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Study on the Characteristics of Atmospheric Dust Environment in Xicheng District of Linyi City

Jicai Qiu, Renjun Liang, Pengfei Qin, Bao Li

Shuangling Road, Linyi, Shandong, China, College of Resources and Environment, Linyi University, Zip Code: 276000

Email: qiujiacai@126.com, Liangrenjun@lyu.edu.cn, Qinpengfei@lyu.edu.cn, Libao@lyu.edu.cn

Abstract. This paper analyses the atmospheric dust in Linyi City about the content and the form distribution of heavy metals. The main research focuses on the eight kinds of heavy metal elements, including As, Cd, Cr, Cu, Hg, Mn, Pb, Zn. The research results show that the annual atmospheric dust deposition in the heavy industrial zone reaches the highest amount at 88.50 g/m². In the Park district, the figure of the year is 28.27 g/m²; compared with the soil background values, the heavy metal content, Hg, Cr, Pb, As, Cd, increased obviously. In addition, the content of Zn is beyond the soil background values of 18 times. And in the industrial zone the content of Zn has the top amount of 3545.55 mg/kg. The enrichment factor of Cu, Cd element is 50~70. The atmospheric dust deposition of Mn is similar to soil background value. Moreover, the source of Mn is mainly from the natural particulate matter of soil.

1. Introduction

In recent years, with the rapid development of urbanization and industry, serious atmospheric environmental problems have arisen. Dustfall in the atmosphere has a harmful effect on the climatic environment, human body and living things, which has aroused people's great research interest [1-2]. Heavy atmospheric dust and heavy metal pollutants have a wide range of sources, mainly from industrial and agricultural production, transportation and so on. In this paper, the content and morphological characteristics of atmospheric dust in the Xicheng District of Linyi City (Fig. 1) were analyzed. Principal component analysis and other analytical methods were used to study the characteristics and sources of heavy metals in atmospheric dustfall.



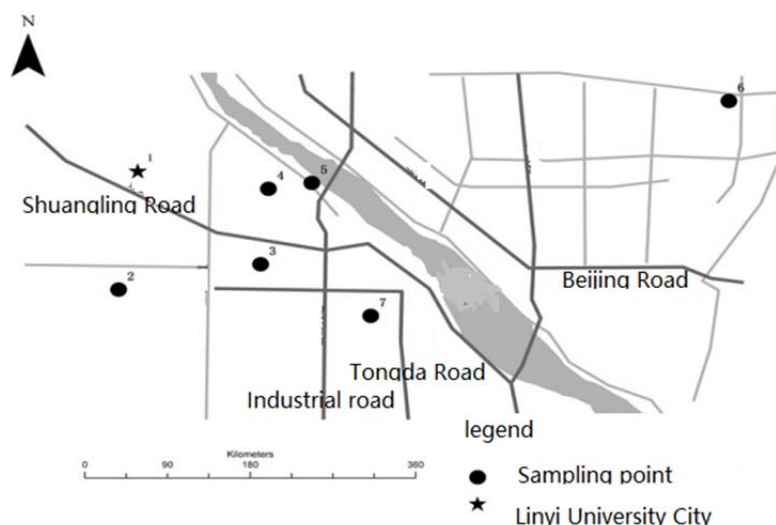


Figure 1. Sample point distribution map

Note: 1 Linyi University City 2 Logistics City 3 Bus Station 4 Residential Area 5 Park Area 6 Industrial Area 7 Comprehensive Business District Map

1.1 Overview of the study area

Linyi City, located in the south of Shandong Province, the terrain is complex and is an important part of Luzhong Mountain area. The terrains such as plains, hills, mountains and mountain rivers form the complex terrain of the city. Linyi City center has a flat terrain. Xicheng District mainly includes Linyi University, the trade and logistics area, and the Beng River which passes by. The study on the content and characteristics of atmospheric dust heavy metals will provide important guidance and have significant influence for the future development of Linyi area

2. Experiments and Methods

Experimental equipment: drying oven; electric heating plate; fume hood; Vista-MPX plasma emission spectrometer, full spectrum direct reading ICP-OES VISTA-MPX (American Wariant); DSHZ-300 multi-purpose water bath thermostat (Taicang, Jiangsu) City Experimental Equipment Factory); TDL-5-A low-speed desktop large-capacity centrifuge (Shanghai Anting Scientific Instrument Factory).

