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Lead content of urban soils in China*

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Abstract— This paper presents the background value of Pb content in soils from Wuhan, Lanzhou, Changchun and Qingdao cities in China, the soils were contaminated by either of smelter, automobile, chemical industries, and traffic road. The degree of Pb pollution in the four cities is different, Wuhan > Qingdao > Changchun > Lanzhou. The heavier pollution is where it is nearer to the pollution source. The Pb pollution in Wuhan, Qingdao and Changchun is similar to that of Bermingham.

Keywords: lead; urban soil; pollution.

1 Introduction

Lead is one of the heavy metals in soil pullution, and now is one of the hotpoints for studying heavy metal in environmental science all over the world. We have carried out the research programme of the ethide in air of Changchun and Jilin (Meng, 1982), furthermore we have studied the level and aspects of Pb content in urban soil in China since 1987, such as Wuhan, Lanzhou, Changchun and Qingdao. Being the center of steel and iron industry, Wuhan is the capital of Hubei Province, the middle part of south China, it is near to the subtropical zone with yellow soil. As the center of automobile industry, Changchun is the capital of Jilin Province, the middle part of northeastern China, it locates in the temperate zone with dark brown soil. Qingdao is in the east part of Shandong peninsula by the Yellow Sea, a light industry and tourist city with well scene, it is in the warm temperate zone with brown soil. Having developed chemical industry, Lanzhou is the capital of Gansu Province of Northwestern China, it is in warm temperate zone with gray-drab-soil.

In the present study, we have focused our sampling on the areas having elevated

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Pb soil and Pb plant: such as the downtown area, the suburb and the rural area of the four cities. We attempted to get a more accurate idea of the extents and level of lead pollution in urban soil of the four cities in China. Furthermore, we have studied the distribution of lead pollution in urban soil to determine the possible sources of Pb contamination.

2 Màterials and methods

2.1 Materials

The soil samples were collected from Wuhan, Lanzhou, Changcun and Qingdao cities in China. A few factors have been considered in the collected samples; the background soil sample was collected from both park soil and suburban soil which are far away from pollution sources; soils contaminated by Pb were near pollution source, such as smelter, steel and iron factory, traffic road (in the range of 300 − 1000 vehicles/h); and the extents from the downtown to the suburban soil in the four cities.

2.2 Methods of sample analysis

The soil, plant samples were dried in room temperature and crushed, passed through 1 mm sieve before analysis, and duplicate samples of soils were digested in hot, concentrated nitric and chloride acid (1 : 1), after then, the samples treated were determined by atomic absorption spectrophotometry. If lead content in soil or plant sample was less than 1μg/g, the samples would be determined by flameless A.A.S. If lead content in soil, plant samples were more than 1.0μg/g, the samples would be determined by flame A.A.S.

3 Results and discussion

The background value of urban soil from four cities have been calculated by the statistical methods. It was rejected if anomal value of soil Pb/X+$S.D.$, and more than that of $(\overline{X}-X_i)\times 4\,S.D.$ According to this principle we have calculated the background value of lead in natural and urban soil. These was shown in Table 1 and 2, respectively.

Table 1 indicates that the background value of lead soil in natural soil from suburb of the four cities. These typical soils are black soil, gray-drab-soil, brown soil and yellow soil (yellow-cinnamon soil). The background value of lead in natural soil of the four cities was 20.98μg/g, 31.68μg/g, 24.30μg/g and 25.30μg/g, respectively. It is similar to normal value (22.0 μg/g) of the world (Swain, 1955). Some soil samples could be contaminated by human activities (such as gasoline, smelter and so on). In

Table 1 Background value of lead in natural soil in four cities

Unit: μg/g

Soil type	Changchun Black soil	Lanzhou Gray-drab-soil	Qingdao Brown soil	Wuhan Yellow soil
N	15[1]	5	5	5
Range	15.0 – 37.90	20.0 – 38.30	14.67 – 38.67	18.20 – 33.3
Mean	20.98	31.68	24.30	25.30
Middle value	26.45	35.0	24.49	25.0
S.D.	6.266	7.161	9.178	5.841
C.V.%	27.9	22.60	37.80	23.10

[1] The data were from the background value in soil in Jilin Province of China, 1990.

the four cities, Pb content in soils was more than the background value in natural soils (Table 2). The order of Pb level of soil in four cities was Wuhan > Qingdao > Changchun > Lanzhou. But Pb content in soil near the Pb pollution source was the highest. for example, Pb content in soil near the smelter in Changchun was 112.40 μg/g, it is nearly 5.37 times as much as that of natural soil. The soil is nearer to pollution sources, the heavier Pb pollution is. There are various pollution sources, such as smelter, traffic road. Pb content in soil by the road can reach 190.67 μg/g, if over 300 cars per hour passed the bridge in Qingdao. In Wuhan, when over 1000 cars passed the harbor road, Pb content in the soil by the road can reach 480 μg/g. Therefore, lead contents in the four cities has much more to do with pollution sources. There are remarkable correlation between lead contents in soils and the distance from the soils to Pb pollution sources. It is obvious that in the four cities, lead contents in downtown, suburb, rural were different, downtown > surburb > rural (Table 3). The influence of Pb pollution sources on urban soil was clearly decreased

