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Urban Soils from Non-pavment Streets and PM10 in Air Quality Transboudary Projects in Reynosa, Tamaulipas, Mexico

Rodríguez–Espinosa P.F.[1+], Morales-García S.S.[1,2] and Victoria Susana Villalba Salgado [1,2]

[1]Centro Interdisciplinario de Investigaciones y Estudios sobre Medio Ambiente y Desarrollo (CIIEMAD), Instituto Politécnico Nacional (IPN). Calle 30 de Junio de 1520, Barrio la Laguna Ticomán, Del. Gustavo A. Madero, C.P.07340, México D.F., México.

[2]Escuela Superior de Ingeniería Química e Industrias Extractivas (ESIQIE), Instituto Politécnico Nacional (IPN), UPALM Edificio 7 1er. Piso col. Zacatenco, Del. Gustavo A. Madero, C.P.07738, México D.F., México.

Abstract. The present work is related to suspended matter in the air (PM10) and the soils from non-paving streets from the border City of Reynosa, Tamaulipas, Mexico. They were collected from PM10 and soils from non-paving streets. Samples were analyzed in Scanning Electron Microscope (SEM), Energy Dispersive Spectroscopy (EDS) on the SEM and X-Ray Diffraction (XRD). The results of the present work established a correlation of the native materials of soils, with a dominion of the crystalline phases of quartz, calcite; with the presence of potash feldspars and calcium and clays of muscovite type. The studied mineral phases in the soils were found in the PM10. The minerals detected in soils and PM10 are regionalized, and they depend on the condition of the dominant wind direction. The present project was technically supported by the program "Air Quality and Street Paving Project" (transboundary project) for the city of Reynosa, Tamaulipas, Mexico (1.7 x10^6 m^2 of hydraulic and asphaltic pavement), which obtained BECC (Mexico-USA) Certification the 06212006 and 05202008 with ID-470 (3.0 x10^6 m^2 of hydraulic and asphaltic pavement).

Keywords: PM_{10}, crystalline phases, soils of non-paving streets, transboundary project, Reynosa, Tamaulipas, México .

1. Introduction

The urban geochemistry of geochemical elements is of growing interest since more than half of world population now live in urban environments. Urban soils are highly variable in composition both spatially and temporally, because they are affected by numerous points and nonpoint sources of contaminants, which often changes as a town or city (Sialelly, et. al., 20011). Recent works relating to the composition of urban soils denote the of natural component of geochemical crust as a major constituent of urban dust (Srimuruganandam et. al. 2011; Contini et. al. 2010; Negral et. al. 2008 and Ordoñez et.al 2003).

The City of Reynosa is located in the State of Tamaulipas in the northern part of Mexico, is border to the north with Hidalgo and McAllen Texas, United States of America (Figure 1). The abundant thorny scrubs in the southern part of the low forests predominant the short thorny and temporal trees with diverse species. The climate is dry and very warm. The meteorological conditions indicate that a prevailing wind field coming from the southwest (8 months) with winds from the north for the winter time. The main economic activities are petrochemical and the refining industries. There are nine industrial clusters with approximately 150 assembly plants. (R. City council of Reynosa, www.reynosa.gob.mx; and COCEF 2006).

The objective of the present research is to study the relation, source and chemical composition of PM10 and soils of the non-paved streets of the City of Reynosa. This research is oriented to urban projects Mexico-USA.

+ Corresponding author. Tel.: + 52 (55) 57296000 ext. 52711,52708.52707; fax: (same to Tel).
E-mail address: prodrigueze@ipn.mx, pedrof44@hotmail.com .

