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Lead Contamination of Soil in Baghdad City, Iraq

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Lead is a non-essential element for man and has toxic potential for all biological systems. In recent years increasing attention is paid to lead contamination from industrial and non-industrial sources, and it has been a matter of health concern (SHROEDER 1965, WARREN & DELEVAULT 1960). One of the important sources of lead contamination in urban areas is the combustion of leaded gasoline by automobiles and the subsequent release of lead particles through exhaust. Consequently, enhancement in the levels of lead in roadside soil and vegetation (CANNON & BOWLES 1962, LAGERWERFF & SPECHT 1970, MOTTO et al. 1970, PAGE & GANJE 1971, HARVE & UNDERDAL 1976) and street dust (DAY et al. 1975, ARCHER & BARRATT 1976, DUGGAN & WILLIAMS 1977, FARMER & LYON 1977, HO 1979) have occurred. Like other metals, lead contamination of soil appears to be virtually irreversible and lead finds access into plants and animals, and thus enters into the food web. Moreover, the anomalous lead content of soils and plants from England and Canada when compared with the health data suggested correlation with several diseases (WARREN & DELEVAULT 1960, WARREN 1961).

Baghdad, with its three million inhabitants, is the biggest and the most industrialized city of Iraq. Due to its rapid development and increasing traffic volume, it is expected to suffer from lead contamination. In spite of this, no information regarding the dispersal and distribution of lead in different parts of the city is available, except some work on Tigris River water (MUTLAK et al. 1980) and indoor settled dust (AL-SHAHWANI & AL-BADRI 1981), which indicated that the lead levels in those samples were high. This study was undertaken to investigate and monitor lead contamination in soil samples from different parts of Baghdad City.

MATERIALS AND METHODS

Soil samples from 36 sites were collected in such as to achieve a spatial coverage of the entire city. Three samples from industrial area were also included. From each place, two surface soil (0-5 cm) samples were collected with a stainless steel corer having a 15-cm length and 5 cm diameter. About 20-25 cores were taken for each sample to constitute a composite and representative sample. The samples placed in polyethylene bags were later transferred to aluminum dishes and were dried at 70°C for 72 h. Samples were then ground in a porcelain pestle and were passed through a 20-mesh (750 um) stainless steel sieve.

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For the estimation of total Pb, a subsample of one g from each was digested with 25 mL of a nitric-perchloric acid mixture in a flask placed over a hot plate. The temperature of the hot plate was gradually increased and the material was digested until the appearance of white fumes and about 2-3 mL of acid was left to avoid over heating. About 40 mL of double-distilled water was added and then filtered into a 50-mL graduated flask and the volume was made up to the mark.

To estimate the Pb available to plants, DTPA extractant (LINDSAY & NORVEL 1978) was used. Besides its use for micronutrients, it has been used to assess the availability of heavy metals (GAYNOR & HALSTEAD 1976). The DTPA extractant was prepared to contain 0.005 M DTPA (diethylenetriaminepentaacetic acid), 0.01 M $CaCl_2$ and 0.1 M triethanolamine, and the pH was adjusted to 7.3 with HCl. Twenty g of the soil sample were placed in a plastic bottle and 40 mL of the DTPA solution was added. The bottles were shaked for 2 h on a reciprocating shaker, and the suspension was filtered. The acid digestate and the DTPA filtrates were analysed for Pb by atomic absorption.

RESULTS AND DISCUSSION

The distribution of Total and DTPA-extractable Pb in different quadrants of Baghdad City is shown in Table 1. The concentration of Total Pb in the soil samples from urban areas varied from 32 to 950 ug/g with an average of 267 ug/g, whereas the mean concentration of Pb in the samples from industrial area was 36 ug/g. It is evident that the Pb concentration in urban areas is far greater than that of the industrial area. The North-East quadrant has the highest Pb concentration followed by that of North-West and South-East quadrants, while the South-West quadrant has the lowest concentration.

The DTPA extractable Pb in these soil samples followed almost a similar pattern as that of Total Pb. It ranged from 2 to 362 ug/g with an average of 105 ug/g in the samples from urban areas, and the mean concentration in the industrial area was 3 ug/g with a range of 2 to 4 ug/g. It is interesting to find that DTPA extractant has extracted more than 30% of the Total Pb present in the samples from urban areas while a much lesser quantity (8%) was extracted in case of samples from industrial area. Moreover, the DTPA extractable Pb has shown a positive and highly significant correlation with Total Pb (Figure 1). The frequency distribution diagrams for Total and DTPA-extractable Pb are presented in Figure 2. It is observed from these diagrams that DTPA extractable Pb in 44% of the samples is less than 50 ug/g and only 21% of the samples showed the Pb content above 150 ug/g. While in case of Total Pb, 21% of the samples have shown the Pb content below 100 ug/g and 49% of them showed the Pb content below 200 ug/g. But only 18% of the samples have the Pb content above 400 ug/g and one sample had an exceptionally high value of 950 ug/g. The direction of wind did not seem to have any profound effect on the distribution of Pb in the samples.

The Pb concentration in the samples from the industrial area is much lower as compared with that of the samples from the urban areas.

Table 1. Distribution of lead (ug/g) in soil samples from different quadrants of Baghdad City and the industrial area.

a. Total Lead

City Quadrant	Mean	Range
North-East	308	111-671
South-East	268	94-950
North-West	276	99-633
South-West	170	111-307
Industrial Area	36	32-40

b. DTPA-Extractable Lead

North-East	117	29-316
South-East	114	21-362
North-West	106	19-326
South-West	59	31-102
Industrial Area	3	2-4

c. DTPA/Total Lead X 100

North-East	35	22-47
South-East	35	23-48
North-West	31	16-42
South-West	35	28-42
Industrial Area	8	6-11

This indicates that the Pb contamination is entirely due to the burning of leaded gasoline by automobiles. As expected, the Pb concentration is high in the areas of high traffic and the samples from city centre have higher concentration as compared to those of the other areas. This is in conformity with the findings of other researchers (AULT et al. 1970, CHOW & EARL 1970) who found that most of the airborne lead originated from the combustion of leaded gasoline by automobiles.

