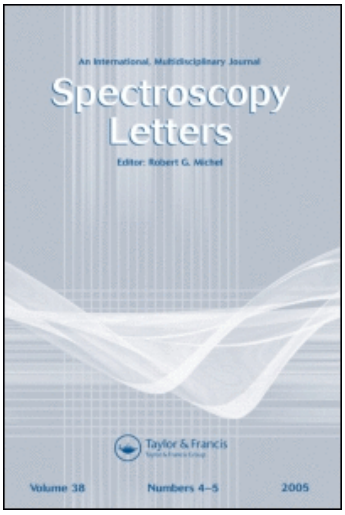

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Study of Lead Pollution by Edxrf Analysis

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STUDY OF LEAD POLLUTION BY EDXRF ANALYSIS

Key words: EDXRF , Lead pollution , soil analysis, plant analysis

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Abstract

Energy dispersive X-ray fluorescence analysis is applied to determine lead pollution from various locations near the highway of Ankara - Istanbul. In this proposed study, a complete optimization including sampling, homogeneity, particle size, critical thickness, measurement geometry for analysis of soils and plants is carried out. It is observed the contribution of the motor transport , along the 25 km of highway, to the lead pollution is very considerable depending on heavy traffic.

Introduction

The determination of pollutants in soil and plants is an important diagnostic method for the measurement of the concentration of components in the environment.

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The atmospheric pollutants enter into water with precipitation, are absorbed by plants, and through plants, enter into animals and man. Motor vehicles are an important source of pollution in the environment. Metals released by their emissions may either be transported before being deposited or be directly deposited in the neighborhood of the road.

Energy dispersive X-ray fluorescence analysis is commonly used for the trace element analysis in the plants and soils because it allows a simultaneous multi-element determination of analytical elements.[1] Recently several works have been carried out in which plants were used as indicators of pollution from traffic or industry. [2-3]

Schorin and Piccioni [4] presented the precise and accurate analysis for sixteen elements including lead in contaminated and uncontaminated tropical materials . Balgava and Matherny [5] applied energy dispersive X-ray fluorescence spectrometry with radionuclide excitation to determine As , Cu , Fe , Rb , Sr , Ti , Zn and Zr in inorganic pollutants of gravitation dust sediments. Tolgyessy et al. [6] determined some heavy element content in plants (Taraxacum officinate) near highway D - 61 Bratislava - Trnava by using ^{238}Pu for excitation.

In the present study, radioisotope excited X-ray fluorescence techniques were applied to the analysis of soil and plant samples from different locations through the 25 km of the Ankara - Istanbul Highway depending on traffic density. Special attention was paid for lead because it is recognized that lead is one of the main pollutants in the environment and may indicate the level of pollution. The concentration of Pb is relatively high in some sampling stations due to heavy traffic. This investigation is fundamental to future studies since they prove the necessity of continuous environmental pollution monitoring of highways with heavy traffic in consideration of human health.

Materials and Methods

Soil and plant samples were collected at eleven locations along the 25 km of highway of Ankara - Istanbul with heavy vehicular traffic. Details for sampling such as location of sampling station , type of samples and distance from the downtown are

TABLE 1

Details for sampling

Sample No.	Location of sampling station	Type of samples	Distance from downtown (m)
1	Ciftlik crossroad	Soil - Plant	0
2	Anadolu Bul.	Soil - Plant	1450
3	Batikent crossroad	Soil - Plant	4400
4	Sanayi crossroad	Soil - Plant	6500
5	Sasmaz crossroad	Soil - Plant	7400
6	ISGUM	Soil - Plant	8400
7	Sincan crossroad	Soil - Plant	10300
8	Eryaman crossroad	Soil - Plant	14300
9	Susuz	Soil - Plant	17500
10	Saraykoy	Soil - Plant	23400
11	ANAEM	Soil - Plant	25000

given in Table 1. Representative samples of soils and plants were dried in ambient conditions then ground to approximately a 200 mesh particle size and sieved to remove debris to (200 mesh size.