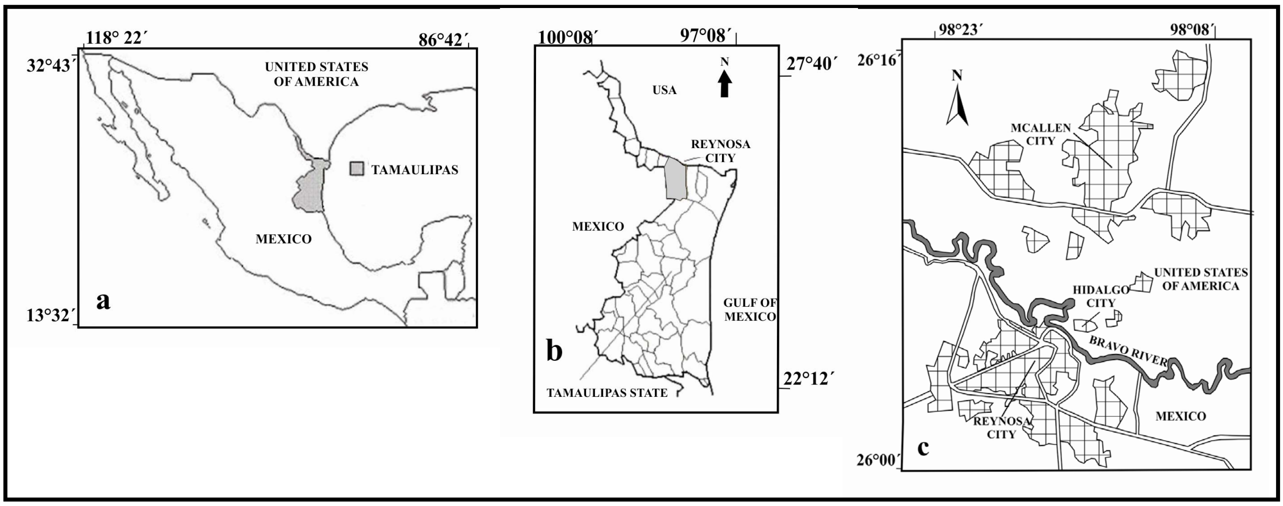
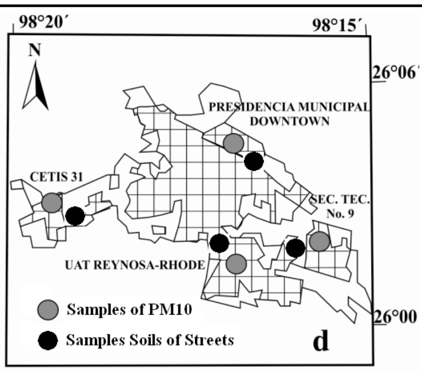


Fig. 1. Geographic location of the City of Reynosa, Tamaulipas, Mexico. a) Mexico Country b) State of Tamaulipas and c) City of Reynosa, Tamaulipas, Mexico; Hidalgo and McAllen, Texas, the USA.

2. Materials and Methods

The sampling of soils was done from non-paved streets in different points from the Reynosa city entering from streets, roads before paving was realized and by using polypropylene bottles. The sampling sites were marked with a GPS3 Garmin 12CX using compatible Geocentric Datum WGS84 to the ITRF92 Age 80. The sampling points and the stations of PM10 monitoring are presented in figure 1 (Table 1).

The sectors of soils sampled and monitoring stations of PM10, were located in different zones of Reynosa City in areas with paved and no-paved streets (Fig. 2). The monitoring stations correspond to the Network of Environmental Monitoring of the Quality of the Municipal Air (REMA).



Sample Code	Name Station	Region
Sector 167	Luis Donaldo Colosio	South Zone
Sector 227	Rancho Grande	North Zone
Sector 268	Solidaridad	West Zone
Sector 143	Zona de desecación de la Laguna Escondida	East Zone

Fig. 2. Geographic location and nomenclature of Monitory Stations, Samples PM10 and Soils of streets in Reynosa City, Tamaulipas, Mexico.

