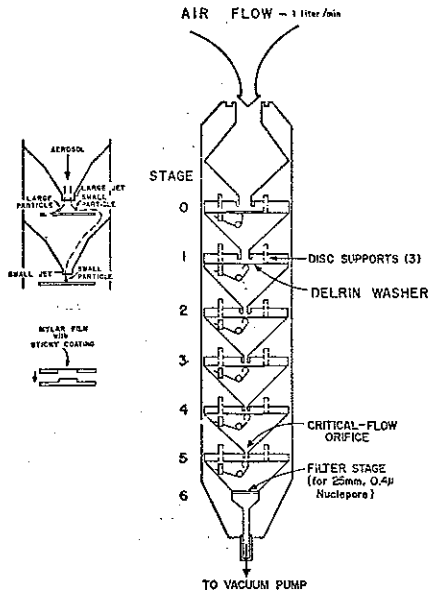
In the " 5TH Clean Air Congress " (Buenos Aires, 1980), the Group for Air Pollution Studies of the Institute of Physics of the University of São Paulo presented the first trace-elements data-set measured on the atmospheric aerosol of São Paulo City[1]. These measurements have been based on samplings by 6-stage cascade impactors combined with the analytical procedure by the PIXE method of elementary analysis.

This poster presents :

1. the extension of the trace-elements data-set to 1981;
2. the display of this data-set on a relative base;
3. an attempt to relate these data-set to their origins.

SAMPLER

The samplers used here the 6-stage Cascade Impactors, Battelle model which design is shown below.



CASCADE IMPACTOR
OPERATED IN THE INVERTED POSITION

SAMPLING

The data-set presented in this work have been generated through sampling with cascade impactors, performed during the years of 1976 to 1981 (except for 1979), according to the table below:

Number of Impactors	Month/Year	Sampling Site(*)
5	May/1976	IFUSP
8	July/1976	IFUSP
6	July/1976	UM
3	February/1977	IFUSP
5	May/1977	IFUSP
3	April/1978	IFUSP
7	Apr.-Jun.-Dec./ 1983	IFUSP
5	Feb.-Mar./1981	IFUSP

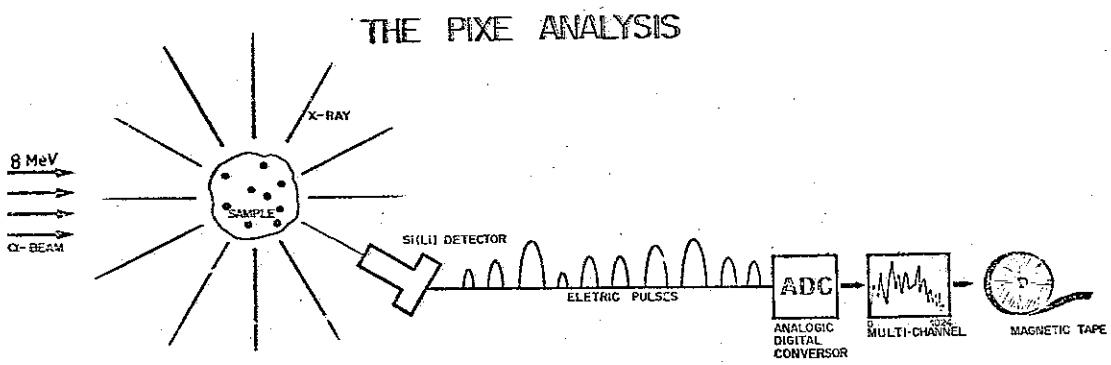
(*) - IFUSP means the Campus of the University of São Paulo in the West periphery of the city; UM means the Campus of the Mackenzie University close to downtown.