In naturally occurring non-polluted soil the Total Pb is around 10 ug/g (SWAINE 1955), therefore, it appears that the soil samples from urban areas are about 30 times more contaminated, except those from the South-West quadrant which showed a lower magnitude of contamination (17 times). Whereas the soil samples from industrial area showed the least contamination (4 times). The direction of wind movement did not seem to have any profound effect on the distribution of

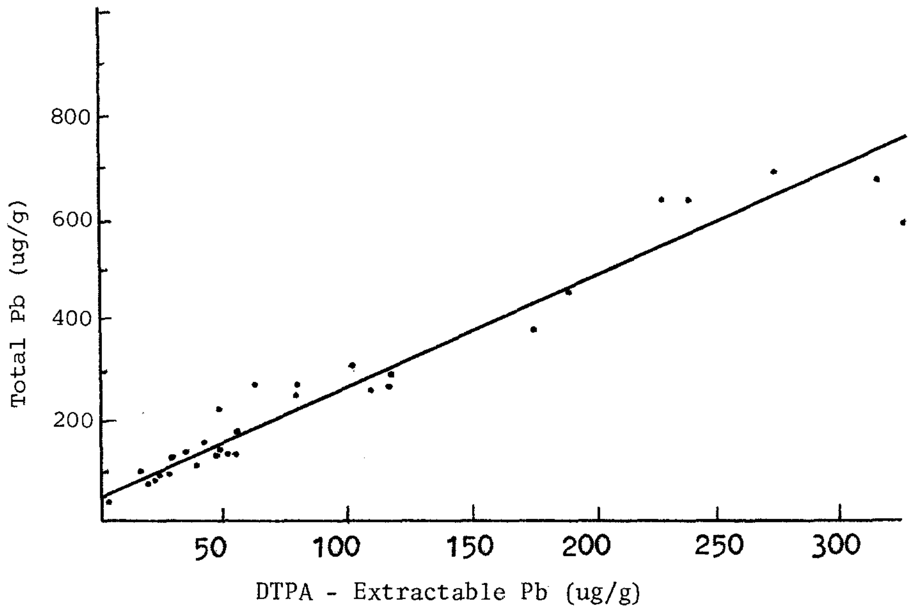

Figure 1: Relationship of Total Pb with Extractable Pb.

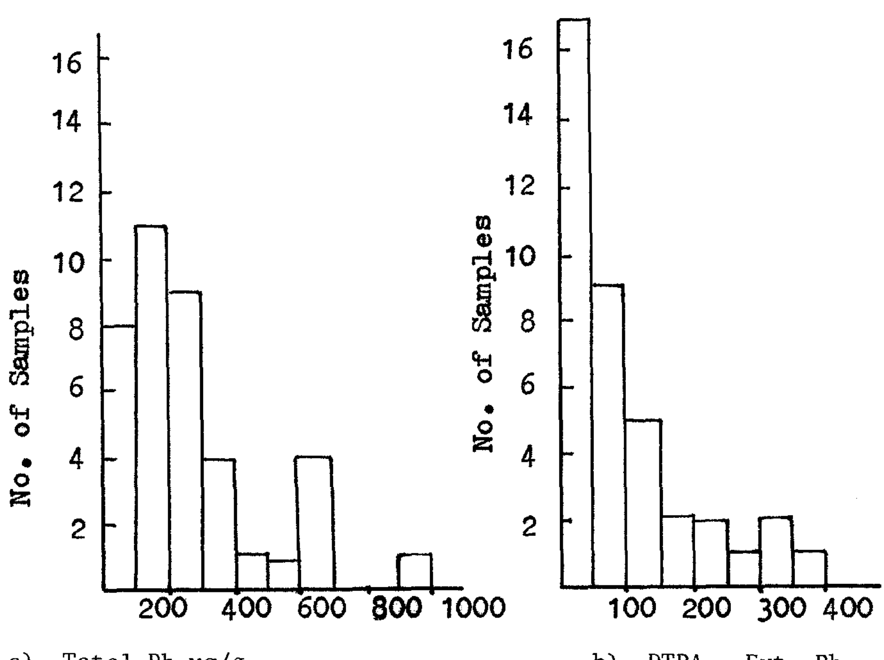

Figure 2: Frequency Distribution Diagrams of Total and DTPA - Ext. Pb in Soil Samples.

lead in these samples. This may be due to the fact that most of the particles more than 5 um settle within 100 m and the soil contamination by Pb is mostly attributed to this fraction and the wind effect is not important over longer distances (CHOW 1970). But certainly, the distance from the city centre and traffic volume are important factors and further investigation is needed to elaborate their relationship. Since DTPA-extractable Pb is an indicator of the bioavailability of Pb to plants and since the Pb concentration in the urban samples is quite high, it may lead to high levels of Pb in plants growing in the urban environment.

Several U.S. studies have reported varying Pb concentrations in soils adjacent to highways. Some of the higher values are 540 (LAGERWERFF & SPECHT 1970), 403 (CHOW 1970), and 160 ug/g (MOTTO et al. (1970). Our results are consistent with the concentration of Pb reported by these workers. This indicates that Pb contamination in the city is serious and is bound to increase with increasing traffic volume. It is, therefore, suggested that some measures may be adopted to control the Pb contamination in the city.

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