Data Processing Analysis Software: Excel, SPSS, Arcgis

2.1 Sample Collection and Processing

This sampling was set up around the Spring Festival of 2014. Seven sampling points (Fig. 1) were set up in Linyi City, and one sample was collected at each sampling point. The sampler used is a plastic drum with a diameter of 40 cm and a height of 50 cm. It is treated with distilled water and dried. It is then taken to the sampling point and fixed on an open roof platform 5 to 10 m away from the ground, away from local obvious pollution sources and tall buildings. 3] to prevent the impact of buildings on natural dustfall. The atmospheric dust is brought back to the laboratory, the dust sample is dried at a low temperature in a dry box, the foreign matter is removed, and the 100 mesh sieve is ground, and the dust sample is thoroughly mixed and then placed in a ziplock bag.

2.2 Experimental Methods

2.2.1 Research Methods for Heavy Metal Content in Atmospheric Dustfall. This experiment uses the more common hot plate digestion method. Weigh 0.30 g (accurate to 0.0002 g) of the mixed sample into 50 mL of Teflon, add a small amount of water to wet, add 10 mL of concentrated HCl, and heat the sample on the hot plate in the fume hood for preliminary decomposition. When it is evaporated to

about 2 mL, then 6 mL of HF, 5 mL of HNO₃, and 3 mL of HClO₄ are added, and after heating, the digestion is continued on the hot plate. Due to the different atmospheric dustfall at each sampling point, there is a difference in the organic matter contained. When digesting, observe that the amount of various acids is different. The digested solution should be white or light yellow with no obvious precipitate.

3. Research Results and Discussion

3.1 Study on Heavy Metal Content in Atmospheric Dustfall.

This time, a total of seven points of samples were collected. The environment of each sampling point is different, and there is a gap in the amount of atmospheric dust. This has a guiding role in analyzing the atmospheric environment in the area. The annual dustfall of each sampling point is shown in Table 1. From the table, the dustfall of the logistics city is 87.38g/m²·a, and the dustfall of the industrial zone is 88.50g/m²·a, which is significantly higher than other areas. Related to the type of industry developed in the region. The traffic area in the logistics area is large, and there is more dust in the air. The pollution of various factories in the industrial area leads to a large amount of dust in the industrial area. The atmospheric dust content in the park area is 28.27g/m²·a. The vegetation coverage in the park area is high, and the green area is large. It has a certain hindrance to atmospheric dust reduction, and the amount of dust in the park area is small.

Table 1. Statistical table of atmospheric dustfall at each sampling point (g/m²·a)

Sampling point	1	2	3	4	5	6	7
content: g/m ²	70.57	87.36	68.62	61.80	28.27	88.50	58.37

The heavy metal content of atmospheric dustfall is shown in Table 2. It can be seen from the table that the total content of heavy metal elements in atmospheric dustfall is generally higher than the soil background value. The range of variation of Mn content and the coefficient of variation are small, and the coefficient of variation of Mn is 0.10. The average content of Mn is close to the soil background value, and the range of variation is not large. The heavy metal contents of Cd, Cu, Zn, Pb, As, Cr and Hg vary widely, and their content is generally high and the soil background value. The content of Cu is 43 times of the background value, far exceeding the soil background value. The content shows a different degree of enrichment, which is basically the same as that of other cities studied by domestic scholars. The enrichment degree of each element is Mn>Cd>Cu>Cr>As>Hg>Pb>Zn. Even the Zn element with lower enrichment is larger than the background value of soil and reaches the soil background. 1.8 times the value.