The study consisted of an basic analysis carried out by Energy Dispersive Spectroscopy (EDS) wich is connected to Scanning Electron Microscope (SEM), *JEOL Model 6300* and a qualitative analysis of phases by X-Ray Diffraction (XRD), *speed of counted 1.5 °/min in 2θ angle (15-100°), using Kα Cu at 35 KV and 25 mA, SIEMENS D5000*. The analysis by EDS was realized at several points of the sample to have a representative way of their chemical nature. Spectra characteristic of urban soils and PM10 filters were developed to carry out analysis XDR in urban soils samples to determine the crystalline mineral phases and qualitative characterize the type of the mineral composition. Similar technique was reported in Sobanska et.al. (2003).

3. Results & Discussion

The results obtained allows us to affirm that the analyzed particles correspond to matured mineral with one resistant to erosion, characteristic of an urban atmosphere corresponding to a crystalline fraction, with low resistance to abrasion and short period of residence in urban conditions.

The determination of elements in the fraction (<10 μm) for the urban soils samples of the streets and roads (focusing the electron beam), it allowed us to corroborate the major presence of the following constituent elements: Si, Ca, K, O and Al; as they were detected in the samples of sectors 167, 227, 268. Weighing the Ca in sample of the total fraction coming from the sediment substrate; for example of the Escondida Lake in the East side of the study area. Some author identification like natural, dust and other mineral components of urban soils (Ali-Khodja et.al. 2008; Li et.al 2003 and Sobanska et.al. 2003).

The particle analysis (urban soils) observed a regionalization for the Eastern sector in Reynosa City; detected the following phases: 1) silicon oxides (SiO_2), 2) silicon-aluminum of potassium [$K(Si_3Al)O_8$] and 3) silicates of calcium and iron [$Ca_3Fe_2(SiO_4)_3$], which is present as a majority in the sample (Fig. 3a). The results of the elementary composition of the suspended fraction in the air (Fig 4b.), allowed us to relate it to the elementary composition observed in the urban grounds (Fig.3a.). Park et.al. (2010), determines a similar distribution of natural components denoting a regional influence of wind direction.

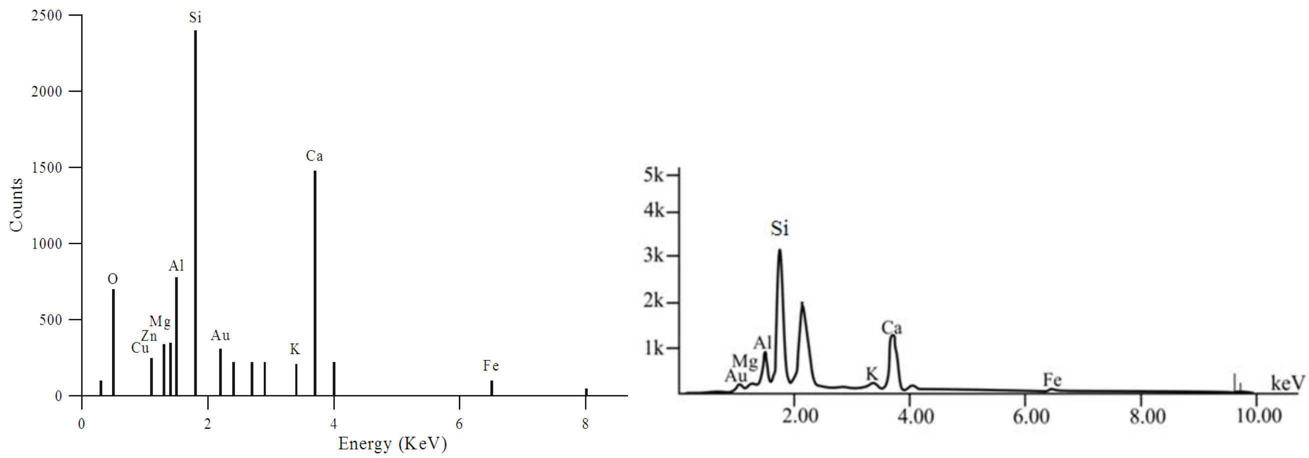


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Fig. 3a. Sample Lodos, (urban soils) from the East Sector by EDS. 3b. Sample Filter 50005 (PM10) from Sec Tec No 9 Monitoring Station in East Sector by EDS.