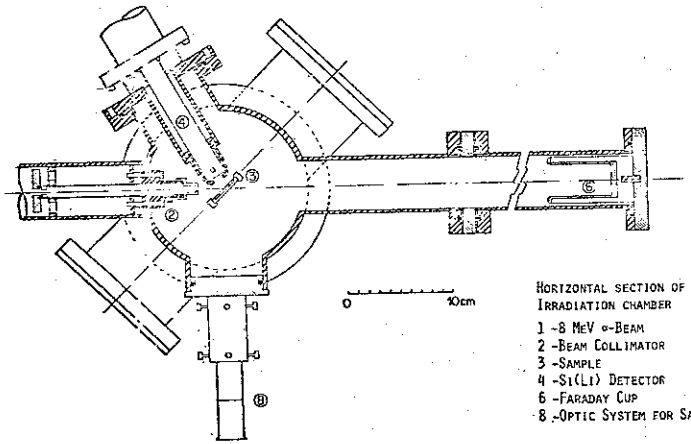
Each impactor has been, in general, exposed for 12 hours to a flow rate of about 1 lpm, for a sampled air volume of about 0,7 m^3.

ANALYTICAL PROCEDURE

WITHOUT ANY FURTHER TREATMENT, THE COLLECTED SAMPLES HAVE BEEN SUBMITTED TO THE PIXE (PARTICLE INDUCED X-RAY EMISSION) METHOD OF ELEMENTARY ANALYSIS TO DETERMINE THEIR TRACE-ELEMENT (ELEMENTS WITH ATOMIC NUMBER $Z \geq 11$) MASSES [2,3].

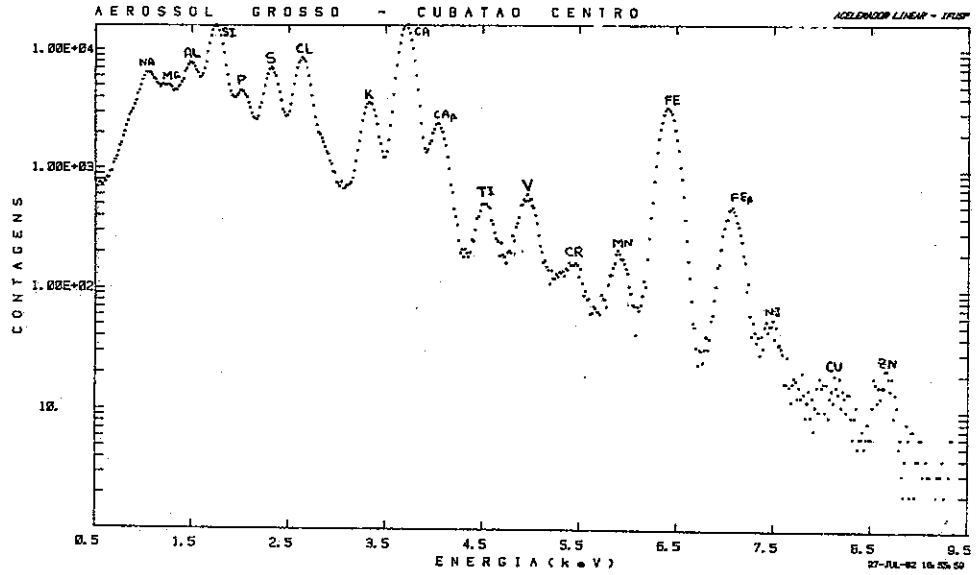
PRINCIPLE OF WORK AND CHARACTERISTICS OF THE SP-PIXE ARE SHOWN BELOW.





