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Airborne Lead In El Paso, 1977-1999

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AIRBORNE LEAD IN EL PASO, TEXAS, 1977- 1999

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I want to dedicate this project to my parents, Juan Diego Camacho and Rosa Maria Araujo, for all their love and support during all my life.

I also want to dedicate this project to my daughter, Maria Julia, who is my motivation in my life.

In addition, I would like to dedicate this project to a very important person in my life, Sergio Castillo for his unconditional support since we met.

Finally, I dedicate this project to my brother Juan Diego, my sisters Jenny, Citlalli and Livier for taking care of my daughter when I was absent.

With all my heart I thank you for all your love.

AIRBORNE LEAD IN EL PASO, TEXAS, 1977-1999

by

INGRID B. CAMACHO ARAUJO

THESIS

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Abstract

Airborne lead is an important component of the biogeochemical make-up of ambient air. Most of the lead emitted to the atmosphere has been in the form of particulate matter.

This study evaluated airborne lead levels in the El Paso airshed at different intervals over the span of three decades between 1977 and 1999. Levels of lead and related metals for a number of years and from a number of sampling stations in El Paso were available from Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analyses previously conducted in Prof. Pingitore's laboratory at UTEP.

Data consisted of some 200 samples, each a composite of approximately 15 24-hour TSP (total suspended particulates) or PM₁₀ (particulate matter 10 µm aerodynamic diameter or less) samples taken at 6-day intervals. The composites coincided with the 3 seasonal wind directions observed at the El Paso Airport. Samples were taken from 5 stations: Kern, Tillman (downtown), Northeast, Riverside, and Ivanhoe. The data collected from those samples was analyzed and plotted by use of a temporal graphical analysis in order to observe both decadal and seasonal trends in airborne lead.

Based on the analysis it was concluded that the airborne lead levels in El Paso decreased by approximately 99% from 1977 thru 1999. Significant "lead events" such as the phasedown in leaded gasoline, technological modifications to reduce emissions in ASARCO and its closing, and the ban of lead-based paint were three of the most important factors that contributed to the decrease on airborne lead levels locally.

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Chapter 1

Introduction

1.1 Historical Air Quality of El Paso

In 1969, the year before EPA (Environmental Protection Agency) was created, El Paso was found to have the highest concentration of airborne lead of any city in the United States (Jackson et al. 2011).

In December 1971, the City-County Health Department in El Paso, Texas, discovered that ASARCO in El Paso was discharging large quantities of lead and other metallic wastes into the air. Between 1969 and 1971, this smelter had released *1,116 tons of lead*, 560 tons of zinc, 12 tons of cadmium, and 1.2 tons of arsenic into the atmosphere through its stacks (Roberts et al. 1974).

Table 1.1.1 Particulate waste stacks emissions in Tons of Lead, Cadmium, Zinc, Arsenic, 1969 to 1971, at El Paso, Texas (Roberts et al. 1974).

Year	Total Particulates	Lead	Cadmium	Zinc	Arsenic
1969	1443	292	3.3	139	0.3
1970	2274	511	4.9	264	0.6
1971	1282	313	3.8	157	0.3
Total	4999	116	12	560	1.2

In August 1972, a random survey of the entire population living within 4.1 miles (6.6 km) of the smelter in south and west El Paso was conducted by the City-County Health Department and CDC (Centers for Disease Control and Prevention). The area was divided along census tract lines into 3 strata, roughly concentric about the smelter and each with a radius of 1.0-1.5 miles (1.6 – 2.4 km). In the small, innermost stratum, all

households were visited; in the 2 outer strata, approximately 2% of households were selected. Of 833 occupied households included in the survey, 672 (80.6%) were reached for the interview. A venous blood sample for lead analysis by atomic absorption spectrophotometry (AAS) was obtained from all persons up to age 20 years and from every other person above that age. Samples of paint, soil, household dust, and pottery were also collected in each home for lead analysis by AAS. In all age groups, the percentage of blood levels greater than or equal to 40 µg/dL was found to be highest in those persons living nearest the smelter (Rosenblum et al. 1972).

A major objective of the El Paso investigation was to determine whether high blood lead levels (BLLs) in children were associated with smelter emissions or were explained by other lead sources also found in the community. The 1972 National Academy of Sciences report on lead, while motivated by growing concern about widespread dispersal of lead in the environment, stated in its preface: "lead attributable to emission and dispersion into the general ambient environment has no known harmful effects." In El Paso, the inverse gradient in air, dust, and soil contamination as one moved away from the smelter, and the parallel blood lead gradient (also found in a complementary investigation of lead exposure in Juarez, Mexico) supported the argument that soil and dust are important vehicles of exposure (Landrigan et al. 1975). This finding foreshadowed subsequent research demonstrating the pathway from lead in soil and dust to lead contamination of hands to lead in blood, presumably from normal hand-to-mouth behavior and ingestion of contaminated soil and dust (Charney et al. 1982).

National data from the Second National Health and Nutrition Examination Survey (NHANES II), conducted from 1976 through 1980, indicated that the mean blood lead

level (BLL) among children aged less than 6 years residing in rural areas was 14 µg/dL. The average levels were 17-20 µg/dL among children living in more urbanized areas (Mahaffey and Annest 1982). During the same period, widespread population exposure to airborne lead emissions was reflected in average BLLs that declined in close parallel to the decreasing consumption of leaded gasoline. Local sources, added to the higher background exposure prevalent at the time, resulted in BLL distributions that were extremely high by today's standards (Annest and Pirkle 1983).

The El Paso survey was a prelude to a large body of continuously refined epidemiologic investigations that provided the impetus for actions to dramatically reduce population lead exposure from lead in gasoline, soldered food cans, drinking water conduits, and other sources in the United States. As a result, mean BLLs among children have declined nationally by greater than 80% overall and by similar amounts in population subgroups defined by age, race, ethnicity, income levels, and urbanization (Annest et al. 1983). An international agreement to reduce the use of leaded gasoline was bringing about significant reductions in worldwide lead exposure. Ironically, the unfortunate epidemics of lead toxicity near smelters in El Paso and elsewhere ultimately enabled more rapid progress in understanding and controlling lead exposure than might otherwise have been possible (Pirkle et al. 1994).

1.2 Lead

Lead is an element with the symbol **Pb** and atomic number 82. Lead is a soft, malleable poor metal. It is also counted as one of the heavy metals. Metallic lead has a bluish-

white color after being freshly cut, but it soon tarnishes to a dull grayish color when exposed to air. Lead has a shiny chrome-silver luster when it is melted into a liquid. (Seiler et al. 1994).

Metallic lead can be toughened by addition of small amounts of antimony, or a small number of other metals such as calcium. All isotopes of lead, except for lead-204, can be found in the end products of the radioactive decay of the even heavier elements, such as uranium and thorium (Charles et al. 1966).

Lead can be found or produced in many isotopes, with three of them being stable. The four natural isotopes of lead are ^{204}Pb , ^{206}Pb , ^{207}Pb , and ^{208}Pb with the slightly radioactive ^{204}Pb regarded as completely primordial lead, and the stable isotopes 206, 207, 208 being formed probably from the radioactive decay of two isotopes of uranium (U-235 and U-238) and one isotope of thorium (Th 232). The one common radiogenic isotope of lead, ^{202}Pb , has a half life of about 53,000 years (George et al. 2003).

Metallic lead does occur in nature, but it is rare. Lead is usually found in ore with zinc, silver and (most abundantly) copper, and is extracted together with these metals. Lead is used in applications where its low melting point, ductility and high density is an advantage. The low melting point makes casting of lead easy, and therefore small arms ammunition and shotgun pellets can be cast with minimal technical equipment. It is also inexpensive and denser than other common metals (Rooney et al. 2007).

