

9.5 SIZE-SEGREGATED MULTI-ELEMENTAL AEROSOL ANALYSIS AT WILLIAMS TOWER DURING TEXAS AIR QUALITY 2000

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1. INTRODUCTION

At the top of the Williams Tower high rise building in west Houston, six-hourly size-segregated aerosol composition measurements were made beginning 15 August 2000 for one month. The objective was (i) to describe changes in elemental composition of PM_{2.5} aerosols as a function of particle size and time and (ii) to gain insight into the origin of aerosols and their change during a typical daily cycle of vertical mixing.

2. METHODOLOGY

Aerosols were collected on mylar film using a three-stage rotating drum cascade impactor (Fig. 1) in size ranges: (i) coarse: 2.5 to 1.15 μ m; medium: 0.34 to 1.15 μ m and fine 0.07 to 0.34 μ m. Subsequent chemical analysis was done non-destructively by synchrotron-XRF, proton induced x-ray emissions spectroscopy (PIXE), proton elastic scattering analysis (PESA) and scanning transmission microscopy (STIM) for mass, hydrogen and fourteen other elements including Al, Ca, Cl, Cu, Ni, S, Si and V. Samples were collected from 15 August to 14 September 2001. They were analyzed with six hourly resolution beginning at midnight.



Figure 1 The DELTA 3-stage rotating drum cascade impactor

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3. RESULTS

3.1 Sulphur and Chlorine

Most S was in sub-micron sizes (Fig. 2). A maximum in coarse fraction of S and of Cl (Fig. 3) was evident initially from 16 -18 August. Note the second maximum in sub-micron S on 3-5 September (Day 34-38 in Fig. 2)

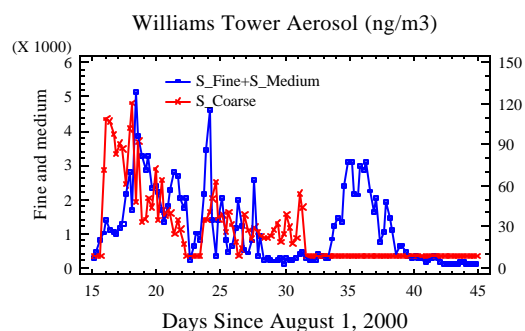


Figure 2 Observed sub-micron and coarse particle S in aerosols.

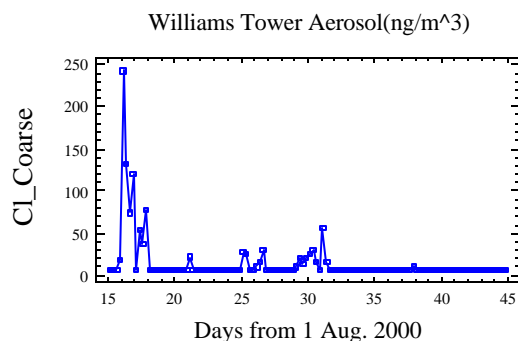


Figure 3 Coarse particle chlorine.

A maximum in coarse fraction of Cl (Fig. 3) was evident initially from 16 -18 August. And corresponds with a maximum in coarse particle S.

3.2 Calcium

Coarse and medium aerosol Ca were detected (Fig. 5). Coarse Ca dominates (note different scales). The September maximum had relatively more medium Ca and corresponds to maximum in submicron S (Fig. 2).

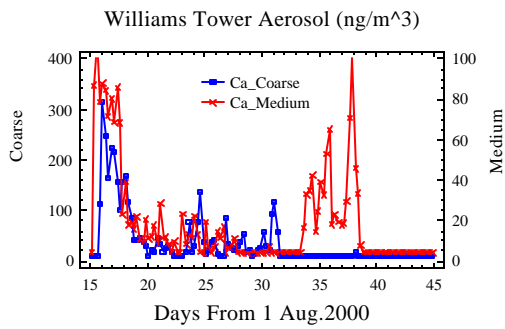


Figure 4 Time series of coarse and medium aerosol Ca.

3.3 Anthropogenic Ni and V Indicate Aerosol Variability And Morning Mixing

The variability of sub-micron Ni in aerosols (Fig.5) is very different than that of S (compare with Fig.1).

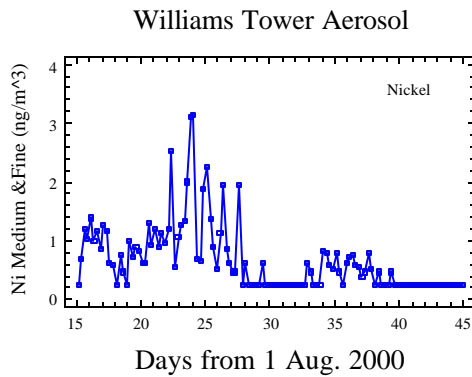


Figure 5. Observed sub-micron Ni in aerosol at Williams Tower, Houston during August and September 2000.

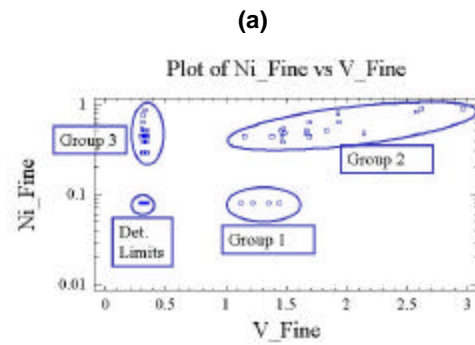
Based on Ni to V content, there are three distinct fine particle aerosol groups (Fig 6 a,b):

- Group 1: Low Ni and high V
- Group 2: Similar concentrations typical of oil combustion.
- Group 3: High Ni and low V

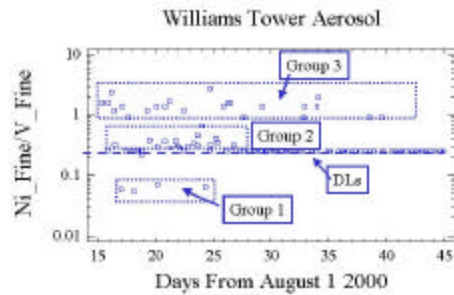
The distribution of Ni/V in fine particles (Fig 6c) shows clear evidence of oil combustion particles in the morning (the 6 hour sample centered on 09:00 LST).

Acknowledgement

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(b)



(c)

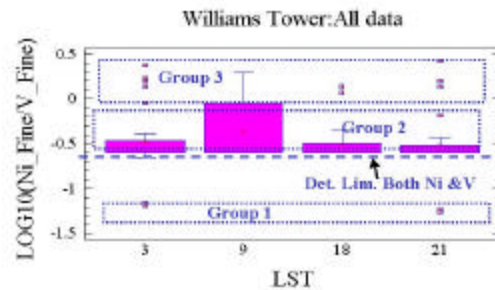


Figure 6 Aerosol data can be grouped according to relative abundance of fine particle Ni and V (a). Some of the temporal variability of relative abundance (b) can be explained by diurnally varying source types (c) whose presence at Williams Tower is modulated by vertical mixing.

4. SUMMARY

Multi-elemental aerosol measurements made with samples collected by an automated three stage cascade impactor have been made and analyzed by synchrotron x-ray fluorescence at the new DELTA group facility at Lawrence Berkley Advanced Light Source (ALS). Observations were obtained at sufficient time resolution to see diurnal mixing effects and significant changes in composition. Improvements in sensitivity of s-XRF analysis as well as subsequent analysis by PIXE/PESA/STIM at Pacific Northwest National Laboratory will add to elements measured as well as mass. Multivariate analysis and air parcel trajectories will be used to analyze the larger data set.