The particles analysis of urban soils (Fig. 4a) and the PM10 samples (Fig. 4b) in Western sector in Reynosa City indicates the following elements: silicon oxides (SiO_2) and calcium carbonate [$CaCO_3$].

The results of the elementary composition of fraction PM10 (Fig 3b and 4b), determined in the filter sample, allowed us to correlate the elementary composition of urban grounds (Fig 3a and 4a), like a general distribution with two different sensitive regions. The correlation is seen in Eastern region of Reynosa, with compounds of silica and in the Western region with Ca compounds.

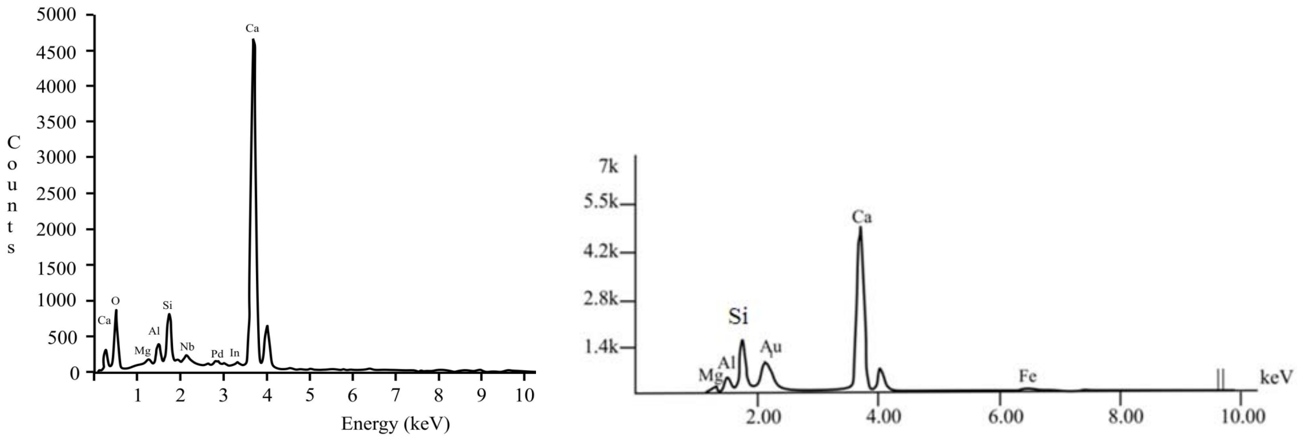

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Fig. 4a. Sample 268, (urban soils) from the West Sector by EDS. 4b. Sample Filter 50006 (PM10) from CETIS 131 Monitoring Station in West Sector EDS.

The results of the qualitative determinations for urban soils were done by XRD, and the mineral species and their regionalization before described obtained by SEM and EDS (Fig. 5).