Table 2 Level of lead content in soil in the four cities

Unit: μg/g

Soil type	Changchun Black soil	Lanzhou Gray-drab-soil	Qingdao Brown soil	Wuhan Yellow soil
N	29	18	25	24
Range	14.1 – 205.0	20.0 – 66.70	14.87 – 190.676	18.20 – 480.00
Mean	46.10	36.16	57.84	70.164
Middle value	43.21	35.00	43.52	48.30
S.D.	45.96	11.80	49.17	59.83
C.V.%	99.70	32.63	85.01	85.27

Table 3 Pb contents in soils from downtown to rural in the four cities

Unit: μg/g

	Changchun	Lanzhou	Qingdao	Wuhan
Downtown	62.44	51.68	107.19	131.21
N	5	4	4	7
Suburb	38.74	35.83	45.63	57.76
N	5	4	3	3
Rural	21.72	23.65	24.25	25.21
N	6	5	4	4

with increasing of the distance from Pb pollution sources.

In addition, we take the road of Changchun-Dehui as an example. Pb contents in the soils by the sides is different because of the distance from the road (Table 4), the nearer it is to the road, the higher the Pb content is.

Table 4 Pb contents in soils in two sides of road of Changchun-Dehui town

Unit: μg/g

Distance, m	The east of road	The west of road
15	24.24	20.12
50	22.44	16.88
100	17.80	16.74
500	19.60	15.54
1000	17.80	17.17

The distribution of Pb contents in soil profiles of the four cities have been shown in Fig.1. It shows that Pb level in top soil was the highest, then it decreased with the depth of the soil profiles, and it is more clear in soil profile of Changchun, Qingdao than that of Lanzhou and Wuhan.

The effect of Pb in soil on the plants grew near Pb pollution sources is very serious. We have thus carried out the correlative calculation of Pb contents in soils and plants (grass) in Qingdao City. The correlation coefficient was 0.6615 ($p < 0.05$). The linear equation is as follows:

$$Y = 2.1711 + 0.1590\,X$$

Where Y indicates Pb content in plant (grass), X indicates Pb content in soil. It is significant for the positive correlation of lead in soils and in plants in the same place. The plants (grass) in the polluted areas have therefore been contaminated by lead in the soils.

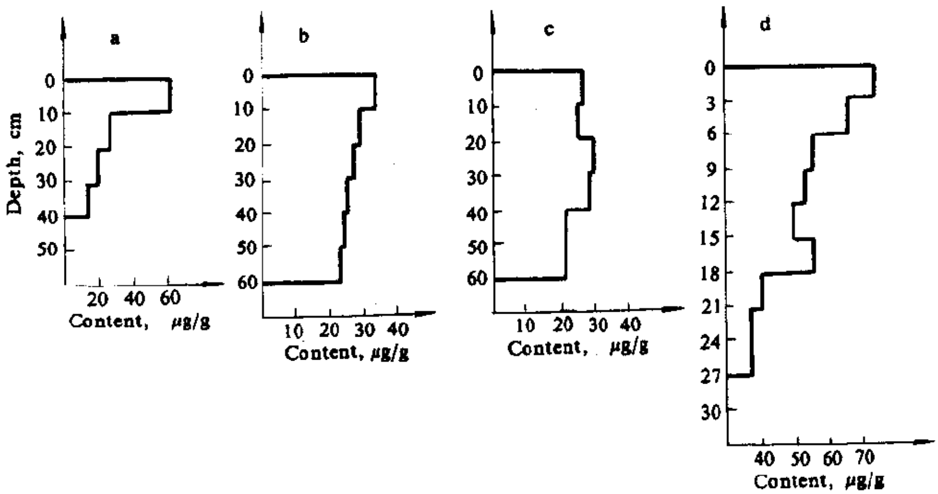

Fig.1 The distribution of Pb content in soil profiles of the four cities
a: Changchun b: Lanzhou c: Wuhan d: Qingdao

Pb content in soils of the four cities was lower than that of Birmingham (Archer, 1976) and Washington D.C. (Preer, 1984; Table 5).

Table 5 Pb content in soil of Birmingham and Washington D.C.

Unit: μg/g

	Birmingham	Washington D.C.
N	31	70
Range	14.0–350	10.0–1400
Mean	110.0	200.0
Middle value	75.0	178.20
S.D.	89.65	–

As mentioned above, Pb content in soils near pollution sources in Wuhan, Qingdao, Changchun and Lanzhou were over 30 μg/g, the world value in top soil. Pb pollution in soil of downtown of Wuhan and Qingdao was resulted from the gasoline of vehicles, somewhere (Changchun), it was resulted from smelter, and others. Pb pollution in urban soil of Wuhan and Qingdao was very heavy and similar to Birmingham and Washington D.C.

4 Conclusion

Soils in the four cities have been contaminated by lead from the pollution sources, such as traffic road, smelter and others. The order of Pb pollution in four cities was Wuhan > Qingdao > Changchun > Lanzhou. Pb level in soil of four cities was more than that of the background value in natural soil, the pollution degree was downtown > suburb > rural. The heavier the soil is polluted, the nearer the Pb pollution sources is. Pb content in top soil near Pb pollution sources was maximum. Pb content in soil profile decreased with the depth of the soil profile.

Pb level in plants in polluted areas in associated with Pb level in soils such as in Qingdao City, there are positive correlation, $r=0.6615$ ($p < 0.05$). The Pb in soil will also be harmful to animal and human being.

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