Deanship of graduate studies

Al Quds University

Analytical study of hazard elements, air pollutants in the area of Bethlehem and Hebron

Suhail Musa Odeh

M. Sc. Thesis

2001

Abstract

In the last few years there was a global concern about the quality of air which humans, plants and animals breath. There is a great need that some one tell us the limits above which air becomes hazardous to breath. This thesis is concerned with this issue. The study to start with addresses the available background pollution resulting from certain source such as stone cutting and grinding, gas emission from vehicles and other known sources. Samples are collected and treated in the required manner and analyses were carried out using the inductively coupled plasma atomic emission spectroscopy (ICP-AES). It has been found that pollution differs from place to place and from time to another as well, depending on the transmission parameters.

The study indicated high detected values for certain elements of great usage in the area, such as Al and Fe. For the sake of completing the study a lot of work needs to be done as suggested in the last chapter of this thesis.

Contents

Chapter 3

Chapter 1

Introduction

The results of increased human activities introduced a lot of input into the air which humans, animals and plants need to breath. One important concern is the particulate matter of diverse diameters emitted in air. In the past few years there was a global concern about the quality of air which we all breath. Some of these particulate matters could be very hazardous if breathed and adhered to the lung walls or penetrated into blood vessels (USEPA, 1997).

For many years health organization and researches try to set a standard for particulate matter. Hundreds of significant new scientific studies have been published on the health effects of particulate matter. Recent health studies suggested that adverse public health effects, such as premature deaths and increased morbidity in children and

other sensitive populations, have been associated with exposure to particle levels well above those allowed by the current standards.

Particulate matter is the general term used for a mixture of solid particles and liquid droplets found in the air. Some particles are large or dark enough to be seen as soot or smoke. Others are so small they can be detected only with an electron microscope. Particulate matter originates from a variety of sources, including diesel trucks, power plants, wood stoves and industrial processes. The chemical and physical composition of these various particles vary widely. While individual particles cannot be seen with the naked eye, collectively they can appear as black soot, dust clouds, or grey hazes (USEPA,1997).

Those particles that are less than 2.5 micrometers in diameter are known as "fine" particles; those larger than 2.5 micrometers are known as "coarse" particles. Fine particles result from fuel combustion for example motor vehicles, power generation, and industrial facilities, residential fireplaces and wood stoves. Fine particles can be formed in the atmosphere from gases such as sulfur

dioxide, nitrogen oxides, and volatile organic compounds. Coarse particles are generally emitted from sources such as vehicles traveling on unpaved roads, materials handling, (for example and crushing and grinding operations), and windblown dust.

A national air quality standard focused on small particles to protect against coarse particle effects. The particles that have a greatest health concern were those equals to or less than 10 micrometers that can penetrate into sensitive regions of the respiratory tract.

Usually the pure air of atmosphere comprises oxygen 21%, nitrogen 78%, and a number of rarer gases, of which argon at 0.93% and carbon dioxide 0.03%. There are number of gases that may atmosphere contain and considered poisonous to humans, animals and damaging to plants and wild life at high concentrations. This is referred to as air pollutants. Also the atmosphere contains a variety of particulate materials that have been accepted as posing a threat to health and environment.

The effect of air pollutants on health and on environment may vary from country to country. Because the different pollutant gases and particles concentration varies with both time and distance from the polluting source. The source of air pollutant gases and particulate materials comes from the dust, gases and smoke, and is generated mainly by human activities and other naturally occurring phenomena.

The common picture of air pollution is of smoking industrial chimneys and traffic exhausts affecting the surrounding populations (ambient air pollution). Although the main sources of air pollutants are man made (traffic and industry) and to less extent from natural contribution. This leads to two categories of pollutants sources: human or anthropogenic and natural (www.who.int)(2000). Natural sources include dust storms, volcanic action, forest fires and formation of radioactive particles gases such as radon.

Most of the anthropogenic sources are a fine particle involve combustion of some sort of materials of biological origin like wood, coal and oil. The large percentage of the anthropogenic sources is motor vehicles, industrial activities and the generation of electricity.

Human activity disturbs the natural self-balanced system; although the natural sources exceed anthropogenic sources on a global scale for production of some pollutants e.g. SO_2.

The combustion of oil and petrol in internal combustion engines leads to the release of organic compounds. These compounds when released condense in the air producing small particles of the order of 1mm in diameter, such particles have a short lifetime (less than one hour) and aggregate or agglomerate to produce particles in the 0.2-2 mm diameter range. This is defined as accumulation mode particles, where these particles are stable, long life period and may transport to hundreds of kilometers before lost from the air(www.osha.gov)(1992).