Lead pigments were used in lead paint for white as well as yellow, orange, and red. Most uses have been discontinued due of the dangers of lead poisoning. Beginning April 22, 2010, US federal law requires that contractors performing renovation, repair, and painting projects that disturb more than six square feet of paint in homes, child care

facilities, and schools built before 1978 must be certified and trained to follow specific work practices to prevent lead contamination. Lead chromate is still in industrial use. Lead carbonate (white) was the traditional pigment for the priming medium for oil painting, but it has been largely displaced by the zinc and titanium oxide pigments. It was also quickly replaced in water-based painting mediums. Lead carbonate white was used by the Japanese for face-whitening make-up, which was detrimental to health (Hong et al. 1994).

1.3 Lead Poisoning and Health Effects

Lead is a poisonous metal that can damage nervous connections (especially in young children) and cause blood and brain disorders. Lead poisoning typically results from ingestion of food or water contaminated with lead; but may also occur after accidental ingestion of contaminated soil, dust, or lead based paint (Agency for Toxic Substances and Disease Registry et al. 2006).

Long-term, low-dose exposure to lead or its salts (especially soluble salts or the strong oxidant PbO_2) can cause nephropathy, and colic like abdominal pains. The main target for lead toxicity is the nervous system, both in adults and children. Long-term, low-dose exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia (Golub et al. 2005). Adverse effects of long-term, low-dose lead exposure such as neurocognitive and

neurobehavioral development in children are some of the public health concerns in El Paso, TX. Children have a heightened susceptibility to environmental lead exposure for several reasons. Compared to that of adults, the juvenile gastrointestinal tract absorbs a higher percentage of lead that is ingested. Normal mouthing behavior of young children results in greater intake of lead in environmental media such as soil or dust. Finally, in proportion to body size, children breathe more air, drink more liquid, and consume more food than adults.

In acute poisoning, typical neurological signs are pain, muscle weakness, paraesthesia, and, rarely, symptoms associated with encephalitis. Abdominal pain, nausea, vomiting, diarrhea, and constipation are other acute symptoms. Lead's effects on the mouth include astringency and a metallic taste. Gastrointestinal problems, such as constipation, diarrhea, poor appetite, or weight loss, are common in acute poisoning. Absorption of large amounts of lead over a short time can cause shock (insufficient fluid in the circulatory system) due to loss of water from the gastrointestinal tract. People who survive acute poisoning often go on to display symptoms of chronic poisoning.

1.4 Research Objectives

The objective was to generate data on the elemental composition of particulates in El Paso airshed for plotting, mapping and understanding of the evolution of air quality in this area. This was achieved by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS). This tool was used to obtain data focused in lead results.

In this research project, historically ambient air filter samples comprised of Total

Suspended Particulate (TSP) filters and Particulate Matter with aerodynamic diameter of 10 micrometers or less (PM₁₀) filters were examined and analyzed. The filter data analyzed was from 1977 to 1999 and it combined TSP and PM₁₀ filters.

1.5 Strategies Used to Achieve the Objectives

In this project we reported elemental composition of particulates trapped on filters collected in 5 different station, or sites, during 1977 to 1999 and the focus being the element lead.

Sampled filters were digested in sealed Teflon bombs Microwave Assisted Extraction (MAE) which is superior to the traditional hot-plate method (Lorentzen et al. 1996).

This extract was stored and kept until analyzed by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) using the Method IO-3.5 in order to screen and analyze the filters digested. Once the data was obtained from the ICP-MS, the lead levels were calculated and graphed.

Chapter 2

Materials and Methods

2.1 Methodology

This study evaluated airborne lead levels in the El Paso airshed at different intervals over the span of three decades between 1977 and 1999. Those dates were chosen due to data availability as well as significant events such as the ban of lead-based paint, the ban of leaded gasoline and the closing of ASARCO. Levels of lead and related metals for a number of years and from a number of sampling stations in El Paso were available from Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analyses previously conducted in Prof. Pingitore's laboratory at UTEP.

Data consisted of some 200 samples, each a composite of approximately 15 samples 24-hour TSP (total suspended particulates) or PM₁₀ (particulate matter 10 µm aerodynamic diameter or smaller) samples taken at 6-day intervals. The composites coincide with the 3 seasonal wind directions observed at the El Paso airport. Samples were taken from 5 stations: Kern, Tillman (downtown), Northeast, Riverside, and Ivanhoe.

Temporal graphical analysis (time versus lead level) was used to observe both decadal and seasonal trends in airborne lead.

2.2 Air Sampling

El Paso City – County Health and Environmental District (EPCCHED) and the Texas Commission on Environmental Quality (TCEQ, formerly TNRCC) were the agencies in charge of the sampling and storage. Access to the filters was provided by these agencies which maintained a library of particulate matter () filters and also of total suspended particulate (TSP) filters. Table 2.2.1 describes the characteristics of every one.

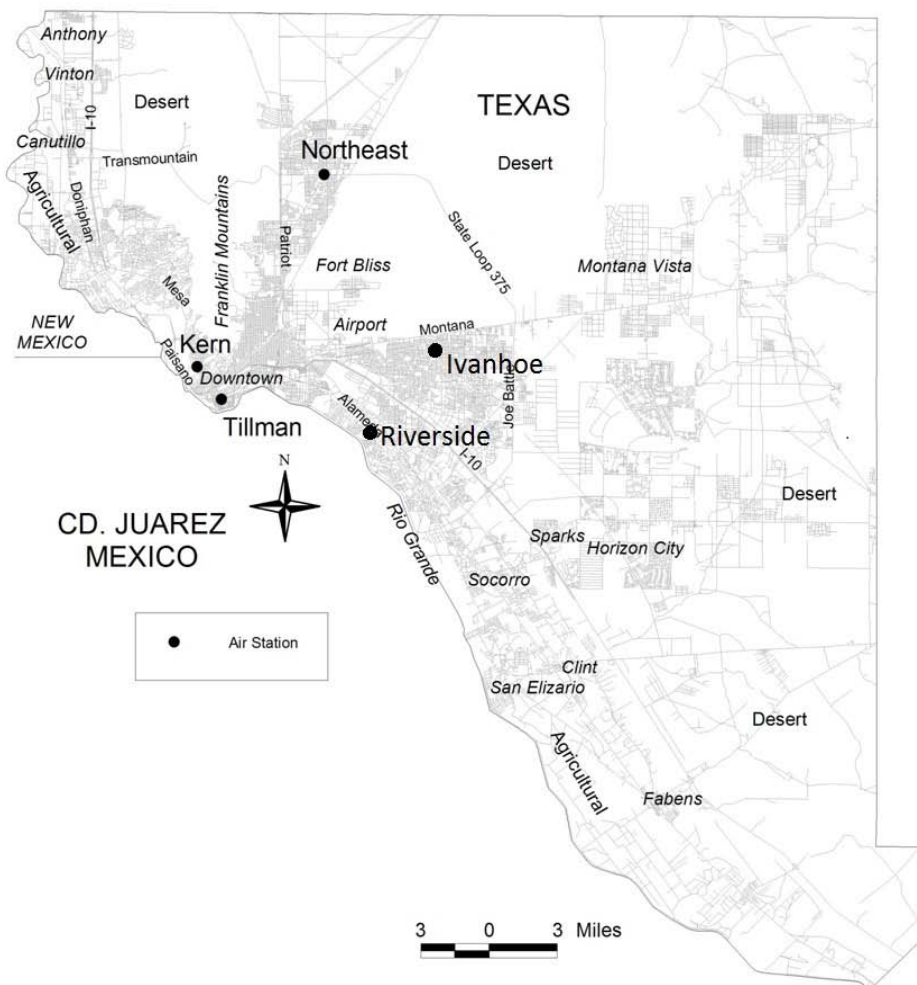
The collection frequency was typically on an every 6th day schedule. Sampling intervals were set daily. Twenty-four hour sampling was done from midnight to midnight through an automated timer under local conditions of temperature and pressure.

