Geochemical investigations in the urban areas of Berlin

M. Birke
U. Rauch

Federal Institute for Geosciences and Natural Resources, Branch Office Berlin, Invalidenstrasse 44,10115 Berlin, Germany.

The present state of knowledge of urban geochemistry of Berlin can be characterized, in general, by a completed geochemical inventory. Industrial emission of toxic substances, which have been generated in different industrial processes by various companies, have led to a variable and high accumulation of toxic materials in the soils of Berlin.

About 4000 soil samples were taken in suburban and poorly contaminated areas from the depth of 0.0–0.2 m and analysed for 11 major and 42 trace elements; TOC, pH and electrical conductivity were also determined. In the topsoils of the city-centre of Berlin and locations of chemical industry organic pollutants, such as hydrocarbons, aromatics, light halogenated compounds were analysed too.

In the surroundings of Berlin about 60 soil profiles were also described and collected to a minimum depth of 150 cm. About 200 soil samples of different urban land uses were leached with 1M $MgCl_2$, 1M Na-Acetat, 0.04M NO_2OHCl and 30% H_2O_2 for the determination of metal mobilization and availability.

In the densely populated and the industrial areas the sampling density was 40 samples on a 1 km^2. The field observation comprised the informations concerning: geographical and geological conditions, land form, urbanizations, mode of land use and vegetation, soil type and horizon, potential sources of contamination.

For purposes of evaluation and interpretation of environmental geochemical data we use both mono-element and multi-element maps (Cluster-Q-analysis), or maps of geochemical associations (component-analysis) and geochemical maps of stress capacity for trace elements. These maps are of great importance for the estimation of environmental conditions and the state of load. They are a basis for reasonal ecological decisions in the conflict situation between urban land use planning and the health of men, animals and plants.

The element distribution in topsoils shows a clear dependence on the type of urban land use and type of production process and industrial complexes. The distribution and concentrations of the elements Al, K, Na, Rb, Zr, Nb and Ti can be related predominantly to natural geo- or pedogenic origin, that means to the composition of the substratum.

According to the temporary evaluation the industrial areas are characterized by contaminations of the subsurface soil with Cu-Zn-Pb-Hg-Sn-Ni. The geochemical background of industrial and commercial areas, in relation to the total geogenic background, is characterized by high-contrast

TABLE 1. Statistical parameters of metal content in the top soils of Berlin and environs (in ppm)

Parameter	Forestry utilization (N = 424)		Agricultural utilization (N = 270)		Residential area city-centre (N = 601)		Industrial area (N = 541)		Geochemical background of Berlin urban areas (N = 3299)
	mean	max	mean	max	mean	max	mean	max	
As	2.9	16.3	3.1	15.1	4.8	42.3	5.2	63.4	2.60
Pb	30.0	269.0	31.0	307.0	131.0	1490.0	129.0	2800.0	21.00
Cd	0.16	5.0	0.35	6.7	0.73	27.5	1.3	131.0	0.12
Cu	7.8	266.0	15.3	323.0	54.7	2910.0	88.7	4240.0	8.00
Ni	2.5	27.2	4.9	21.9	9.8	47.7	13.1	769.0	4.00
Hg	0.05	1.4	0.14	3.8	0.48	5.7	0.51	71.2	0.04
Zn	33.0	484.0	52.0	272.0	227.0	6040.0	331.6	25210.0	24.00

enrichments in Pb, Hg, Ca and electrical conductivity.

The regional geochemical background in urban soils of Berlin shows anthropogenic enrichments in Cd, Ni, Cu, Hg, Pb, Sn, Th and Tl, which are caused by the processing of raw materials in high temperature processes.

The backgrounds of agricultural areas and settlements indicate an enrichment in Cd, Cr, V and P, caused by the extensive use of fertilizers and sewage sludge. In the surroundings of Berlin high-contrast and two-dimensional anomalies are detectable near locations of iron and steel industry and building materials industry as well as in the range of the sewage farms.

The element associations and their distribution patterns and intensities in the urban areas of Berlin and its surroundings were determined by principal component analysis and cluster-Q-analysis. They allow a clarification of global and local migration cycles of technogenic elements and their causes in the exogene geochemical field as well as the qualitative distinction of natural and various anthropogenic element associations.