Air pollution is a major environmental health problem and pollutant concentrations may be different between indoor and outdoors environment. For some pollutants, indoor concentration usually exceeds outdoor concentration. Indoor air pollutants present a major health threat to millions of people. In the developing countries the major sources of indoor pollution are coal and biomass materials (cow dung, crop residues and grass) (www.who.int)(2000). The

domestic burning using these materials as fuel for heating and cooking, in poor countries this has it's great threat to women and children who live and spend most of their time closer to pollution sources. Coal burning for heating and cooking in developing countries results in indoor particle concentrations, is much higher level than ambient concentrations in polluted cities.

Outdoor concentrations of air pollutants vary from place to place. For example, concentrations of primary pollutants generated by motor vehicles decline rapidly as one move away from busy roads (www.who.int)(2000).

Particulate matter at last precipitate at walls and plant leaves, into solid materials. One of the rigorous methods to analyze of particulate matter precipitated into solid materials on walls and plant leaves is to use plasma Atomic Emission Spectrometric methods (AES). This technique requires that the sample to be introduced into a plasma source, where it is evaporated, and dissociated into free atoms and ions. Further additional energy is supplied to excite the free atoms and ions to higher energy states (Lajunen, 1992).

Plasma is partially ionized gas, which remains macroscopically neutral, and is a good conductor of electricity. The high temperature of the plasma and the dissociation of the analyzed compounds to atoms and ions and their excitation are produced by collisions with other particles, mainly with free electrons. The excited state is unstable and the atom or atomic ion loses its excess energy either by collisions with other particles, or by a radiate transition to a lower energy level. The resulting radiation is called spontaneous emission of radiation. The AES methods are based on these spontaneous emission spectra. These spectra originating from a plasma source are very complex. The source contains many kinds of atoms and ions originating from the sample and gas streams, and the emission spectrum of each particle present in the cell have many lines (Lajunen, 1992). Therefor, a monochromatic wave with a good resolution power and possibility for background correction is required for the spectrometer in AES.

The wavelengths of the emission lines are characteristic of the elements present in the plasma source. The detection of radiation at

particular wavelengths can be applied to the qualitative analysis of the sample and the intensities measured at these wavelengths to the quantitative analysis of the analyzed elements (Ebdon ,Evans, Fisher, and Hill,1998).

Most analytical plasma sources are electrical gas discharges at atmospheric pressure, usually in argon or in another inert gas. The various plasmas look like flames, but their temperatures are significantly higher – normally more than 5000K in the viewing zone (Lajunen,1992).

In this work the theory of plasma detection and analysis is viewed in chapter 2 . Sample collection and preparation for analysis is discussed and the results obtained are given in chapters 3 and 4 respectively. The rest of the thesis deals with discussion of results and suggestions for further work.

Chapter 4

Experimental Results

4.1. Introduction

Digested samples are analyzed by aspiration into inductively coupled argon plasma. This technique uses a high-power radio frequency (RF) source to power a water-cooled coil (inductor) around the end of the plasma torch. A high-voltage source initiates the plasma by causing some of the argon gas to ionize. The presence of ions renders it conductive. The high electrical power induced in the conductive plasma heats it to very high temperatures in the range 5000 to 8000 K, and is capable of producing atomic and ionic emission lines (spectra) of elements aspirated into the argon stream.

Sixty samples were collected and prepared as explained in section 3.4. Sample testing was then carried out and compared against standard

samples having the expected elements. The corresponding wavelengths used for identification of each of the element are shown in table 4.1. For analytical elements by ICP-AES there are two channels for each element to determine whether there were significant interference coincident or adjacent to the analyzed line, the wavelengths for each analytical line included in the array with the corresponding order are listed in the following table for 18 elements:

Table (4-1) the wavelength of the emitted photon from each associated element at which the measurements were taken.

Element	Wavelength (nm)
Ag	338.289
Al	396.152
Ba	493.408
Bi	223.061
Cd	226.502
Co	228.615
Cr	267.716
Cu	327.395
Fe	259.940
Ga	294.363
In	325.609
Li	670.783
Mn	257.610
Ni	231.604
Pb	182.143
Sr	407.771
Tl	276.789
Zn	202.548

The wavelength for each element shown in the table is obtained by the system torch for the standard sample (to be calibrated with) and the analyzed sample emit the wavelength of the spectrum appears in the torch.

