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RESEARCH ARTICLE

Physico-chemical characterization of total suspended particles (TSP) analysis by sem-eds

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Abstract

The work describes the use of Scanning Electron Microscopy (SEM) combined with dispersive X-RAY spectrometer (EDS) to characterize inorganic atmospheric particles samples collected on glasses filters from three zones within the city of Hermosillo, Sonora, Mexico . Specimens were initially processed by separating the collected particles from the filters by means of submersing a 2 cm² section of each filter into isopropilic alcohol within a test tube for 5 minutes. The different elements found amongst individual particles were Al, Ba, Br, Ca, Ce, Cl, Cr, Cu, Fe, K, Mg, Si, Ti, W, Zn and Zr. Based on EDS results, these particulate matter was primarily composed of W (AT% 12.53), Na (AT% 10.57), Al (AT%9.94), Fe (AT% 9.67), Si (AT% 7.28). The results obtained from the characterization of the particles captured by TSP filters, showed that are usually related with litophilic sources, such as agricultural activities, areas of soil free of anthropogenic impact, paved streets and construction sites These particles morphology and chemical composition, illustrate an abundance of natural elements within the zone. However some of these elements present are directly related with human activities, and are of much interest for the public health and environmental perspectives.

INTRODUCTION

Suspended matter as such is not a single pollutant but a mixture of different subclasses of pollutants that contain numerous chemical compounds. Suspended matter finally appears in the atmosphere as a result of interactions of chemical, through different mechanisms of formation, different chemical composition and different relationships against their exposure Bacci et al. (1983). The main source of airborne particles are combustion processes, including combustion of coal and other fossil, traffic and industry, burning of vegetation and forest fires and melting and refining processes of metals. These particles are carried by hot gases along a pipe or chimney can appear spontaneous nucleation of carbon particles after the broadcast. TSP is generally composed of several components including resuspended soil particles, weathered materials, fly ash and vehicle generated pollutants, and they are ubiquitous environmental pollutants that formed in building construction, combustion of coal wood and atmospheric chemical reaction. But by far, responded road dust, traffic, and other combustion processes are usually deemed to be the principal sources of TSP. Determination of the origin of TSP is often based on their morphological and chemical characteristics. For this reason, a number of morphological and chemical studies of TSP have been carried out previously, such as (Ariola et al. 2006; Querol et al. 1998; (Brooke et al. 2004; Paoletti et al. 2002). In this context, it is of fundamental importance to understand the origin, i.e. natural of anthropogenic, of the particles in the atmosphere. Total suspended particles (TSP) have been reported to have various negative effects on human health (Pope et al. 2002; Richards et al. 1989; Chung et al. 2008). Because the scanning electron microscope has sufficient specificity for the analysis of small particles and below the range of nanometers, we provide the information that was essential for observation of aerosol, since we can identify and fully characterize and individually, what is in our interest, from among a large group of particles, whatever we need, plus it combines a brilliant image of the morphology of the particle, size, rugosity, etc., as an analytical information of the chemical elements that integrate

the particle using the dispersive X-RAY spectrometer. This study focuses on chemical and physical characterization of the Total Suspended Particles (TSP) and attempts to identify possible sources.

Material and Methods

This work is based on samplings collected in three atmospheric monitoring stations of the Air Quality Improvement Municipal Program. Each monitoring station consists of high volume samplers with glass fiber filters for the collection of total suspended particles (TSP), and are established in three different zones within the city. Monitoring station #1 is located in the northwestern area of the city, high traffic zones and commercial buildings plus areas of industrial activity; Monitoring station #2 in the downtown area, by office commercial buildings and by high traffic areas and Monitoring station #3 in the northeast area, is surrounded by residential and roadside areas. For this study we use glass fiber filters (TSP); We obtained 320 images of TSP. The characterization of individual particles was completed by using Scanning Electron Microscopy combined with X-ray Dispersive Energy Spectrometry (EDS) (JEOL JSM-5800LV). For the particles analyzed through the SEM, a section of the filter was placed over a sample holder and then covered with gold, then placed in position for its viewing; Later on, we made a variation of this sample preparation method, instead of using a gold covered section of the filters, specimens were processed by separating the collected particles from the filters by means of submersing a 2 cm^2 section of each filter into isopropilic alcohol within a test tube for 5 minutes and applying ultrasonic waves to the submerged filter sections inside the test tubes for 10 seconds (fig.1), we took several aliquots from the same alcohol suspensions, and placed each one over individual aluminum sample holders. These individual holders were then placed on a holder grid and into the SEM for the viewings.EDS is used for elemental composition investigation of single particles. The elemental analysis was carried out in spot mode in which the beam is localized on a certain area of single particles manually chosen within the field of view. SEM images and corresponding EDS spectra of individual airborne particles were acquired.