Table 2.2.1 Characteristics of TSP filter and filter.

Type of Filter	Filter Media	Flow Rate (cfm)	Flow Rate (/day)	Particulates Collected	Collection method
TSP Total Suspended Particles	Cellulose	40	1631	Particles matter of aerodynamic diameter of 40 µm or smaller.	Impaction
Particulates Matter of 10µm or smaller.	Pure quartz	20	815.5	Particles matter of aerodynamic diameter of 10 µm or smaller.	Impaction

2.3 Location Stations

Five sampling stations located along the city of El Paso were used. These sites were Tillman, Northeast, Riverside, Ivanhoe and Kern. Selection of particulate sampling location was guided by the EPA regulation criteria (U.S Environmental Protection Agency, 1987). Map 2.3.1 shows the air monitoring stations in the city of El Paso used for this project followed by Table 2.3.1 which describes each station.



Map 2.3.1 Map of El Paso County and some TSP and air monitoring stations. It was taken from "Urban Airborne Lead: X-Ray Absorption Spectroscopy Establishes Soil as Dominant Source" (Nicholas E. Pingitore Jr., et al. 2009) Two additional air monitoring stations were superimposed on this map.

Table 2.3.1 Describes air monitoring stations in the City of El Paso.

Station	Address	Geographic Coordinates
Tillman	222 South Campbell St. El Paso, TX	Latitude: 31° 45' 27.00" North (+31.757500°) Longitude: 106° 28' 58.00" West (-106.482778°) Elevation: 1134 m (3721 ft)
Kern	301 East Robinson El Paso TX	Latitude: 31° 46' 37.00" North (+31.776944°) Longitude: 106° 30' 6.00" West (-106.501667°) Elevation: 1189 m (3901 ft).
Ivanhoe	10834 Ivanhoe Dr. El Paso, TX	Latitude: 31° 47' 11.00" North (+31.786389°) Longitude: 106° 19' 27.00" West (-106.324167°) Elevation: 1207 m (3960 ft)
Riverside	301 Midway Dr. El Paso TX	Latitude: 31° 44' 1.68" North (+31.733800°) Longitude: 106° 22' 19.56" West (-106.372100°) Elevation: 1120 m (3675 ft).
Northeast	2701 Harrison Avenue El Paso, TX	Latitude: 31° 48' 50.00" North (+31.813889°) Longitude: 106° 27' 47.00" West (-106.463056°) Elevation: 1255 m (4118 ft)

2.4 Microwave Assisted Extraction

The samples were prepared by Microwave Assisted Extraction (MAE). Preference of the MAE over the Hot-Plate EPA method 3050B was based on the efficiency and effectiveness (Lorentzen et al. 1996).

EPA METHOD 3051A "MICROWAVE ASSISTED ACID DIGESTION OF SEDIMENTS, SLUDGES, SOILS, AND OILS" was followed and the CEM MDS2000 Microwave

Digester Oven was used. The unit was not equipped with a temperature feedback control so calibration of the equipment had to be performed.



Figure 2.4.1 Shows the CEM MDS2000 Microwave Digester Oven

The following procedure was used for the microwave acid digestion of the filters:

1. Filters were cut with a circular shape with a 2 cm of diameter.
2. The circular shaped filters were then placed on the vessels and the nitric acid was added to the vessels.
3. The quality control in the microwave was implemented in every 12 samples in the carousel and each sample contained a quality control spike.
4. The microwave was used at 81% power of 630 watts of its 100% power during two stages at the times of 25 and 45 minutes and at pressure of 60 psi and 120 psi, respectively.
5. After microwave digestion the vessels were cooled and the acid extracts were brought to a final volume of 50 milliliters.

The glassware went through a clean-up procedure which consisted of soapy water and soaking the glassware for a minimum of 4 hours in an acid bath. This bath solution was

a mixture of nitric acid, hydrochloric acid and deionized water in a 1:2:9 ratios, respectively.

2.5 Inductively Coupled Plasma - Mass Spectrometry

Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) was developed in the late 1980's to combine the easy sample introduction and quick analysis of ICP technology with the accurate and low detection limits of a mass spectrometer. The resulting instrument is capable of trace multielement analysis, often at the part per trillion levels. ICP-MS has been used widely over the years, finding applications in a number of different fields including drinking water, wastewater, natural water systems/hydrogeology, geology and soil science, mining/metallurgy, food sciences, and health sciences. The schematic below illustrates this sequence of processes.

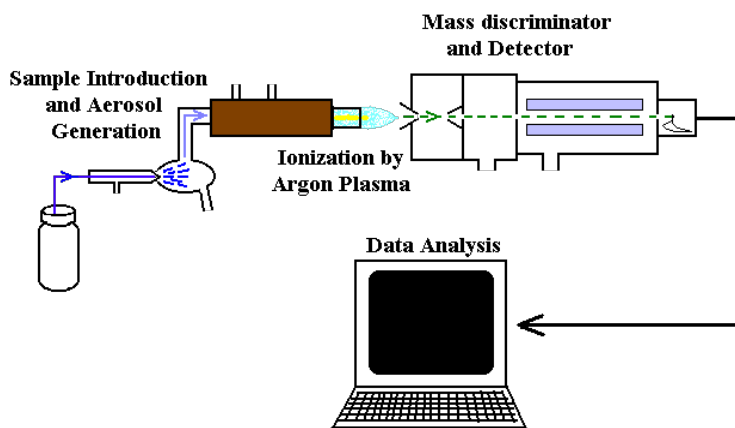


Figure 2.5.1 Schematic of ICP-MS main processes

The analysis of the acid extraction from the Microwave Assisted Extraction (MAE) was performed using a Hewlett Packard HP 4500 ICP-MS.

The procedure followed the Method IO-3.5 "DETERMINATION OF METALS IN AMBIENT PARTICULATE MATTER USING INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETRY (ICP/MS)" (Center for Environmental Research Information et al, June 1999). This procedure is listed below:

1. Samples were received from the extraction in a 10-mL centrifuge tube. The samples contained a nitric acid.
2. For every new or unusual matrix, a semi-quantitative analysis was carried out to screen for high element concentrations.
3. Information gained from this procedure was used to prevent potential damage to the detector during sample analysis and to identify elements that may be higher than the linear range.
4. Matrix screening was carried out by using intelligent software.
5. The sample was screened for background levels of all elements chosen for use as internal standards to prevent bias.
6. Instrument software was run to procedures quantitative analysis.
7. It monitored all masses that might affect data quality during the analytical run.
8. The rinse blank was used to flush the system between samples.
9. Samples that had concentrations higher than the established linear dynamic range were diluted into range and reanalyzed.
10. The sample was analyzed for trace elements and the detector was protected from the high concentration elements.

11. The sample with high concentration was diluted to determine the remaining elements.

2.7 Calculations

After the data was obtained from the analysis provided by ICP-MS, the concentration was calculated using the procedure that follows.

The lead concentration in the air sample was calculated with the following equation:

$$C = [(\mu\text{g Pb/L}) \times (\text{Digestion volume L/\# samples}) (\text{Factor})] - (F_m) / V_{\text{Local}}$$

Where:

C = Lead concentration per cubic meter of air ($\mu\text{g Pb/m}^3$)

$\mu\text{g Pb/L}$ = Lead concentration from the digested composite.

Digested volume (L) = Total volume from extraction (0.05L)

Samples = Number of individual samples in the seasonal composite (typically 15 samples)

Factor = Using exposed filter area (64.69 Samples/Filter) (see Eq. 1)

F_m = Average lead concentration of clean filters, (μg)

V_{Local} = Sampled air volume at local conditions (m^3).

The measurements were taken at local conditions. This method suggests the correction of the volume at standard condition, using temperature and pressure measured. There was no data readily available for those parameters (temperature and pressure) in these measurements. Hence, the V_{Local} corresponds to the volume of air sampling at local condition, 40 cfm (cubic feet per minute) for TSP filters and 20 cfm (cubic feet per minute) for .