The results of the analyzed and standard samples are obtained from the computer controlling the process. The personal computer was used to perform iterative interelement corrections and several functions including the following:

a) Speed up the data processing

b) Provide the ability to assess different interelement correction algorithms without need to reanalyze the samples

c) Present the results in a form amenable to reporting samples

4.2. Data

The results of the processed samples are arranged as shown in table 4.2 below:

Sample Label	Ag mg/g	Al mg/g	Ba mg/g	Bi mg/g	Cd mg/g	Co mg/g	Cr mg/g	Cu mg/g	Fe mg/g
BL1.1	0.068	38.05	0.35	0.024	0.006	0	0.085	0.072	25.05
BL2.1	0.042	115.8	0.486	0	0.011	0.042	0.101	0.043	55.69
BL3.1	0.068	31.96	0.387	0	0.004	0.041	0.056	0.054	22.77
BL4.1	0.095	34.96	0.285	0	0.006	0	0.064	0.037	26.37
BL5.1	0.082	27	0.908	0	0.006	0.01	0.05	0.032	20.81
BL6.1	0.171	27.54	0.274	0.007	0.003	0.023	0.054	0.026	18.04
BL7.1	0.023	60.99	0.361	0	0.005	0.016	0.113	0.036	40.34
BL8.1	0.061	36.57	0.356	0	0.005	0.006	0.078	0.105	24.17
BL9.1	0.025	67.18	0.279	0.013	0.006	0.019	0.082	0.03	36.6
BL10.1	0.116	34.03	0.158	0	0.003	0.016	0.05	0.022	21.86
BL11.1	0.121	40.52	0.597	0	0.01	0.057	0.083	0.106	32.93
BL12.1	0.062	40.11	0.534	0	0.007	0.017	0.073	0.075	29.71
BL13.1	0.222	24.47	0.447	0	0.005	0	0.066	0.129	20.08
BL14.1	0.092	16.63	0.166	0	0.003	0	0.032	0.024	11.14
BL15.1	0.104	41.74	0.482	0	0.007	0.022	0.083	0.097	28.38
BL16.1	0.05	17.01	0.233	0	0.003	0.007	0.054	0.097	13.76
HE1.1	0.052	42.71	0.545	0	0.006	0.036	0.092	0.055	28.56
HE2.1	0.068	50.2	0.579	0	0.006	0.145	0.091	0.132	35.49
HE2.2	0.014	41.27	0.383	0	0.004	0	0.061	0.05	21.85
HE3.1	0.021	38.61	0.521	0	0	0	0.06	0.051	20.63
HE4.1	0.026	26.05	3.149	0.019	0.005	0	0.09	0.092	20.87
HE4.2	0.032	29.69	1.077	0	0.005	0.016	0.047	0.074	21.74
HE4.3	0.155	48.32	1.231	0	0.009	0.024	0.082	0.086	34.91
HE5.1	0.392	28.46	0.34	0	0.008	0.012	0.043	0.06	19.44
HE5.2	0.409	58.54	0.542	0	0.008	0.019	0.082	0.104	32.79
HE6.1	0.405	33.07	0.551	0	0.008	0.015	0.078	0.163	33.25
HE6.2	0.482	61.96	0.589	0	0.008	0.025	0.114	0.148	42.09
HE7.1	0.436	50.6	0.7	0	0.009	0.018	0.114	0.182	45.58
HE8.1	0.455	38.99	0.404	0	0.005	0.013	0.059	0.068	25.45
HE9.1	0.521	27.49	0.539	0	0.005	0.015	0.069	0.084	27.07

Table 5 Concentration levels of 18 heavy elements mentioned in table 4.1. Samples are taken from Bethlehem, Beit Sahour, Beit Jala & Hebron as indicated by sample labels.