A large number of soil and plant samples were prepared for analysis at a saturation level that were adjusted to the characteristic X-ray peaks of lead to ensure the highest count rates independent of the amount of material. Saturation levels for lead were obtained by using samples of 1500 mg for soil and plant material. This amount of soil was mixed with 250 mg of cellulose as a binder and diluent, then briquetted under a load of 15 tons pressure in 3 cm diameter pellets. In a similar way, 1500 mg of plant material were pressed as loosely bound pellets with no binder.

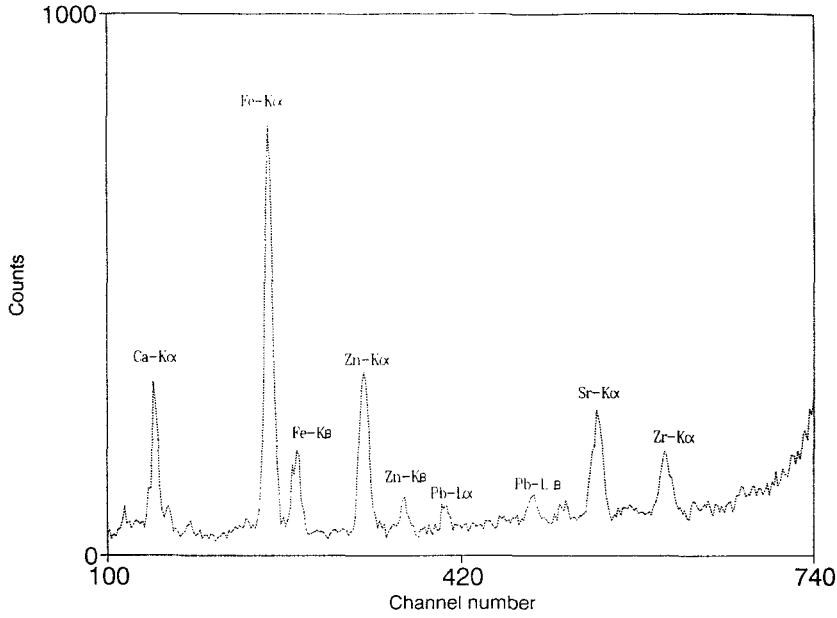

FIG 1. XRF spectrum of soil from sampling station 1 - Ciftlik crossroad

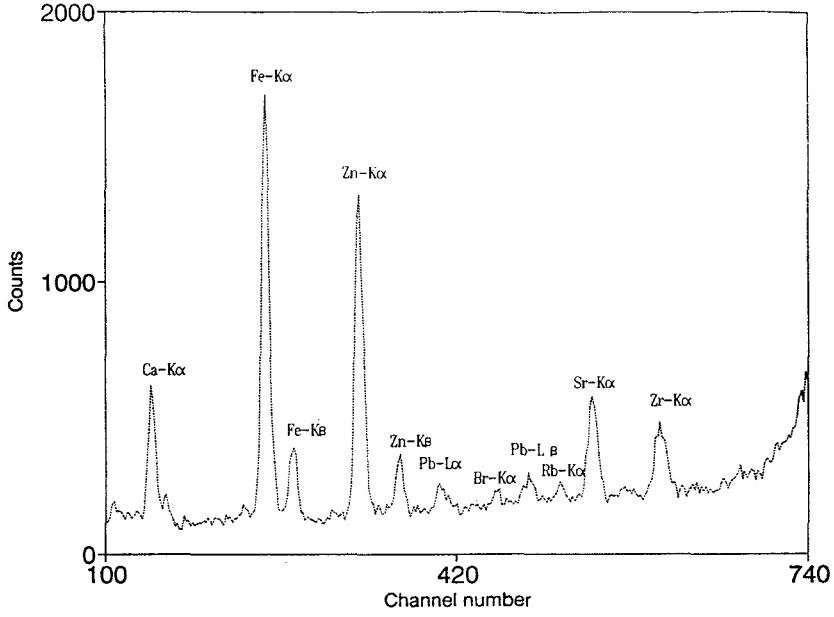

FIG 2. XRF spectrum of plant from sampling station 1 - Ciftlik crossroad