Table 2. Statistical content of heavy metal elements in atmospheric dustfall

	unit	Content range	average	standard	Coefficient of	Soil background
Cu	mg/kg	722.42~2530.93	1520.60	561.34	0.37	35
Zn	mg/kg	450.87~7502.52	1819.18	2074.62	1.07	100
Mn	mg/kg	480.60~675.16	544.30	51.84	0.10	552
Pb	mg/kg	46.30~760.31	219.36	162.55	0.73	35
Cr	mg/kg	110.87~395.10	188.56	83.05	0.46	90
Cd	mg/kg	8.45~15.91	10.59	1.71	0.16	0.20
Hg	mg/kg	0.94~3.71	1.97	0.10	0.58	0.15
As	mg/kg	8.38~92.74	41.44	20.76	0.50	15

3.2 Elemental Correlation Analysis.

Correlation analysis of heavy metal elements can well indicate the same source of material or migration pathway that heavy metal elements may have. See Table 3 for the correlation coefficient of heavy metal elements in atmospheric dust. It can be seen from the table that Pb has a good positive correlation with Mn and Cd, and they may have the same material source. Pb is generally considered to be an indicator of vehicle exhaust emissions. Hg and As are the indicator elements of coal combustion. The positive correlation between Cr and Hg indicates that Hg, As and Cr elements in atmospheric dust are related to coal combustion activities. Zn is related to industrial production, and there is a significant positive correlation between Cd and Zn. The correlation coefficient is 0.592, which indicates that Cd is related to the emission of automobile exhaust gas, and also has a great relationship with industrial exhaust gas pollution. Mn has a good correlation with Cd, Pb, Cr and Hg. The correlation between Mn and Cd is as high as 0.864. In addition to the exhaust gas and coal burning activities, Mn, Cd and Pb are also partly derived from Natural soil particles.

Table 3. Heavy metal correlation coefficient table

	Correlation coefficient							
Elements	Cu	Zn	Mn	Pb	Cr	Cd	Hg	As
Cu	1.000							
Zn	-0.153	1.000						
Mn	-0.029	0.336	1.000					
Pb	-0.544*	0.478	0.506*	1.000				
Cr	0.313	0.059	0.481*	0.011	1.000			
Cd	-0.008	0.592	0.864*	0.615**	0.344	1.000		
Hg	-0.082	0.107	0.491*	0.200	0.505*	0.3933	1.000	
As	-0.204	-0.199	0.091	-0.377	0.187	-0.022	0.246	1.000

Note: ** significance level is 0.01, * indicates that the significance level is 0.05

3.3 Analysis of Enrichment Factors.

The enrichment factor is an important indicator to indicate the degree of enrichment of heavy metal elements in atmospheric particulate matter to reflect the degree of disturbance of human activities to the natural environment. The source of the elements (natural and anthropogenic sources) is judged and evaluated. It is mainly through the comparative analysis of the actual measured values of the elements in the experimental sample and the background value of the elements to determine the influence of the human activities of each element. The calculation of the enrichment factor introduces the reference element for standardization, and the content of the selected reference element should have certain stability. The reference element can generally be selected from Fe, Mn, Ti, Al, and the like. The calculation of this enrichment factor selects Mn as the reference element. The formula for calculating the enrichment factor is:

$$EFs = (C_i / C_n)_{\text{sample}} / (C_i / C_n) \quad (1)$$

C_i is the concentration of heavy metal element i ; C_n is the concentration of heavy metal element Mn. If the enrichment factor of the element is close to 1, it can be considered that the element is basically not enriched, mainly composed of soil particles; if it is greater than 10, it means that the element is natural. The soil source is also affected by human activities.