Sample Label	Ag mg/g	Al mg/g	Ba mg/g	Bi mg/g	Cd mg/g	Co mg/g	Cr mg/g	Cu mg/g	Fe mg/g
HE10.1	0.538	21.3	0.358	0	0.004	0	0.115	0.343	18.69
HE11.1	0.012	51.08	0.415	0	0.006	0.01	0.075	0.151	32.06
BJ1.1	0.068	33.91	0.421	0	0.006	0	0.073	0.151	23.65
BJ2.1	0.063	22.95	0.262	0	0.008	0	0.044	0.034	16.68
BJ3.1	0.143	47.44	1.537	0	0.007	0.035	0.077	0.112	34.9
BJ4.1	0.108	32.74	0.859	0.051	0.006	0.023	0.216	0.045	24.6
BJ5.1	0.129	28.23	0.226	0	0.002	0	0.044	0.034	16.91
BJ6.1	0.029	16.16	11.05	0	0.045	0.051	0.153	0.103	240.5
BJ7.1	0.162	27.78	2.72	0	0.003	0	0.086	0.054	21.88
BJ8.1	0.083	37.15	1.509	0	0.013	0.012	0.125	0.058	23.61
BJ9.1	0.057	32.04	1.859	0	0.041	0.015	0.079	0.166	32.66
BJ10.1	0.076	43	1.108	0	0.013	0.048	0.076	0.099	32.97
BJ11.1	0.077	60.72	0.449	0	0.008	0.018	0.162	0.024	29.59
BJ12.1	0.075	62.12	0.429	0	0.008	0.014	0.172	0.025	30.21
BS1.1	0.06	28.44	3.136	0	0.018	0.227	1.943	0.053	82.32
BS2.1	0.138	29.06	0.757	0	0.011	0.05	0.226	0.11	45.48
BS3.1	0.194	41.73	0.646	0	0.012	0.015	0.098	0.083	30
BS4.1	0.095	32.01	0.362	0	0.023	0.022	0.059	0.123	22.08
BS4.2	0.013	151.1	0.338	0	0.031	0.004	0.147	0.023	82.18
BS5.1	0.2	22.06	0.511	0	0.02	0.022	0.057	0.027	13.51
BS5.2	0.204	30.38	0.485	0	0.039	0.026	0.079	0.088	26.12
BS6.1	0.041	27.97	0.976	0	0.004	0.03	0.076	0.041	19.27
BS7.1	0.113	28.02	0.626	0	0.012	0	0.059	0.028	20.06
BS8.1	0.047	41.64	0.434	0	0.014	0.019	0.129	0.055	27.13
BS9.1	0.079	23.89	1.022	0	0.008	0.021	0.053	0.031	19.71
BS10.1	0.088	57.65	0.527	0	0.034	0.027	0.104	0.077	37.69
HEW1	0.125	59.13	0.195	0	0.02	0.021	0.053	0.018	28.78
HEE1	0.04	253.1	0.458	0.018	0.044	0.07	0.262	0.052	138.9
HES1	0.052	99.66	0.274	0	0.04	0.02	0.089	0.034	51.87
HEN1	0.05	53.75	0.537	0	0.027	0.045	0.128	0.107	39.87

Table 4.2 continued

Sample Label	Ga	In	Li	Mn	Ni	Pb	Sr	Tl	Zn
	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g
BL1.1	0.004	0.018	0.019	1.462	0.059	0.103	0.641	0	1.318
BL2.1	0.013	0.02	0.038	3.099	0.056	0.01	0.508	0	0.921
BL3.1	0.005	0.011	0.017	1.594	0.046	0	0.491	0.061	1.44
BL4.1	0.002	0.006	0.019	1.739	0.049	0.069	0.488	0	0.976
BL5.1	0	0.016	0.016	1.34	0.032	0.089	0.443	0	1.618
BL6.1	0	0	0.015	1.303	0.044	0.109	0.508	0	0.765
BL7.1	0.004	0.009	0.028	2.088	0.059	0.092	0.592	0.034	0.664
BL8.1	0	0.004	0.019	1.456	0.046	0	0.462	0.026	1.095
BL9.1	0.011	0.011	0.029	2.397	0.059	0.051	0.389	0	0.62
BL10.1	0.003	0.01	0.016	1.378	0.042	1.204	0.273	0	0.485
BL11.1	0	0.02	0.022	2.087	0.061	0.142	0.552	0	1.007
BL12.1	0.009	0.015	0.02	1.597	0.051	0.221	0.5	0.033	0.754
BL13.1	0	0.02	0.013	1.225	0.052	0.152	0.528	0.023	1.033
BL14.1	0.003	0.009	0.008	1.224	0.046	0.09	0.573	0	0.411
BL15.1	0	0.022	0.02	1.816	0.073	0.219	0.631	0.028	0.976
BL16.1	0	0	0.011	0.922	0.068	0.078	0.382	0	0.927
HE1.1	0	0.016	0.029	1.756	0.044	0.287	0.398	0.033	0.762
HE2.1	0.005	0.027	0.03	2.512	0.056	0.232	0.498	0	1.425
HE2.2	0	0.02	0.018	1.213	0.032	0.138	0.345	0	1.13
HE3.1	0	0	0.017	1.164	0.032	0.123	0.328	0	0.626
HE4.1	0	0.01	0.014	1.235	0.039	0.133	0.349	0.037	2.64
HE4.2	0	0.014	0.014	1.277	0.042	0.138	0.296	0.011	1.09
HE4.3	0.006	0.027	0.021	1.704	0.053	0.207	0.379	0.046	1.409
HE5.1	0	0.012	0.011	1.323	0.046	0.212	0.26	0.024	0.84
HE5.2	0.007	0.011	0.021	1.74	0.067	0.193	0.424	0.021	2.882
HE6.1	0	0.029	0.019	2.194	0.07	0.306	0.464	0.024	1.428
HE6.2	0.007	0.02	0.032	2.341	0.072	0.233	0.555	0	1.048
HE7.1	0.004	0.023	0.029	2.401	0.058	0.606	0.433	0	0.984
HE8.1	0	0.018	0.016	1.7	0.031	0.142	0.361	0.03	0.823
HE9.1	0	0.013	0.014	1.612	0.065	0.296	0.326	0	1.185