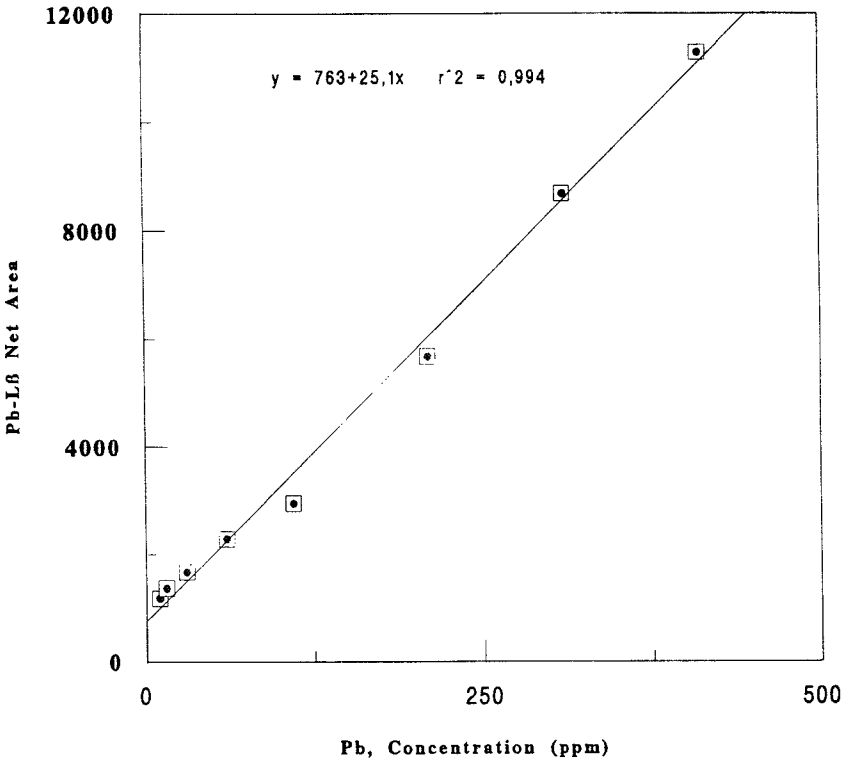

FIG 3. Calibration curve for lead in soil

Analysis of soil and plant samples were carried out using energy dispersive X-ray fluorescence spectrometry. The system employs an annular isotopic source ^{109} Cd radioisotope for excitation of samples and the resulting photons are detected by a Si (Li) detector with a resolution of 180 eV at 5.9 keV coupled to a Canberra - 85 multichannel analyzer and interfaced to an IBM - PS / 1 computer as described in Reference 7 . Figure 1 and 2 illustrate X-ray fluorescence spectra of soil and plant samples from sampling station 1.

The net peak intensities were calculated using an AXIL software program which was developed by the University of Antwerp group for the deconvolution of complex