The Factor in the equation of the concentration is a relationship between circle samples and the whole filter. The factor was calculated as follows:

Table 2.7.1 Shows the Dimensions of the Filter

Filter total area=8"x10"	516.13 cm ²
total area exposed= 7"x9"	406.45 cm ²
circle diameter = 2 cm , area=	3.14 cm ²
1 sample = 2 circles , area =	6.28 cm ²
Factor =	64.69 samples/filter

Eq 1.

$$406.45 \frac{\text{cm}^2}{\text{filter exposed area}} * \frac{\text{sample}}{6.28 \text{ cm}^2} = 64.69 \frac{\text{samples}}{\text{filter}}$$

This Factor must be constant in the equation of the concentration as well as the digested volume which is 0.05L. The number of samples should vary, but the number 15 was typically used, which is the number of samples per composite.

Chapter 3

Results and Discussions

3.1 Airborne Lead Concentration

During the decade of the 70's, high levels of airborne lead in the airshed of El Paso, TX were found. In Figure 3.1.1 we can see the airborne lead concentration of the year 1977 which is higher in the winter season. Table 3.1.1 shows the values obtained for every site and its correspondent season for that year. The highest lead concentration 2581.3 corresponds to Kern site by the winter season and the lowest lead concentration of 624.6 corresponds to the Northeast site by summer season.

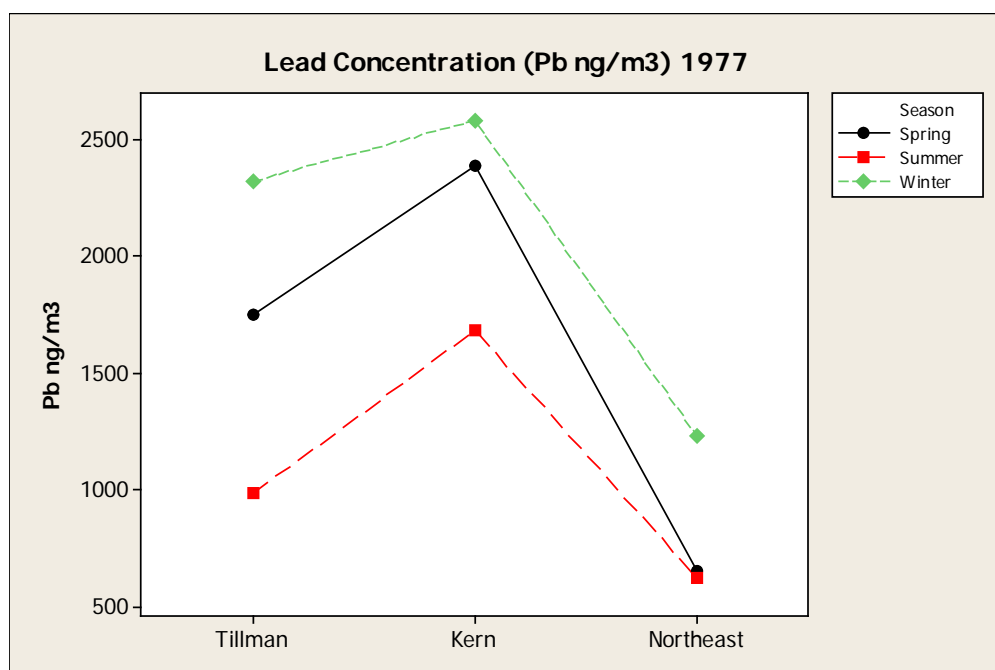


Figure 3.1.1 Shows the airborne lead concentration in nanograms per cubic meter () during the year 1977 through the spring, summer and winter seasons by every site Tillman, Kern and Northeast.

Table 3.1.1 Airborne lead concentration in nanograms per cubic meter () 1977 at every site Tillman, Kern and Northeast by three seasons spring, summer and winter.

Pb 1977 (TSP Filters)			
Season	Tillman	Kern	Northeast
Spring	1749.5	2387.0	654.7
Summer	988.0	1681.9	624.6
Winter	2321.8	2581.3	1231.5

Figure 3.1.2 shows the airborne lead concentration during the year 1980. We can see the higher airborne lead concentration during the winter season. This corresponds to the Tillman station located in the downtown area. The lowest airborne lead levels belong to the Ivanhoe site and these levels occur during the summer season.

Table 3.1.2 shows Tillman with the highest airborne lead concentration of 1815.6 and Ivanhoe with the airborne lead concentration of 248.6 .

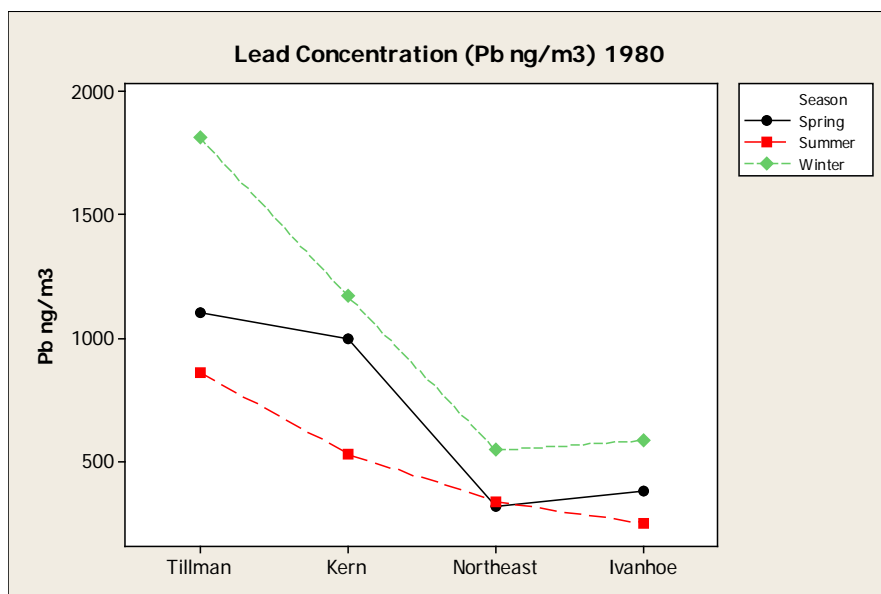


Figure 3.1.2 Airborne lead concentration in nanograms per cubic meter () during the year 1980 through the spring, summer and winter season by every site Tillman, Kern, Northeast and Ivanhoe.

Table 3.1.2 Airborne lead concentration in nanograms per cubic meter () 1980 at every site Tillman, Kern, Northeast and Ivanhoe by three seasons spring, summer and winter.

Pb 1980 (TSP Filters)				
Season	Tillman	Kern	Northeast	Ivanhoe
Spring	1102.8	1000.4	315.2	379.2
Summer	860.1	530.9	336.7	248.6
Winter	1815.6	1171.6	546.0	584.4

The concentration of the airborne lead in El Paso during 1984 had a pattern similar to the previous year. These similarities were the high airborne lead concentration during the winter in most of the sites and the lowest concentration during the summer for all of them.

From Table 3.1.3 we can get the exact values for those appreciations 492.1 and 97.2 , respectively.