Table 4.2 continued

Sample Label	Ga mg/g	In mg/g	Li mg/g	Mn mg/g	Ni mg/g	Pb mg/g	Sr mg/g	Tl mg/g	Zn mg/g
HE10.1	0	0.008	0.013	1.232	0.345	0.604	0.38	0.036	1.816
HE11.1	0.006	0.018	0.023	2.12	0.079	0.158	0.462	0	1.444
BJ1.1	0	0.017	0.017	1.808	0.045	0.252	0.507	0	1.055
BJ2.1	0	0.015	0.015	1.083	0.055	0.084	0.406	0.022	0.927
BJ3.1	0	0.016	0.022	1.913	0.061	0.2	0.467	0.035	1.933
BJ4.1	0.006	0.012	0.019	1.73	0.043	0.288	0.589	0.021	1.06
BJ5.1	0.007	0	0.015	1.14	0.034	0.123	0.551	0.041	0.509
BJ6.1	0.025	0.067	0.009	7.421	0.121	4.079	0.268	0	16.72
BJ7.1	0	0.005	0.014	1.19	0.04	0.242	0.527	0	1.397
BJ8.1	0	0.011	0.023	1.531	0.177	0.149	0.448	0	2.898
BJ9.1	0.006	0.023	0.014	1.716	0.534	0.153	0.439	0.026	1.124
BJ101	0	0.018	0.021	1.941	0.111	0.411	0.526	0	1.936
BJ11.1	0	0.026	0.04	2.308	0.072	0.128	0.615	0.029	0.856
BJ12.1	0.008	0	0.041	2.335	0.076	0.072	0.63	0	1.135
BS1.1	0.007	0.021	0.014	2.395	0.074	5.214	0.606	0	2.074
BS2.1	0	0.014	0.019	1.983	0.104	0.23	0.515	0.021	1.437
BS3.1	0	0.007	0.021	1.798	0.065	0.101	0.586	0	2.201
BS4.1	0	0.007	0.015	1.293	0.218	0.205	0.51	0	0.81
BS4.2	0.017	0.041	0.067	4.808	0.328	0.006	0.207	0	0.835
BS5.1	0	0	0.01	0.83	0.197	0.069	0.712	0.029	0.763
BS5.2	0	0.014	0.015	1.733	0.46	0.241	0.534	0.046	0.993
BS6.1	0	0.016	0.014	1.158	0.059	0.185	0.577	0.043	1.29
BS7.1	0.005	0.011	0.013	1.171	0.112	0.046	0.657	0	0.895
BS8.1	0	0.016	0.019	1.832	0.125	0.235	1.016	0.034	1.644
BS9.1	0	0.01	0.011	1.13	0.089	0.122	0.559	0	1.325
BS10.1	0.006	0.026	0.025	2.462	0.369	0.378	0.565	0	5.773
HEW1	0.006	0.017	0.037	2.094	0.258	0	0.328	0.03	0.768
HEE1	0.038	0.042	0.092	6.452	0.429	0.036	0.18	0	0.9
HES1	0.009	0.028	0.037	3.8	0.504	0	0.355	0	0.542
HEN1	0.005	0.019	0.024	2.437	0.336	0.162	0.609	0	1.363

Table 4.2 continued

4.3 Results analysis:

Tests are concerned with particulate matter, which is a mixture of solid particles and liquid droplets found in air. Two types of particles are distinguished in the atmosphere as far as particle diameters are concerned. Fine particles with diameter <2.5 μm and Coarse particles with diameter >2.5μm (WHO,1999).

a. Coarse particles :