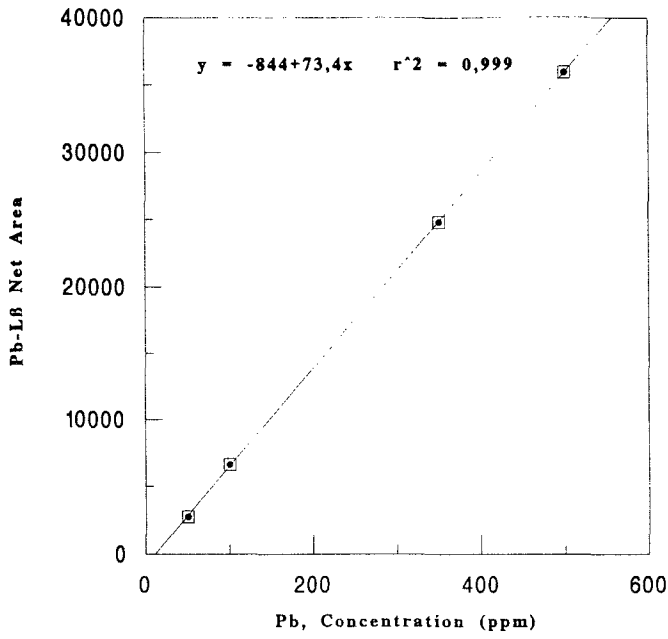

FIG 4. Calibration curve for lead in plant

X-ray spectra. The quantitative analysis of samples was performed by a calibration standardization procedure. The most common method of calibrating the X-ray spectrometry is to use a calibration curve of standards . Aliquots of a pure standard of lead solution from $Pb(NO_3)_2$ were added to Soil - 7 (IAEA - Standard Reference Material) containing increasing amounts of lead. Figure 3 shows the calibration curve for soil analysis with a good correlation coefficient of 0.994.

A similar way was followed for plant reference material. The solution from $Pb(NO_3)_2$ was added to cabbage leaves CL - 1 (Academy of Mining and Metallurgy, Krakow - Poland) with increasing amounts of lead. Figure 4 illustrates the calibration curve for plants with a correlation coefficient of 0.999. The standard reference materials of soils and plants were pelletized following the same sample preparation method. The known reference materials and unknown soil and plant samples were

TABLE 2

Results of lead analysis in soil and plant samples

Sample No.	Soil , ppm	Plant , ppm
1	565	61
2	205	46
3	456	77
4	371	51
5	329	41
6	309	50
7	171	56
8	175	91
9	162	91
10	(DDL*	41
11	(DDL*	(DDL **

*DDL for Pb = 30 ppm

**DDL for Pb = 10 ppm

analyzed with the instrumental parameters set identically to those mentioned in the above setup.

Results and Discussion

Motor vehicles are an important source of lead pollution in the environment. In an effort to study the lead pollution situation, samples of soils and plants were collected from eleven sampling stations in crossroads of the 25 km of Ankara - Istanbul Highway (Table 1) . Six of these (No. 1 - 6) are characterized by heavy traffic; the other four (No. 7 - 10) have less traffic. For comparison, the last station (No. 11) is in a relatively clean area , almost without traffic.

All samples were analysed without any chemical pretreatment. The plant samples were not washed prior to the analyses, a reliable estimate can be obtained for the lead deposited on the leaves. It is well-known that lead is emitted in gasoline combustion from vehicles, as is bromine (Figs. 1 - 2). In addition, it is assumed to originate from industrial emission and road dust. Surfaces of 0 - 3 cm of soil were using a trowel from all sampling points to comprise subsamples of approximately 0.5 kg. Samples were individually placed in plastic bags to minimize cross contamination.

The computerized EDXRF analysis procedures described above have been thoroughly applied on various soil and plant samples. Classical calibration standardization methods were used for quantitative evaluation in the case of saturation thickness. The average lead results of plant and soil samples are summarized in Table 2 .

It can be seen that lead has higher concentrations in samples obtained in sampling station Nos. 1 - 6 than those in Nos. 7 - 10 assuming No. 11 to be a pollution free reference site. This result is a measure of the enhancement of the lead in the Highway where a good correlation was observed with the intensity of the traffic. For bromine, which is sometimes associated with gasoline, we did not observe any such correlation to traffic volume. These results allowed us to estimate the significance of lead pollution caused by traffic. The contribution of motor transportation to the air, soil and plant pollution is very considerable.

Small- scale studies may be helpful for identifying the basic processes and approach for a large scale investigation of environmental pollution in urban areas.

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