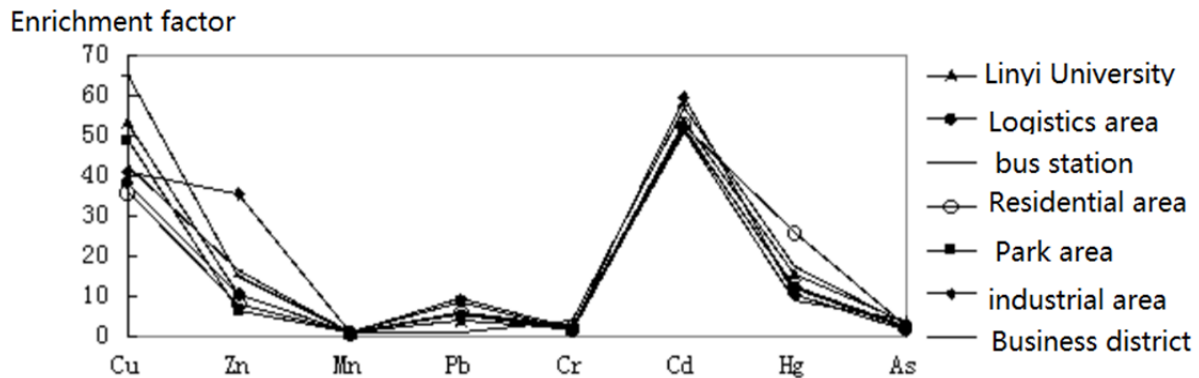


Figure 2. Graph of heavy metal element enrichment factor in atmospheric dustfall

The enrichment factor of heavy metal elements in atmospheric dustfall at 7 sampling points is shown in Fig. 2. It can be seen from Fig. 2 that element enrichment factors such as As, Cd, Cr, Cu, Hg, Mn, Pb, and Zn can be roughly classified into three types: the first type is Mn, and its enrichment factor is closest to 1, indicating that Mn is The main source is soil particulate matter; the second type is As, Pb, Cr, their enrichment factor values are generally between 1 and 10, Pb is close to 10, and As and Cr are less than 5, indicating that these elements are not only naturally In addition to the soil source, it may also affect the effects of agricultural pollution; the third category is Cd, Cu, Hg, Zn, their enrichment factor is significantly greater than 10, such as Cu enrichment factor of 40 ~ 65, Cd up to 60 , indicating that these elements are greatly affected by human activities.

3.4 Spatial Distribution of Heavy Metal Pollution Elements.

The content of metal elements in the atmospheric dustfall at different sampling points is shown in Figure 3-5. The content of Mn is roughly equivalent to the background value of soil, and Mn is mainly derived from soil particles. The content of Pb in logistics city, bus station and industrial area is obviously higher than other areas. The content of Pb in the air station of the bus station has reached 195.64mg/kg, which is related to the large traffic volume of the bus station. The content of metal elements such as Hg, As, Cr, etc. forms a high value area in the university city and business district. In Fig. 3, the content of Zn element is in order: industrial area > comprehensive business district > bus station > university city > logistics city > residential area > park area. Zn is an industrial indicator, and the industrial area even reaches 3545.55mg/kg, which is closely related to the establishment of various factories in the suburbs. Pb has formed a high-value area in the area where the traffic volume of the bus station and logistics city is large, and the atmospheric dustfall of the bus station is 195.64 mg/kg, which is the highest value.