Coarse particles come from a variety of sources including windblown dust and grinding operations. They are generally comprised of soil and sea salt elements. The major elements of these particles are Si, Al, Ca, Fe, Ti, and Sr.

b. Fine particles:

Fine particles arise from gas-to-particles conversions, combustion, in general, for example fuel combustion from (motor vehicles, power generations, industrial facilities, power plants, and diesel buses and trucks). The major components of fine particles are sulfate, nitrate, organic and elemental carbon and ammonium ions, also they contain a variety of trace metals from the combustion processes. For comparison between fine and coarse particle shown in the table 4.3

Table 4.3. Comparisons of ambient fine and coarse mode particles

	Fine Mode	Coarse Mode
Formed from:	Gases	Large solids/droplets
Formed by:	Chemical reaction; nucleation; condensation; coagulation; evaporation of fog and cloud droplets in which gases have dissolved and reacted.	Mechanical disruption (e.g. crushing, grinding, abrasion of surfaces); evaporation of sprays; suspension of dusts.
Composed of:	Sulphate, $SO_4^{=}$; nitrate NO_3^{-}; ammonium, NH_4^{+}; hydrogen ion, H^{+}; elemental carbon; organic compounds; metals (e.g. Pb, Cd, Ni, Cu, Zn, Mn, Fe); particle-bound water.	Resuspended dusts (e.g., soil dusts, street dust); coal and oil fly ash, metal oxides of crustal elements (Si, Al, Ti, Fe); $CaCO_3$, NaCl, sea salt; pollen, mould spores; plant/animal fragments; tire wear debris
Solubility	Largely soluble, hygroscopic and deliquescent	Largely insoluble and non-hygroscopic
Sources	Combustion of coal, oil, gasoline, diesel, wood; atmospheric transformation products of NO_x, SO_2 and organic compounds including biogenic species (e.g. terpenes) high temperature processes, smelters, steel mills, etc.	Resuspension of industrial dust and soil tracked onto roads; suspension from disturbed soil (e.g. farming, mining, unpaved roads); biological sources; construction and demolition; coal and oil combustion; ocean spray
Lifetimes	Days to weeks	Minutes to hours
Travel Distance	100s to 1000s of kilometers	< 1 to 10s of kilometers

Source: USEPA (1995)

There is a variety of potential sources of the trace elements such as combustion of coal and oil (including gasoline), wood burning, waste incineration, and metal mining and production. There are also natural sources of metals, such as windblown dusts, sea salt, forest fires, and emissions from vegetation. Not all the above mentioned had noticeable effect in Palestine. For example, a forest fire effect is very rare in our region.

Metal particles are produced by mechanical processes, e.g. windblown dust in large particles, and by other processes like combustion in fine particles.

The concentrations of both fine and coarse particles are greater in the urban areas than in the rural areas. Since there are larger primary emissions compared to the rural area, larger concentration of oxidation and others to carry out gas-to- particles conversions. In addition, greater activation likes automobile traffic to suspend coarse particles such as soil dust. And also the difference in the nature of the sites

The elemental composition of aerosol particles has a relation to their source like the V and Ni are an indication of oil combustion and

elevated concentration of elements such as As and Se associated with coal burning. Therefore, element concentration may change from that at the source as the air mass travels over downwind sources.

The particulate matter has an effect on both health and environment. Because they easily reach the deepest recess of the lungs creating significant health problems and causes a premature death (WHO,1999).

There is a standard for air contaminants where the permissible exposure limits, as Occupational Safety & Health Administration (**OSHA**) published it in USA. The following table shows the list of these standards

Air Contaminants - OSHA Permissible Exposure Limits

Name of elements	Symbol	Concentration mg/m^3
Silver	Ag	0.01
Aluminum	Al	2
Barium	Ba	0.5
Bismuth	Bi	---
Cadmium	Cd	0.2
Cobalt	Co	0.1
Chromium	Cr	1
Copper	Cu	1
Iron	Fe	10
Gallium	Ga	---
Indium	In	0.1
Lithium	Li	0.025
Manganese	Mn	5
Nickel	Ni	1
Lead	Pb	0.005
Strontium	Sr	---
Thallium	Tl	0.1
Zinc	Zn	15

Table 4.4 standards of air contaminates

Chapter 5

Discussion

The results from table 4.2 show the concentration levels for 18 of the heavy elements in Bethlehem, Beit Sahour, Beit Jala, and Hebron. For some elements the measured value differ from site to another in the same city. Some sites have high levels of concentration for some elements and low levels of concentration for other elements. This is due to the difference between the source of pollution from site to site. As mentioned before sources of pollution are randomly scattered in cities.