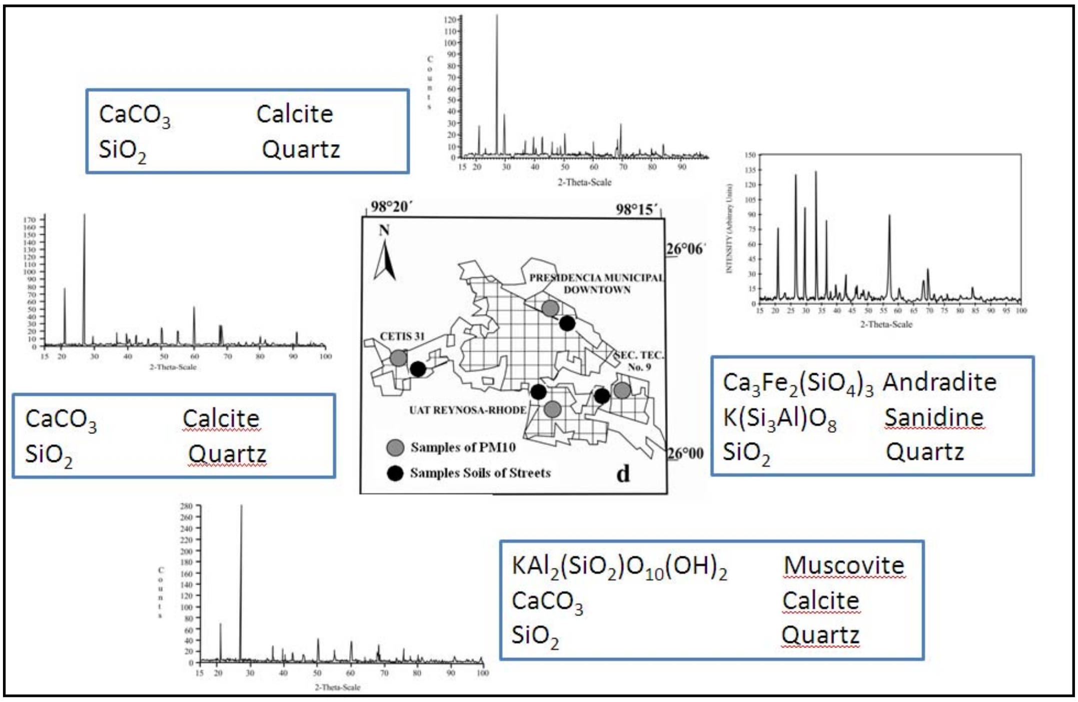

Fig. 5a. Regionalization of urban soils determinate by XRD. Sample Soils from South, mineral composition, $KAl_2(SiO_2)O_{10}(OH)_2$, Muscovite, $CaCO_3$ Calcite SiO_2, Quartz α SiO_2. Soils from East, mineral composition, Andradite $Ca_3Fe_2(SiO_4)_3$, Sanidine $K(Si_3Al)O_8$, Quartz α SiO_2, and Calcite $CaCO_3$ Calcite SiO_2 and Quartz α SiO_2 for the North and West sectors; determinates by XRD, speed of counted 1.5 °/min in 2θ angle (15-100°), using Kα Cu at 35 KV and 25 mA, SIEMENS D5000

The results of the present work establishes a correlation of the native materials of soils, with domination of the crystalline phases of quartz and calcite; with the presence of potassium ash feldspars, calcium and clay type muscovite (Fig. 5).

4. Conclusions

The results of the present project indicate different mineral phases of urban soils and it is a result of the, incorporating the suspended fraction in to the air (PM10). Establishing a regional distribution related to geology, podology and condition of the wind direction of the urban zone of Reynosa.

The results described here allow us to report that the native fraction of dust of the streets and roads of the city of Reynosa suggets a direct correlation with particles smaller to 10 µm. The prevailing wind field (SE) had transported the crystallographic mineral phases of urban soils between the east to west sectors of the city, the south-east, south to north and north-west of Reynosa city. The present study demonstrates that the mineral composition found in urban grounds and the PM10 of the city of Reynosa is transported as a result of the wind and can reach the border cities of Hidalgo and McAllen, Texas.

The present project was supported scientifically and technical support to approve the program "Air Quality and Street Paving Project" (transboundary project) for the city of Reynosa, Tamaulipas, Mexico ($1.7x10^6$ m^2 of hydraulic and asphaltic pavement), which was obtained from BECC (Mexico-USA) Certification the 06212006 and 05202008 with ID-470 (3.0 $x10^6$ m^2 of hydraulic and asphaltic pavement).

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