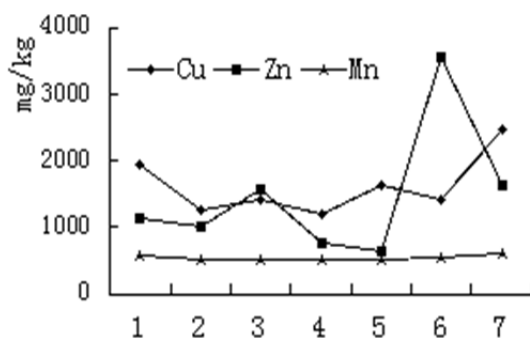


Figure 3. Line diagram of Cu, Zn and Mn content at each sampling point

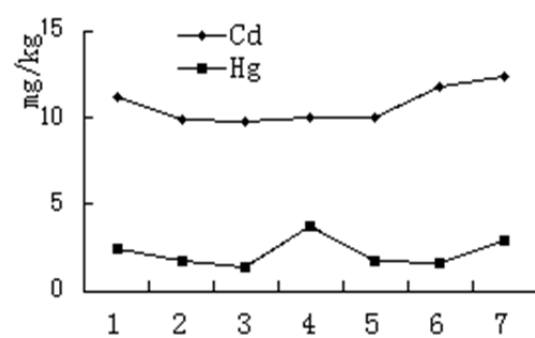


Figure 4. Cd and Hg content line graphs at each sampling point

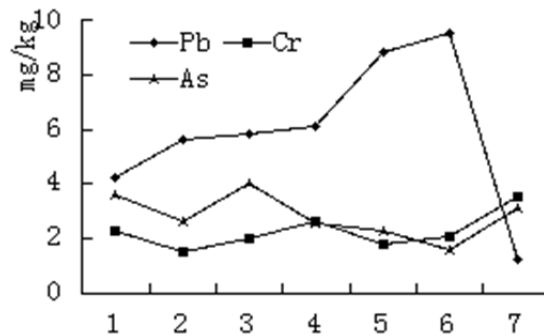


Figure 5. Pb, Cr, As content line graph of each sampling point

Note: 1 University City 2 Logistics City 3 Bus Station 4 Residential Area 5 Park Area 6 Park Area 7 Comprehensive Business District

3.5 Heavy Metal Sources and Hazards

Table 4. Heavy metal content table at each sampling point (mg/kg)

Sampling point	element							
	Cu	Zn	Mn	Pb	Cr	Cd	Hg	As
1	1912.500	1136.70	579.24	155.52	216.54	11.21	2.44	57.02
2	1231.24	847.14	525.25	186.51	127.79	9.85	1.78	37.49
3	1377.57	1579.68	527.17	195.64	171.15	9.81	1.33	57.60
4	1157.78	773.99	526.07	104.20	224.71	10.06	3.71	36.36
5	1589.21	634.23	526.43	105.69	152.27	10.00	1.76	32.57
6	1382.37	3545.55	547.94	131.21	182.06	11.84	1.56	23.16
7	2423.20	1633.81	598.52	46.29	395.10	10.41	2.88	50.21

Table 5. Secondary standard value of soil environmental quality (mg/kg)

Land use	standard value						
	Zn	Cu	Pb	Cr	Cd	Hg	As
Residential land	500	300	300	400	10	4.0	50
Commercial land	700	500	600	800	20	20	70
Industrial land	700	500	600	1000	20	20	70

3.5.1 Analysis of Heavy Metal Sources. Hg, Cr, Pb, As, and Cd in the dustfall of the Xicheng area of Linyi City may have the same source, and their content and enrichment factor are larger than the soil background values. The source of As has a lot to do with coal burning activities. The typical indicator element Pb is considered to be the result of automobile exhaust emissions, combined with the spatial distribution of heavy metal pollution elements, so they are considered to be mainly from coal burning activities and automobile exhaust emissions. Compared with the background value of soil, Cu, Cd and Zn also have higher content and larger enrichment factor, and the content of Zn in the industrial area has the highest value of 3445.55mg/kg, which further indicates that they are related to nearby industrial activities. The Mn in atmospheric dust is close to the background value of soil, the enrichment factor is small, and it has no obvious correlation with other polluted elements. Even the correlation between Mn and Cu is -0.029, which indicates the source of Mn. Mainly natural soil particles.

3.5.2 Environmental Quality Hazard Assessment. The increase of heavy metal content in atmospheric dust damages the growth of organisms and the living environment of human beings, endangers the normal survival of human beings, leads to the destruction of ecosystems, increases the disease, and studies on the hazards of heavy metal elements in atmospheric dustfall should be paid enough attention to the flora and fauna. Provide reference and foundation for survival and economic development. According to Table 4 and Table 5, except for the park area of 526.43 mg/kg, the Zn element exceeded the standard value in other areas, and the industrial area Zn content of 3545.55 mg/kg was 5 times of the standard value. The content of Cu far exceeds the standard value. The Cu content in the residential area is 3.8 times of the standard value, and the Cu content in the comprehensive business area has reached 2423.20 mg/kg. The heavy metal elements in the atmospheric dusting will affect the soil environment and human survival. The content of Hg, As, Pb and Cr is within the standard value range, and it has little or no harm to the soil environment and human body, and the risk is very small.

4. Acknowledgments

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5. References

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