Table 5.1 The minimum and maximum value for the detected elements for each city.

Note :*mg/g means number of mg found in 1 gram of collected solid sample*

Element	Range	
	Minimum value (mg/g)	Maximum value (mg/g)
Bethlehem		
Ag	0.023	0.222
Al	16.63	115.8
Ba	0.158	0.908
Bi	0	0.024
Cd	0.003	0.011
Co	0	0.057
Cr	0.032	0.113
Cu	0.022	0.129
Fe	11.14	55.69
Ga	0	0.013
In	0	0.022
Li	0.008	0.038
Mn	0.922	3.099
Ni	0.032	0.073
Pb	0	1.204
Sr	0.273	0.641
Tl	0	0.061
Zn	0.411	1.618
Hebron		
Ag	0.012	0.538
Al	21.30	61.96
Ba	0.340	3.149
Bi	0	0.019
Cd	0	0.009
Co	0	0.145
Cr	0.043	0.115
Cu	0.050	0.343
Fe	18.69	45.58
Ga	0	0.007

In	0	0.029
Li	0.011	0.032
Mn	1.164	2.512
Ni	0.031	0.345
Pb	0.123	0.606
Sr	0.260	0.555
Tl	0	0.046
Zn	0.626	2.882

Beit Jala

Ag	0.029	0.162
Al	16.16	62.12
Ba	0.226	11.05
Bi	0	0.051
Cd	0.002	0.045
Co	0	0.051
Cr	0.044	0.216
Cu	0.024	0.166
Fe	16.68	240.5
Ga	0	0.025
In	0	0.067
Li	0.009	0.041
Mn	1.083	7.421
Ni	0.034	0.534
Pb	0.072	4.079
Sr	0.268	0.630
Tl	0	0.041
Zn	0.509	16.72

Beit Sahour

Ag	0.013	0.204
Al	22.06	151.1
Ba	0.338	3.136
Bi	0	0
Cd	0	0.227
Co	0	0.004

Cr	0.053	1.943
Cu	0.023	0.123
Fe	13.51	82.18
Ga	0	0.017
In	0.007	0.041
Li	0.010	0.067
Mn	0.830	4.808
Ni	0.059	0.460
Pb	0.006	5.214
Sr	0.207	1.016
Tl	0	0.046
Zn	0.763	5.773

Table 5.1 shows that the range of concentration levels of a certain element have almost the same value except for few recorded values which is very high relatively to the others. this indicates that there is elemental pollution in these sites.

For silver (Ag) as shown from table 5.1 the range of concentration levels for all cities is almost the same. except in Hebron where there are some sites in Hebron has a high value of the concentration levels. Those sites, which are in Al-Shalal St., daboyah Al-akrad area, Bani naem cross and Yatah road, have a high density of traffic movement and many of restaurants at these sites using coal for cooking, in addition the factories of stones at Bani naem cross and Yatah road.

Aluminum (Al) registered high level of concentrations at Beit sahour cross in Bethlehem and at Alsha'ab market in Beit sahour where other values have a low range relative to these values since at these sites there is a bus station. For Barium (Ba) at Islamic bank in Hebron and at Al-Obeideyah cross in Beit sahour, and at Iskander cross and Al- sahel street in Beit jala. Where these sites have be considered as main streets and active areas in these cities, which means the high number of trucks and cars passing through these sites and many of factories exist in these sites.

Bismuth (Bi) has a low concentration in all cities, so it can be considered of non toxic level. Cadmium also has a low level of concentration, except at Al- sahel street in Beit jala, and at mosque cross, Nasr street in Beit sahour. Cobalt (Co) has a range of concentration levels between 0 to 0.5 mg/g but at Al-Obeideyah cross in Beit sahour and at Ras Aljorah in Hebron has a high value (0.227mg/g,0.145mg/g respectively) because at these sites there is some workshops for irons and stores for painting. In addition, the concentration of chromium (Cr) is very high in these sites, which is

1.943mg/g at Al-Obeideyah cross, while the range of concentration is between 0.03mg/g to 0.16mg/g in other sites.

The highest concentration for copper (Cu) was recorded at Yatah road site in Hebron, which is 0.343mg/g where in other sites it is found to be in the range 0.02mg/g to 0.16mg/g. Also nickel in this site has a high level where its value is 0.345mg/g while the range for most sites is between 0.03mg/g to 0.08mg/g . Iron has also a high concentration at Al-Obeideyah cross and Alsha'ab market in Beit sahour and at Beit sahour cross in Bethlehem and very high concentration level is recorded at Al-sahel street in Beit jala, which is 240.5mg/g, where the other sites are in the range of 11mg/g to 45mg/g. Also Gallium (Ga), Indium (In), Manganese (Mn), and Nickel (Ni) have high concentration levels in these sites.