HORIZONTAL SECTION OF THE SP-PIXE IRRADIATION CHAMBER

1 -8 MeV α-BEAM
2 -BEAM COLLIMATOR
3 -SAMPLE
4 -Si(Li) DETECTOR
6 -FARADAY CUP
8 -OPTIC SYSTEM FOR SAMPLE CENTRALIZATION



DATA REDUCTION AND DATA-SET FORMATS

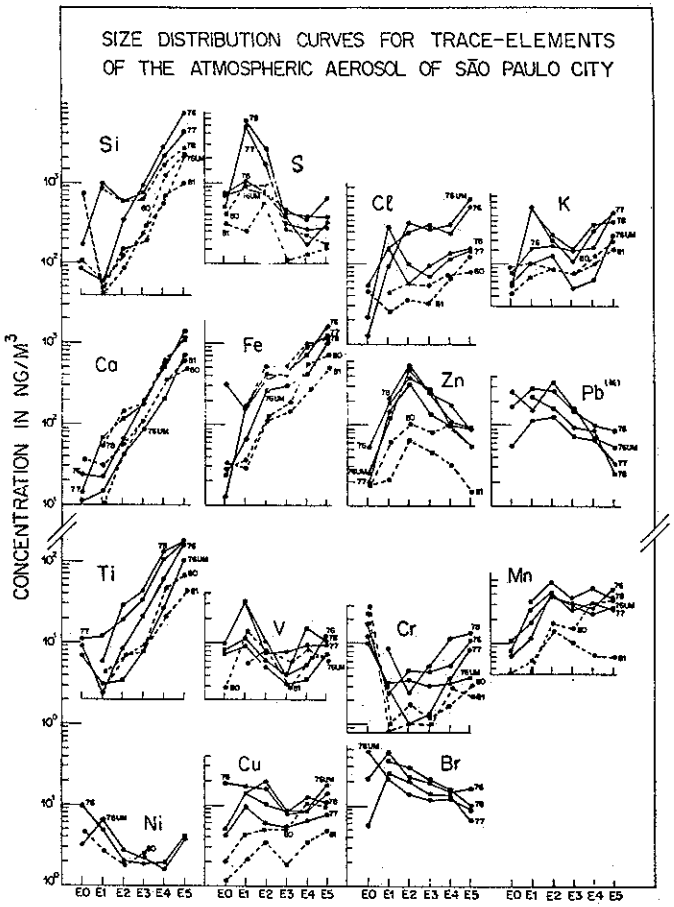
ALL SPECTRA MEASURED HAVE BEEN PROCESSED SEMI-AUTOMATICALLY BY SPECIAL COMPUTER PROGRAMS, FOR THE MASS DETERMINATIONS OF ALL TRACE-ELEMENTS (WITH $Z \geq 11$) CONSTITUENT OF THE SAMPLES ANALYZED BY THE PIXE. THE FINAL AIR CONCENTRATION OF EACH TRACE-ELEMENT WAS ACHIEVED DIVIDING ITS MASS BY THE SAMPLED AIR VOLUME.

FINAL DATA-SET ARE DISPLAYED HERE IN TWO GRAPHICAL FORMATS:

(1) - THE ANNUAL AVERAGED ELEMENTARY SIZE-DISTRIBUTION CURVES;

(2) - THE HISTOGRAMS, FOR EACH TRACE-ELEMENT, OF THE RELATIVE AIR CONCENTRATIONS (TO THE SUMMATION OF ALL THE TRACE-ELEMENT CONCENTRATIONS) ANNUALLY AVERAGED, DISCRIMINATED FOR THE FINE AND COARSE COMPONENTS OF THE INHALABLE AIR PARTICLES.

IMPORTANT REMARK: WE SHOULD KEEP IN MIND THAT THE ANNUAL SAMPLINGS HEREIN REPORTED ARE NOT STATISTICALLY EQUIVALENT, BOTH BECAUSE THEY HAVE NOT BEEN PERFORMED UNDER THE SAME PHYSICAL CONDITIONS, AND THE NUMBER OF IMPACTORS SAMPLES VARIED WIDELY FROM YEAR TO YEAR (13 IN 1976-IFUSP; 6 IN 1976-UM; 9 IN 1977;3 IN 1978;7 IN 1980;5 IN 1981)