Result and Discussion

The studies by EDS to TSP showed that elements are Al, Ba.Ca, Ce, Cl, Cr, Cu, Fe, K, Mg, Mo, Na, Ni, Pb, S, Si, Ti, W, Zn y Zr (Fig. 1). The results obtained from the characterization of the particles captured by TSP filters, showed that elements such as Al, Si, Ca, Fe, K, Mg and W are largely abundant, and are usually related with litophilic sources, such as agricultural activities, areas of soil free of anthropogenic impact, paved streets and construction sites (Shwarts 1994; Querol et al 1998). While elements such as Cl are more frequently associated with incineration and combustion activities as well as derived from marine aerosols Chung et al (2008). Other chemical elements such as Ba, Br, Cu, Cr, Ti, and Zn are more commonly related various human and industrial activities (Semeniuk et al 2007; Chung et al 2008). Zr is intensely associated to particles containing Fe and Ti as well as to particles with Ca and Al silicates (Chung et al 2008; Querol et al 1998).

In terms of particle morphology (Fig. 2), 85% of the examined particles had a composition diverse, with a size greater than 10 microns and they usually present a relative two-dimensional aspect, with length and width prevailing over thickness. It is often found that such particles have outlying edges, with fracture lines on its surface. In the case of particles that are very old and highly eroded, the tendency is to conform to ovoid shapes. Based on the above we can classify these particles as of origin natural. Where land, sea and biomass are the largest generators of these particles and their characteristics can vary significantly depending on the geographical area in which they originate. While the remaining 15% is formed by spherical particles and amorphous, latter with a surface containing a multitude of holes that give a form cavernous; resulting from combustion and are characterized, in most instances primarily due to the melting process that occurs during formation; such characteristics define at the particles known as anthropogenic.

In this study, it is emphasize that the predominant elemental constituents contained by TSP samples in urban area are W, Si, Al, Ca, and Fe, which are also the main constituents of Earth's soil crust; therefore, elemental composition reflects the geological location. Also, atmospheric particles in urban area contained predominantly Fe-rich silicate minerals and elements specific to construction sites (Ti) and traffic (Pb, Zn), indicating the anthropogenic contribution.

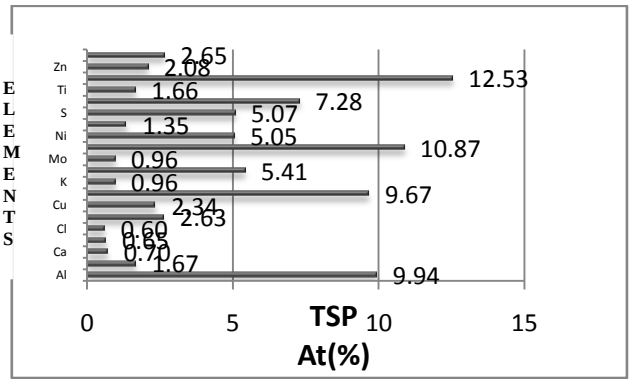

Fig. 1 Porcentage (At%) by individual particle elements (EDS)

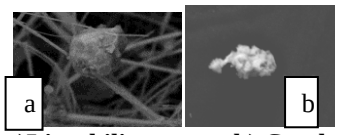

Fig. 2 Particle type. a)Litophilic source; b) Combustion source (SEM)

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