PA46) Non-destructive Characterization of MSW-contaminated Surface Soils by EDXRF and low-Z Particle EPMA

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1. Introduction

The easter fringe of the city of Kolkata, West Bengal, India, has been earmarked for dumping of municipal solid wastes (MSW) generated in the city and its suburbs since the middle of the 19th century. Dumping of MSW is still continuing in this region, although with the passage of time, the core dumping site has shifted more eastwards. The vast stretch of lands adjoining the core area (around 2000 acres) and bound by a highway bypass running north to south along the western border is presently used for farming. Surface soil samples from this area, popularly known as Dhapa, have been subjected to study by two different non-destructive techniques, energy dispersive X-ray fluorescence (EDXRF) and low-Z particle electron probe X-ray microanalysis (low-Z particle EPMA). In addition, analysis results of MSW-contaminated soil samples were compared to that of an apparently non-contaminated country-side soil sample.

2. Materials and Methods

Six surface soil samples (Dh_1-Dh_6) from dumping sites of MSW, were collected progressively from six locations starting from the present core site to the bypass highway during June 2007 at Dhapa, located at the eastern part of Kolkata city (22°32′N, 88°24′E). An apparently non-contaminated soil sample (Cs) was collected during January 2008 from country-side, located at approximately 50 km north of Kolkata city. Each of the seven soil samples was throughly mixed to improve the homogeneity and ground with an agate mortar and pestle and sieved using a 250 mesh of ASTM standard. Samples were then dried in oven at 105°C for 24 hr. Pellets were made from the homogeneous mixtures under 10 tons pressure in a hydraulic press. Bulk elemental constituents of the pellet was analyzed by using EDXRF. In EDXRF spectrometer, a ^{109}Cd source has been used to obtain the exciting radiation. Chemical compositions of individual soil particles were analyzed by using low-Z particle EPMA. The measurements were carried out on a JEOL JSM-6390-SEM equipped with an Oxford Link SATW ultra thin window energy-dispersive X-ray (EDX) detector. Based on SEIs data, elemental concentrations, and X-ray spectra, the individual particles were classified into different particle types.

3. Results and Discussion

Bulk analysis of elemental constituents of the seven different soil samples were performed by employing ^{109}Cd induced EDXRF. The concentration of the major elements, i.e., K, Ca, and Fe, are almost same for all samples (Fig. 1). The concentrations of heavy elements in the contaminated surface soil samples are higher than those of the country-side sample. Overall 1900 particles for the

same soil samples (approximately 270 for each sample) were analyzed using the low-Z particle EPMA technique. Major chemical species encountered in the soil samples are aluminosilicate-containing, SiO_2, $CaCO_3$-containing, and carbonaceous particles. Aluminosilicate-containing particles are the most abundant (on average 72.5%), followed by SiO_2 (on average 13.9%) particles in all samples. $CaCO_3$-containing and carbonaceous particles are absent in the country-side sample, whereas they are present in the range of 2.3-8.7% relative abundances for all the MSW-contaminated samples. It was observed that SiO_2 particles were more frequently encountered in the country-side soil sample than in MSW-contaminated samples (on average 22.6 vs 12.5%). The contents of minor elements such as Na, Mg, K, Ca, and/or Fe in aluminosilicate-containing particles vary among the soil samples. K and Mg in aluminosilicate-containing particles are more abundant in the country-side soil sample than in the MSW-contaminated soil samples. The relative abundances of heavy-metal containing particles in the road-side sample, i.e., Dh_6 is significantly higher than other samples (Fig. 2). An exceptionally high concentration of Pb in the road-side sample was observed in both types of investigation.

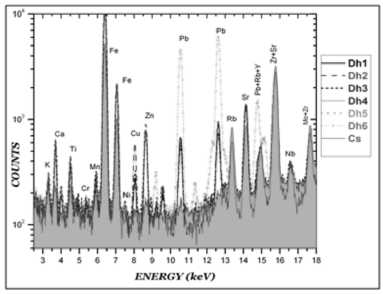

Fig. 1. A comparision of EDXRF spectra of different MSW-contaminated soil samples (Dhx) and non- contaminated country-side soil sample (Cs).

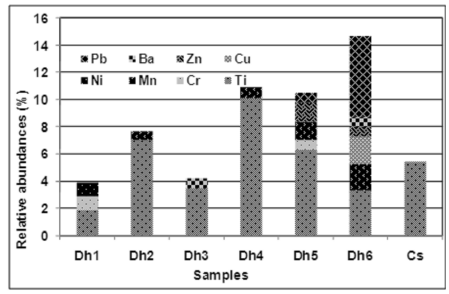

Fig. 2. Relative abundances of heavy-metal containing particles encountered in different MSW-contaminated soil samples (Dhx) and non-contaminated country-side soil sample (Cs).