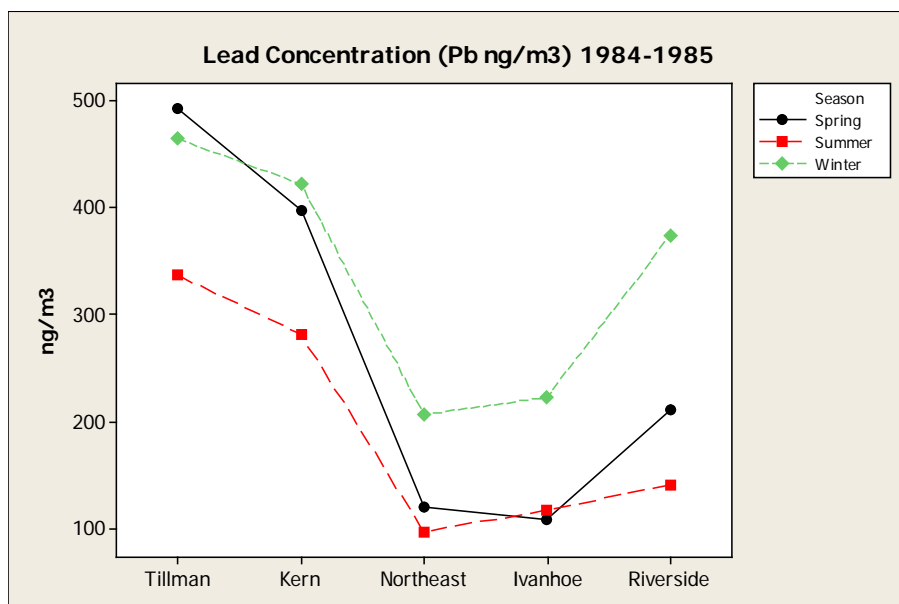


Figure 3.1.3 Airborne lead concentration in nanograms per cubic meter () during the period of time comprehended by the years 1984 and 1985 through the spring, summer and winter season by every site Tillman, Kern, Northeast, Ivanhoe and Riverside.

Table 3.1.3 Airborne lead concentration in nanograms per cubic meter () 1984-1985 at every site Tillman, Kern, Northeast, Ivanhoe and Riverside by three seasons spring, summer and winter.

Pb 1984-1985 (TSP Filters)					
Season	Tillman	Kern	Northeast	Ivanhoe	Riverside
Winter	464.0	421.7	206.5	223.0	374.1
Spring	492.1	397.3	121.0	108.0	210.8
Summer	336.7	281.6	97.2	117.6	141.3

During the period between 1989 and 1990, the analysis of filters was incorporated by the EPCCHED. This analysis corresponds to the sites named RS (Riverside filters), Ivanhoe (filters), NE (Northeast filters) and Till (Tillman filters). The analysis shows a result similar to the previews years that was obtained by using only TSP filters. The behavior of the airborne lead concentration in the El Paso airshed during the winter increases and during the summer the airborne lead concentration is at its lowest.

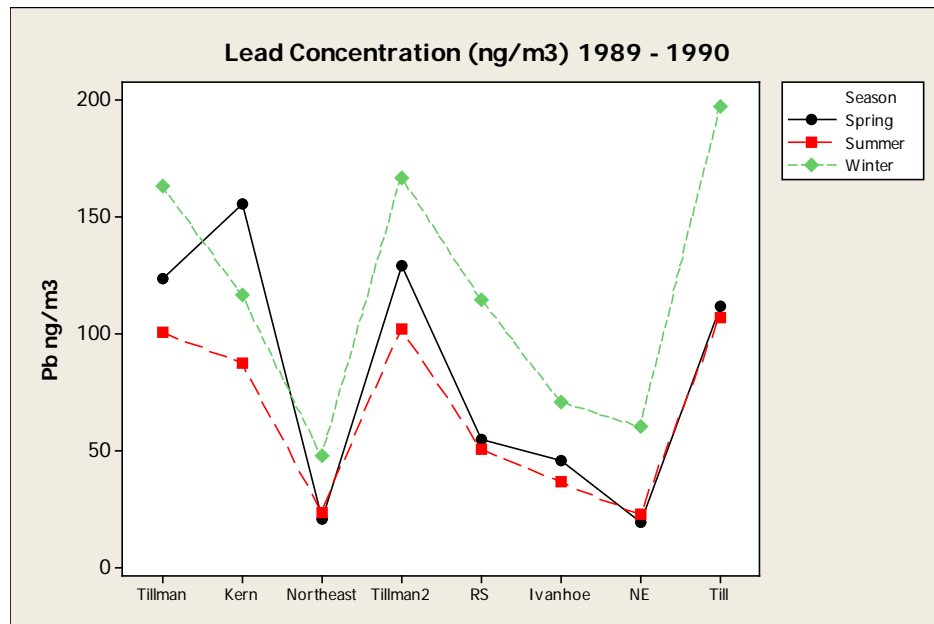


Figure 3.1.4 Airborne lead concentration in Nanograms per cubic meter () during the period of time comprehended by the years 1989 and 1990 through the Spring, Summer and winter season by every site Tillman, Kern, Northeast, Tillman2, RS, Ivanhoe, NE and Till.

Table 3.1.4 Airborne lead concentration in nanograms per cubic meter () 1989-1990 at every site Tillman, Kern, Northeast, Tillman2, RS, Ivanhoe, NE and Till by three seasons spring, summer and winter.

Pb 1989-1990 (TSP Filters)				
Season	Tillman	Kern	Northeast	Tillman2
Winter	163.1	116.3	47.6	166.6
Spring	123.6	155.5	20.8	128.6
Summer	100.4	87.2	23.8	102.0
Pb 1989-1990 (Filters)				
Season	RS	Ivanhoe	NE	Till
Winter	114.6	70.8	60.0	196.6
Spring	54.9	45.9	19.6	111.7
Summer	50.7	36.3	22.6	107.0

The airborne lead concentration during the year 1996 decreases in relation with the previous years. The lead concentration is between 7.3 and 52.6 as the lowest and highest levels, respectively. The lowest value shown in Table 3.1.5 corresponds to the site located at the NE (northeast area sampling) during the summer season and the highest value corresponds to the downtown area which is the Tillman2 site.

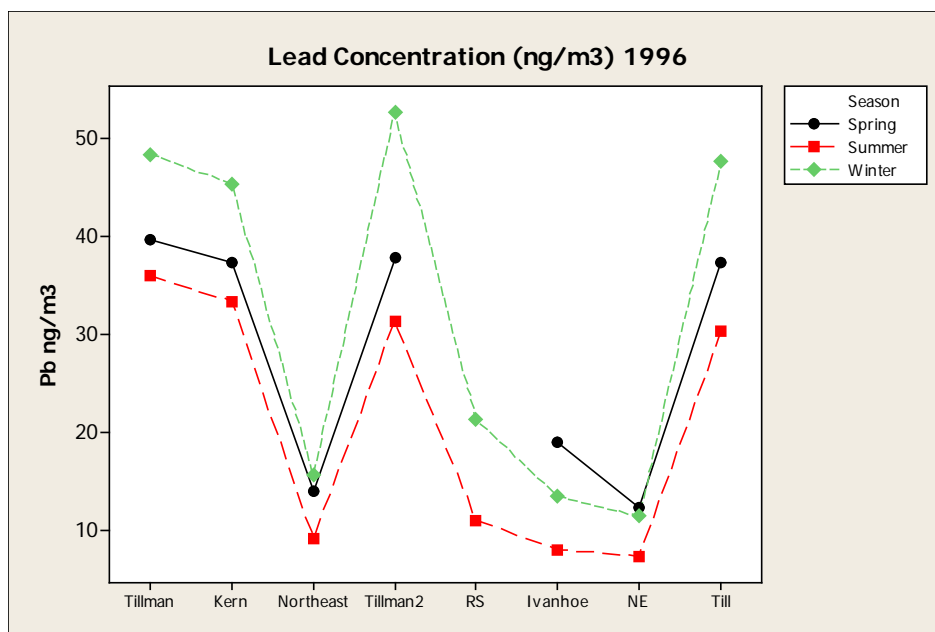


Figure 3.1.5 Airborne lead concentration in Nanograms per cubic meter () during the year 1996 through the spring, summer and winter seasons by every site Tillman, Kern, Northeast, Tillman2, RS, Ivanhoe, NE and Till.