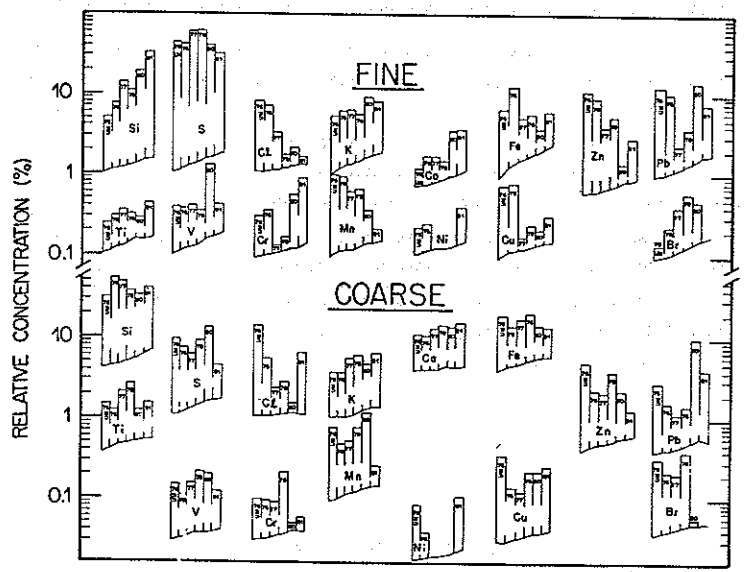


(*) NOT COMPUTED DATA FROM 1980 AND 1981

ELEMENTARY SIZE DISTRIBUTION CURVES INTERPRETATION

We may interpret the elementary size-distribution curves as follows:

1. Because the trace-elements S, Zn, Pb, and Br are the majority in the fine mode of their size - distribution curves, they seem to be originated from combustion-process-sources;
2. On the contrary, Si, Ca, Ti, and Fe, more abundant in the coarse mode of their size-distribution curves, probably proceed mainly from mechanical-process-sources;
3. All the other trace-elements found (Cl, K, V, Cr, Mn, Ni, and Cu) have been probably originated from both kinds of sources;
4. The set of elementary size-distribution curves for each element suggest a general decrease in the concentrations in the years of 1980 and 1981. To bring more light to this matter we consider the histograms presented below.



HISTOGRAM OF THE RELATIVE CONCENTRATIONS OF TRACE-ELEMENTS IN THE INHALABLE AIR PARTICLE OF SÃO PAULO

HISTOGRAM INTERPRETATION

The following tendencies may be inferred :

1. In the <u>fine particles</u> component there is a decrease in the relative values for the typically anthropogenic trace-elements (S, Cl, Zn, Mn) in the year of 1980 and 1981, contraposed by the corresponding increase in the so called "natural" trace-elements Si, Ca, Fe, and Ti;
2. In the <u>coarse particles</u> component we notice a nice constancy in the relative values of the "natural "trace-elements Si, Ca, Fe, and Ti during the whole period considered (1976-81).

CONCLUSIONS

The interpretations mentioned above make it clear that the behavior of the trace-elements may serve to monitor variations in the source emissions. Particularly, in this case :

1. It has not been observed, in general, any significant variation in the shape of the size-distributions curves ;therefore, the structure of sources in the city did not change significantly on the period of time considered;

2. In spite of the previous conclusion, there has been a remarkable decrease in the relative presence of the anthropogenic trace-elements in 1980 and 1981, relatively to 1976 to 1978, suggesting a sensible decrease in the rate of combustion -source emissions;

3. The beginning of the referred decrease in the source-emissions was, not coincidentally , at the same time of the beginning of the recession period of the country's economy;

4. It seems, therefore, that the trace-elements behavior is a good way to follow sensible variations in the emissions of the sources. However, to quantify these variations a statistically more significant data-set is needed.

REFERENCES

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2. Johansson, S.A.E. and Johansson, T.B., Nucl.Instr. and Meth.137 (1976)473-516.
3. C.Q. Orsini and L.C. Boueres, Nucl.Instr. and Meth.,142(1977)27-32.