One of the most poisonous elements is lead (Pb). It was found in high levels of concentration at the following sites:- Bab zkak in Bethlehem, Al-sahel street in Beit jala (4.079mg/g) and the most high level was recorded at Al-Obeideyah cross in Beit sahour which is

5.214mg/g while the mximum value of concentration in other sites is in the order of 1mg/g.

There is one site in which a high level of concentration for Strontium (Sr) was measured, which is Abu Sada street site in Beit sahour. Where the value of the concentration is 1.016mg/g and the range for other sites is between 0.2mg/g to 0.7mg/g . In addition, Thallium (Tl) has a high concentration at central market cross in Bethlehem where its value is 0.061mg/g and the range of the other sites are between 0mg/g to 0.04mg/g . The high concentration of zinc (Zn) (16.72mg/g) was found at Al- sahel street in Beit jala and at Eisteih street in Beit sahour while the other sites are in the range between 0.4mg/g to 3mg/g .

The source of air pollution in these sites as shown in Al- sahel street in Beit jala which is suffering from a high concentration of most of pollutant elements is due to existence of factories of stones and concrete, traffic, combustion of some sort of materials of biological origin like wood, animal dung, crop residues, grass, and the use of coal burning for heating and cooking especially in public restaurants.

The existence of the workshops for example iron works and painting stores, bakeries which use coal or diesel as fuel for heating, increases the concentration of pollutants in air.

The local concentration of air pollution depends on certain factors as follows (www.who.int,2000):

1. Strength of the sources of air pollution and the efficiency of their dispersion.
2. Winds: where the concentrations being inversely related to wind speed for ground level sources. However, wind is very important for dispersing air pollutants.
3. Temperature: where the temperature controls the depth of the layer of air adjacent to the ground in which the pollutants are well mixed.

Therefore, air pollution is varying from place to place and from time to time.

Chapter 6

Conclusions & Further work

The study has indicated some of heavy element pollutants in our region. The used method ICP-AES was found to be a useful and satisfactory method for such study. There is an indication of high levels of some elements such as Al and Fe in certain regions. In view of the non available agreement on the standard limit of poisonous limit in the world and since this study is performed on solid accumulated samples over the past period, there is an urgent need for further work.

Further work:

There is a need to perform the following:

- A Study that covers the most air cities and villages in the West Bank especially the cities which have pollutant factories e.g. like Jenien where the factories of coal exist there. The result of this is to establish a map of pollutant distributions.

- Establish different ways for collecting the samples where the age of the sample and the quantity of the dust that exist in one meter cube of air can be known. To relate to the universal standards. Established by the world health organization (WHO).
- Test samples with different techniques for comparison and design an easy in situ testing methods.

References

- Dendy Richard, Plasma Physics: An introductory course, Cambridge University Press, Great Britain, (1993).
- Ebdon L., E.H. Evans, A. Fisher, S.J. Hill, An introduction to Analytical Atomic Spectrometry, John Wiley &sons publishers Ltd., Great Britain, (1998).
- Eliezer Yaffa & Shalom, The fourth state of matter an introduction to physics of Plasma, IOP publishers Ltd. Israel,(1989).
- Galeeu A.A., R.N. Sudan , Basic Plasma Physics, North Holland Publishing, Amesterdam,(1983).
- Lajunen, L.H.J, Spectrochemical analysis by atomic absorption and emission, Bath press, Bath, UK, (1992).
- Manual of Microwave Accelerated Reaction System (MARS), (1997).
- Manual of vista ICP-AES (catalogue of manufacture), (1998).
- Martin R. Carter, Soil sampling & methods of analysis, Lewis publishers, USA, (1996).
- Miymoto K., Plasma physics for nuclear fusion, MIT, Tokyo, (1980).

- Nicholas A.K., Principle of plasma physics, Mc GRAW–Hill.Inc, (1973).
- Palestine Central Bureau of Statistics, Book publishers, (2000).
- Robinson James W., Atomic spectroscopy, 2nd Edition, Marcel dekker, USA, (1996).
- The web site of the Occupational Safety & Health Administration (OSHA), www.osha.gov , (1997).
- The web site of the United State Environmental Protection Agency (USEPA) on the internet, www.epa.gov, (1997).
- The web site of the World Health Organization (WHO), www.who.int, (2000).