Table 3.1.5 Airborne lead concentration in nanograms per cubic meter () 1996 at every site Tillman, Kern, Northeast, Tillman2, RS, Ivanhoe, NE and Till by three seasons spring, summer and winter.

Pb 1996 (TSP Filters)				
Season	Tillman	Kern	Northeast	Tillman2
Spring	39.6	37.3	13.9	37.9
Summer	35.9	33.3	9.2	31.4
Winter	48.3	45.3	15.6	52.6
Pb 1996 (Filters)				
Season	RS	Ivanhoe	NE	Till
Spring		19.0	12.3	37.2
Summer	11.0	8.0	7.3	30.2
Winter	21.3	13.4	11.4	47.7

In 1999, the airborne lead concentration kept the similar behavior of the year 1996, with the values below 50.6 . The lowest lead concentration of 5.0 corresponds

to the site Ivanhoe and that site was sampled by filters. The lead concentration value found in Table 3.1.6 corresponds to the site Tillman 2 with a value of 50.6 .

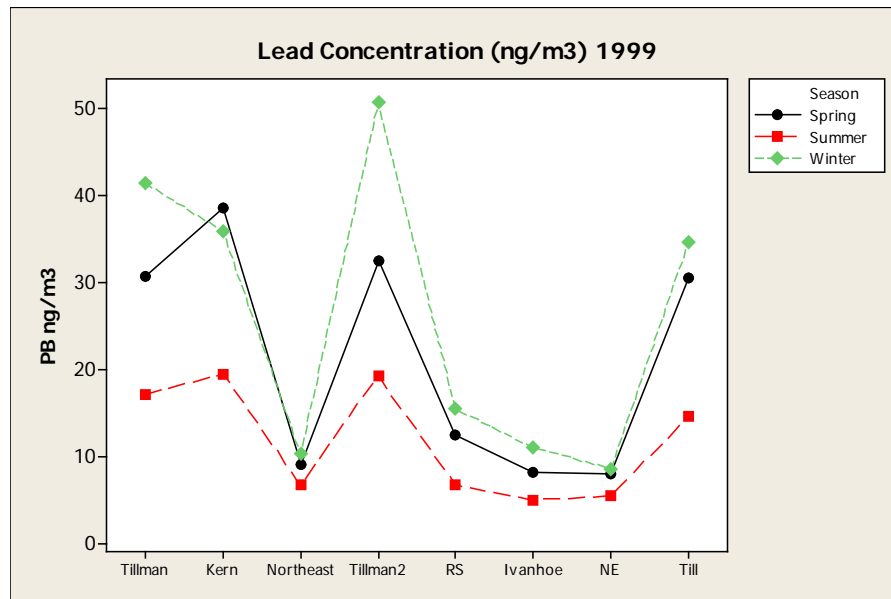


Figure 3.1.6 Airborne lead concentration in Nanograms per cubic meter () during the year 1999 through the spring, summer and winter seasons by every site Tillman, Kern, Northeast, Tillman2, RS, Ivanhoe, NE and Till.

Table 3.1.6 Airborne lead concentration in nanograms per cubic meter () 1999 at every site Tillman, Kern, Northeast, Tillman2, RS, Ivanhoe, NE and Till by three seasons spring, summer and winter.

Pb 1999 (TSP Filters)				
Season	Tillman	Kern	Northeast	Tillman2
Spring	30.7	38.5	9.0	32.4
Summer	17.1	19.4	6.7	19.3
Winter	41.3	35.8	10.2	50.6
Pb 1999 (Filters)				
Season	RS	Ivanhoe	NE	Till
Spring	12.4	8.2	8.0	30.4
Summer	6.7	5.0	5.4	14.6
Winter	15.4	10.9	8.6	34.6

3.2 Relevant Events with a Significant Impact on Airborne Lead Levels

Between 1980 and 2006, average lead concentrations decreased 96 percent nationally (Figure 3.2.1). This decrease, which occurred mostly during the 1980's and early 1990's, is largely attributed to reduced lead content in gasoline (U.S. EPA, 2003).

The lead concentration in the area of El Paso, Texas has behaved in a manner similar to the concentration of lead nationwide as shown on Figure 3.2.1 and Figure 3.2.2.

Airborne lead concentration in the U.S. and El Paso, 1977-1999

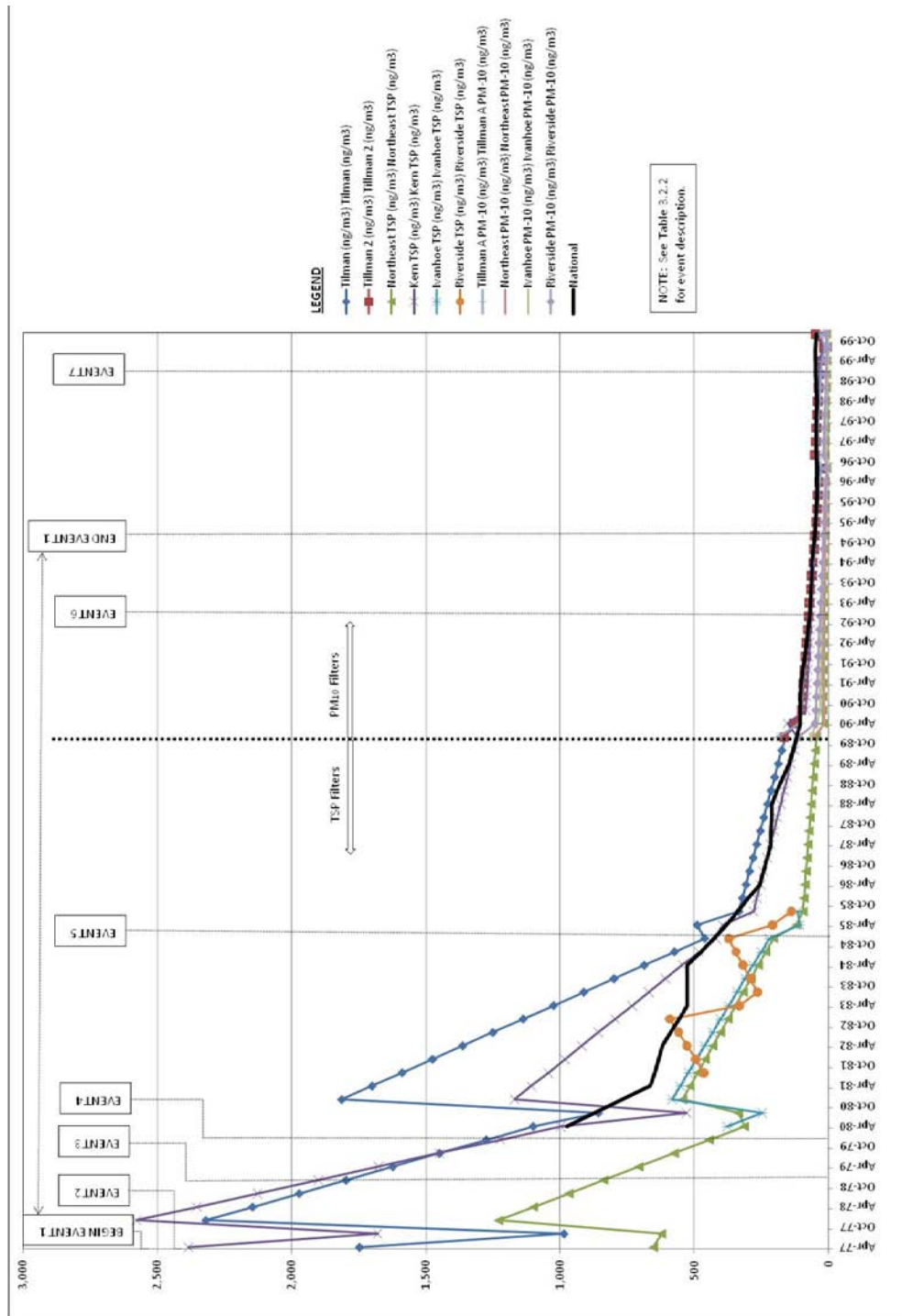


Figure 3.2.1 Average airborne lead concentration (black line) in the United States (U.S. EPA, 2007) and air borne lead concentration in El Paso (Tillman, Kern, Ivanhoe, Riverside and Northeast) between 1977 and 1999. Over the X axis there is the time since 1977 to 1999 and over Y axis there are the lead concentration in nanograms per cubic meter ().

