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Spatial Distribution and Source Identification of Trace Elements in Surface Soil from Izmir Metropolitan Area

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Abstract : The soil is a crucial component of the ecosystem, and in industrial and urban areas it receives large amounts of trace elements from several sources. Therefore, accumulated pollutants in surface soils can be transported to different environmental components, such as deep soil, water, plants, and dust particles. While elemental contamination of soils is caused mainly by atmospheric deposition, soil also affects the air quality since enriched trace elemental contents in atmospheric particulate matter originate from resuspension of polluted soils. The objectives of this study were to determine the total and leachate concentrations of trace elements in soils of city area in Izmir and characterize their spatial distribution and to identify the possible sources of trace elements in surface soils. The surface soil samples were collected from 20 sites. They were analyzed for total element concentrations and leachate concentrations. Analyses of trace elements (Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Ga, Gd, Hf, Ho, K, La, Li, Lu, Mg, Mn, Mo, Na, Nd, Ni, P, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Tb, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn and Zr) were carried out using ICP-MS (Inductively Coupled Plasma-Mass Spectrometer). The elemental concentrations were calculated along with overall median, kurtosis, and skewness statistics. Elemental composition indicated that the soil samples were dominated by crustal elements such as Si, Al, Fe, Ca, K, Mg and the sea salt element, Na which is typical for Aegean region. These elements were followed by Ti, P, Mn, Ba and Sr. On the other hand, Zn, Cr, V, Pb, Cu, and Ni (which are anthropogenic based elements) were measured as 61.6, 39.4, 37.9, 26.9, 22.4, and 19.4 mg/kg dw, respectively. The leachate element concentrations were showed similar sorting although their concentrations were much lower than total concentrations. In the study area, the spatial distribution patterns of elemental concentrations varied among sampling sites. The highest concentrations were measured in the vicinity of industrial areas and main roads. To determine the relationships among elements and to identify the possible sources, PCA (Principal Component Analysis) was applied to the data. The analysis resulted in six factors. The first factor exhibited high loadings of Co, K, Mn, Rb, V, Al, Fe, Ni, Ga, Se, and Cr. This factor could be interpreted as residential heating because of Co, K, Rb, and Se. The second factor associated positively with V, Al, Fe, Na, Ba, Ga, Sr, Ti, Se, and Si. Therefore, this factor presents mixed city dust. The third factor showed high loadings with Fe, Ni, Sb, As, Cr. This factor could be associated with industrial facilities. The fourth factor associated with Cu, Mo, Zn, Sn which are the marker elements of traffic. The fifth factor presents crustal dust, due to its high correlation with Si, Ca, and Mg. The last factor is loaded with Pb and Cd emitted from industrial activities.

Keywords : trace elements, surface soil, source apportionment, Izmir
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