Airborne lead concentration in the U.S. and El Paso, 1977-1999 (Logarithmic)

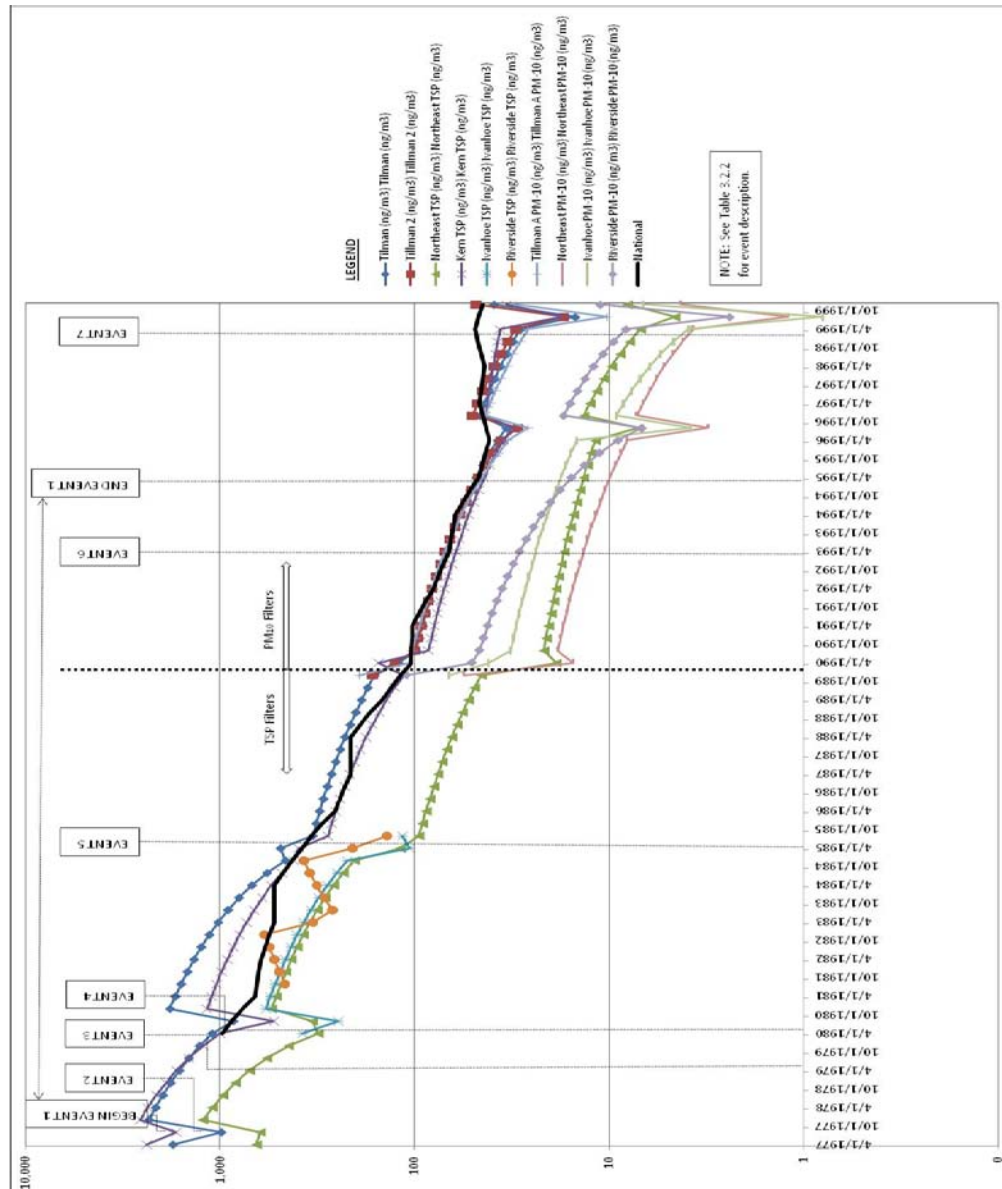


Figure 3.2.2 Logarithmic time series of lead concentration in nanograms per cubic meter () in the different monitoring stations at El Paso, TX during the period of 1977-1999. On the X axis are the seasons of each year and on Y axis are the lead concentrations.

The lead concentration ranges from 2,579.20 during the winter of the year 1977 as the highest lead concentration at Kern station and to 0.80 during the summer of the year 1999 as the lowest lead concentration found at Ivanhoe station (see Table 3.2.1).

Table 3.2.1 Airborne lead concentration in nanograms per cubic meter () in El Paso airshed and National airshed during the period of 1977 and 1999. Orange highlighted data corresponds to filters and the blue highlighted data to TSP filters.

Time	National	Tilman (ng/m3)	Tillman 2 (ng/m3)	Northeast TSP (ng/m3)	Kern TSP (ng/m3)	Ivanhoe TSP (ng/m3)	Riverside TSP (ng/m3)	Tillman A PM-10 (ng/m3)	Northeast PM-10 (ng/m3)	Ivanhoe PM-10 (ng/m3)	Riverside PM-10 (ng/m3)
4/15/1977		1,747.40		652.6	2,385.00						
8/14/1977		985.9		622.5	1,679.80						
12/14/1977		2,319.80		1,229.50	2,579.20						
4/15/1978		2,145.66		1,098.59	2,353.37						
8/15/1978		1,971.51		967.67	2,127.54						
12/14/1978		1,797.37		836.76	1,901.71						
4/15/1979		1,623.23		705.84	1,675.89						
8/15/1979		1,449.09		574.93	1,450.06						
12/15/1979		1,274.94		444.01	1,224.23						
4/14/1980	975.14	1,100.80		313.1	998.4	377.1					
8/14/1980	870.95	858		334.7	528.8	246.5					
12/14/1980	766.76	1,813.50		544	1,169.60	582.3					
4/15/1981	662.58	1,700.87		515.70	1,107.10	552.18					
8/14/1981	647.56	1,588.23		487.40	1,044.60	522.07	464.1				
12/14/1981	632.54	1,475.60		459.10	982.10	491.95	495.67				
4/15/1982	617.52	1,362.97		430.80	919.60	461.83	527.25				
8/15/1982	587.46	1,250.33		402.50	857.10	431.72	558.83				
12/14/1982	557.40	1,137.70		374.20	794.60	401.60	590.4				
4/15/1983	527.34	1,025.07		345.90	732.10	371.48	331.9				
8/15/1983	526.63	912.43		317.60	669.60	341.37	264.5				
12/15/1983	525.91	799.80		289.30	607.10	311.25	291.38				
4/14/1984	525.20	687.17		261.00	544.60	281.13	318.25				
8/14/1984	476.60	574.53		232.70	482.10	251.02	345.13				
12/14/1984	428.00	461.9		204.4	419.6	220.9	372				
4/15/1985	379.40	490		118.9	395.2	105.9	208.7				
8/14/1985	338.73	334.6		95.1	279.5	115.5	138.2				
12/14/1985	298.07	321.25		91.28	266.78						
4/15/1986	257.41	307.89		87.47	254.07						
8/15/1986	242.68	294.54		83.65	241.35						
12/14/1986	227.95	281.18		79.84	228.64						
4/15/1987	213.21	267.83		76.02	215.92						
8/15/1987	212.86	254.48		72.21	203.21						
12/15/1987	212.52	241.12		68.39	190.49						
4/14/1988	212.17	227.77		64.58	177.78						
8/14/1988	190.39	214.42		60.76	165.06						
12/14/1988	168.62	201.06		56.95	152.35						
4/15/1989	146.84	187.71		53.13	139.63						
8/14/1989	132.59	174.35		49.32	126.92						
12/14/1989	118.34	161	164.5	45.5	114.2			192.3	55.8	66.6	110.3
4/15/1990	104.09	121.5	126.4	18.7	153.4			107.4	15.3	41.7	50.7
8/15/1990	103.57	98.3	99.8	21.7	85.1			102.7	18.4	32.1	46.5
12/14/1990	103.05	94.72	96.04	21.12	82.16			98.60	17.79	31.08	44.29
4/15/1991	102.53	91.15	92.27	20.54	79.23			94.50	17.19	30.05	42.09
8/15/1991	95.17	87.57	88.51	19.95	76.29			90.40	16.58	29.03	39.88
12/15/1991	87.81	83.99	84.74	19.37	73.36			86.30	15.98	28.01	37.68
4/14/1992	80.45	80.42	80.98	18.79	70.42			82.20	15.37	26.98	35.47
8/14/1992	75.79	76.84	77.21	18.21	67.49			78.10	14.76	25.96	33.27
12/14/1992	71.14	73.26	73.45	17.62	64.55			74.00	14.16	24.94	31.06
4/15/1993	66.49	69.69	69.68	17.04	61.62			69.90	13.55	23.91	28.86
8/14/1993	64.96	66.11	65.92	16.46	58.68			65.80	12.95	22.89	26.65
12/14/1993	63.43	62.54	62.15	15.88	55.75			61.70	12.34	21.86	24.44
4/15/1994	61.90	58.96	58.39	15.29	52.81			57.60	11.74	20.84	22.24
8/15/1994	57.00	55.38	54.62	14.71	49.88			53.50	11.13	19.82	20.03
12/14/1994	52.09	51.81	50.86	14.13	46.94			49.40	10.52	18.79	17.83
4/15/1995	47.19	48.23	47.09	13.55	44.01			45.30	9.92	17.77	15.62
8/15/1995	45.22	44.65	43.33	12.96	41.07			41.20	9.31	16.75	13.42
12/15/1995	43.25	41.08	39.56	12.38	38.14			37.10	8.71	15.72	11.21
4/14/1996	41.28	37.5	35.8	11.8	35.2			33	8.1	14.7	9.01
8/14/1996	42.95	33.8	29.3	7.1	31.3			26	3.1	3.8	6.8
12/14/1996	44.61	46.2	50.5	13.5	43.2			43.4	7.2	9.2	17.1
4/15/1997	46.28	43.69	47.61	12.56	42.23			40.94	6.70	8.44	15.83
8/14/1997	45.43	41.17	44.73	11.61	41.26			38.49	6.20	7.69	14.56
12/14/1997	44.58	38.66	41.84	10.67	40.29			36.03	5.70	6.93	13.29
4/15/1998	43.74	36.14	38.96	9.73	39.31			33.57	5.20	6.17	12.01
8/15/1998	45.47	33.63	36.07	8.79	38.34			31.11	4.70	5.41	10.74
12/14/1998	47.20	31.11	33.19	7.84	37.37			28.66	4.20	4.66	9.47
4/15/1999	48.94	28.6	30.3	6.9	36.4			26.2	3.7	3.9	8.2
8/15/1999	46.90	15	17.1	4.6	17.3			10.3	1.2	0.8	2.4
12/15/1999	44.87	38.2	48.5	8.1	33.7			30.4	4.3	6.7	11.1

Table 3.2.2 Table of Significant Events with an Impact on Airborne Lead Levels

No. Event	Date	Event	Description
1	1973-1995	Phasedown of lead in gasoline	In 1973 lead content was 2-3 grams per gallon. In 1995 the percentage was of 0.6 of total gasoline sales. (http://www.epa.gov/history/topics/lead/02.htm)
2	1977	Banned lead base paint	The United States government's Consumer Product Safety Commission banned lead paint(U.S. Consumer Product Safety Commission (Release # 77-096)_
3	1979	Modernization of El Paso plant ASARCO	The modernization of El Paso Plant was completed and it reduced emissions of sulfur dioxide (U.S. EPA et al.1999).
4	1980	Stop processes lead, zinc, antimony, cadmium	The smelter no longer processed lead, zinc, antimony or cadmium in El Paso, TX (U.S. EPA et al.1999).
5	1985	Suspended lead smelting	Lead smelting operation was suspended in El Paso plant ASARCO (U.S. EPA et al.1999)
6	1993	Installation of CONTOP	ASARCO installed a Continuous Top feed Oxygen Process Technology (CONTOP) which was meant to increase production and reduce emissions (U.S. EPA et al.1999).
7	1999	ASARCO closed	ASARCO closed due to depressed copper markets (U.S. EPA et al.1999)

Lead concentration in El Paso, TX is generally displayed as a decreasing trend, well pronounced after the early 80's. The highest concentrations were measured between 1977 and 1980. After that, there was a steady concentration decrease with the lowest concentrations measured between 1996 and 1999.

Chapter 4

Conclusion

The lead levels of the El Paso airshed have decreased over the years. In the early 1970's, the El Paso airshed had lead levels above the national standards for this air pollutant criteria. It was not until the mid 1980's when it began a steady decrease in the levels of lead and it placed under the standards for lead levels nationally. The national standard lead level being 1.5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$).

Nationwide, lead emissions have dropped nearly 97% since 1980 (see Figure 3.2.1), due in large part to the phasedown of leaded gasoline. Similarly, the lead concentration in the El Paso area has dropped more than 99% since 1977. The analysis of data collected at five different stations, or sites, in El Paso, TX during the period of 1977 to 1999 indicates that the lead concentration in this airshed has decreased over the years but varies seasonally. For example, higher lead level particulates were present during the winter season of those years. By contrast, lower concentrations were found during the summer and spring seasons. One of the reasons for this difference can be explained by thermal condition. The particulate matters behave as the median condition allows it. During the spring and summer the particulate matters can move easier than during the winter condition. As a result, the particulate matter displacement is limited due to the thermal inversion. The atmospheric lead levels are not greatly affected by weather conditions such as wind speed and wind direction. They are, however, directly related to temperature, as the high airborne lead levels indicate in the winter season.

There are some important events between 1977 and 1999 that had a high impact with the results. For example, the ban of lead in gasoline was vital in removing tons of lead in the El Paso airshed. This is directly reflected on the figures and tables (see Figure 3.2.1 and Table 3.2.1) previously discussed after the year 1986. After that year, lead concentration levels in the El Paso airshed decreased, similar to the nation ambient lead concentration (Figure 3.2.1).

The ban of lead-based paint also had an impact on lead level concentrations. Table 3.1.1, for example, shows high levels of lead within the downtown area. This area corresponds to some of the oldest construction in El Paso where many buildings were built before 1977. This is the year when the U.S. Government's Consumer Product Safety Commission banned this kind of paint. As a result, lead concentration levels began to decrease.

Lead has been used industrially in the production of gasoline, ceramic products, paints, metal alloys, batteries, and solder. Some chemicals containing lead were previously added to gasoline to enhance vehicle performance, but that practice was phased out during the 1970's and 1980's. As a result, air emissions of lead from the transportation sector decreased dramatically during that period.

Today, the highest levels of airborne lead are usually found near industrial operations that process materials containing lead, such as smelters (U.S. EPA, 2003). This is the El Paso airshed situation, where the ASARCO smelter was a significant source of lead in the atmospheric level. As was explained in section 3.2, with the stop of this industry the concentration of airborne lead levels decreased. Presently, ASARCO is in a cleanup process to eventually be removed from its present location.

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[U.S. Consumer Product Safety Commission](#)(Release # 77-096)

Curriculum Vitae

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