

Relationship between Heavy Metal Content in Polluted Soil and Soil Organic Matter and pH in Mining Areas

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Abstract. Taking the tailings dump of the beneficiation plant in Xiaoqinling Gold Mine as the research object, the characteristics of soil organic matter, pH value and heavy metal contents in soil were studied, and their correlations were analysed. The results showed that the content of soil organic matter in the study area was generally moderate, and the content was between 10.8 and 18.2 g/kg. The soil pH was weakly alkaline with the content ranging from 7.48 to 8.17. The contents of heavy metals such as Cu, Zn and Cd were serious Exceeded. There was a significant positive correlation between soil organic matter content and Ni, as, soil pH was negatively correlated with Cu, positively correlated with Ni, as and so on, but significantly positively correlated with Cr. Through the relationship between soil organic matter, pH and heavy metal content, it shows that soil organic matter and pH value are important indexes that affect heavy metal content in soil.

1. Introduction

Industrial production, mining development, sewage irrigation and rock weathering are the main ways for heavy metal elements to enter the soil ecosystem [1]. With the development of industrialization and urbanization, the intensity of mineral development is enhanced, and the content of heavy metals in soils is increasing rapidly. People are paying more and more attention to soil heavy metal pollution [2].

Heavy metals are hard to be removed from the soil due to their difficulty in decomposing in the process of soil biological cycling and energy exchange, which eventually results in difficulties in remediation of heavy metal pollution in the soil [3]. And with the absorption of crops, eventually through the biological enrichment effect on human health [4]. Therefore, the research on the law of heavy metal pollution in soil and its influencing factors can clarify the characteristics and rules of heavy metal elements migration and transformation in soil ecosystem on the one hand, and provide guidance and data support for crop planting and green agriculture construction on the other hand.



Based on the investigation of heavy metal content, pH and organic matter content in the five kinds of soils around the slag, the paper focuses on the investigation of heavy metal pollution in the soil around the slag. According to Yin Liping et al. [5], soil Organic matter content and pH are the main factors that control the bio-availability and chemical behavior of heavy metals. Studying the relationship between heavy metal content in contaminated soils and soil organic matter and pH is very important for ecological environment protection and land re-use in Tongguan area Guidance.

2. Materials and Methods

2.1. Description of the research area

Tongguan mining area is located in the junction of Shanxi, Shaanxi and Henan Xiaoqinling gold area, the geographical coordinates of 343056 ~ E343121, N1101923 ~ 1101956, elevation 471 m ~ 517 m. Xiaoqinling gold mine is China's second largest gold-producing area, the main exploitation of quartz veined gold mine, a warm temperate continental rainy season monsoon arid climate, with four distinct seasons, mostly in summer precipitation, and mostly Rainstorm, the annual average temperature of 13.0 °C, the coldest January, the average temperature of -1.6 °C, extreme low temperature -18.2 °C. The hottest July, the average temperature of 26.1 °C, the extreme maximum temperature of 42.7 °C, the difference between the east and the west is not obvious, large temperature difference between day and night. In the area, the high gully is deep, the wind is large, and the soil evaporates strongly. The annual evaporation is 1193.6 mm, and the precipitation is 52.41% of the evaporation. Four Seasons windy, annual average of more than 8 gale 15.12 times [6-7]. The average annual rainfall of 587.4 mm, the maximum rainfall of 958.6 mm, the minimum rainfall of 319.1 mm, significant differences between north and south, decreasing from north to south. From south to north can be roughly divided into brown soil, cinnamon, sand clay, clay, soil five kinds of soil. The project research area is located in Yao Shang Village, Taiyao Town, Tongguan County, and 20 km away from Tongguan County. The main pollution source is tailings. Most of the tailings are piled randomly along the river courses and bank slopes, and are restored to cultivated land after isolation and treatment by soil engineering. The main planting Corn, peanuts and masson pine.

2.2. Sample collection and test

In September 2016, samples were collected from the slag of Taiyao Town, Tongguan County, respectively according to the distances of 0 m, 10 m, 30 m and 50 m from the slag mound. According to the requirements of "Soil Environmental Monitoring Technical Specification", at each sampling point, Select the plant roots around 1 m² range, the use of plum-shaped sampling method laid 5 sampling points, remove the surface 5 cm topsoil, dust prevention to prevent heavy metal content of soil samples, 0 ~ 30 cm after sampling mixed to a soil mixture Samples, using the quartet leave a sample of about 1 kg, sealed in self-sealing bag, to avoid sample contamination. In the sampling process, accurately record the sampling location and the surrounding environment characteristics. A total of 48 tailings and soil samples were collected.

The soil samples were air-dried in the laboratory to remove debris and ground through 0.149 mm nylon mesh, and stored to be measured [8, 9]. The soil total Pb-Zn was determined according to GB / T 17141-1997, "Determination of Lead and Cadmium in Soil Quality: Graphite Furnace Atomic Absorption Spectrometry" Determination of chromium: Flame atomic absorption spectrophotometry "(HJ 491-2009)," Determination of soil quality nickel: Flame atomic absorption spectrophotometry "(GB / T 17139-1997)," Determination of soil quality of copper, zinc: Flame atomic absorption spectrophotometry "(GB / T 17138-1997)," Determination of total mercury in soil quality, total arsenic, total lead by atomic fluorescence spectrometry Part 1: Determination of total mercury in soil "(GB / T 22105.1-2008), "Determination of total mercury, total arsenic and total lead in soil quality: atomic fluorescence spectrometry Part 2: Determination of total arsenic in soil" (GB / T 22105.2-2008).

3. Results

3.1. Statistical characteristics of soil heavy metals, pH and SOM around the slag

Table 1 shows the descriptive statistical characteristics of soil heavy metals, pH and organic matter at different sampling sites.

Table 1. Soil heavy metal, pH and organic matter content in the soil around slag

Distance	Depth	pH	SOM	Cu	Zn	Cr	Ni	As	Cd
0 m	0~5	7.55	10.8	110.56	47.13	51.01	7.06	1.62	0.47
	5~15	7.48	11.6	130.85	54.02	50.69	7.97	2.03	0.52
	15~30	7.60	13.3	145.63	492.08	58.68	10.77	2.42	5.34
10 m	0~5	7.59	13.0	367.91	542.22	59.63	22.41	10.76	5.31
	5~15	7.90	14.5	277.82	334.21	63.15	22.28	5.12	3.42
	15~30	7.36	15.3	397.17	807.03	51.86	18.95	5.10	9.00
30 m	0~5	8.00	14.2	36.57	57.27	60.51	27.89	12.46	0.39
	5~15	8.11	13.2	22.61	47.44	60.12	26.78	11.13	0.17
	15~30	8.00	14.1	28.06	55.51	63.32	29.26	12.22	0.22
50 m	0~5	8.02	18.2	49.20	79.45	61.08	29.61	13.89	1.47
	5~15	7.54	16.2	22.35	53.92	60.31	29.03	12.35	0.16
	15~30	8.17	13.5	30.30	56.55	62.11	29.13	13.52	0.36

The contents of soil heavy metals in the study area are shown in Table 1 and Figure 1. The results showed that the content of heavy metals in the soil less than 10 m was significantly higher than that in the soil 30 m away from the slag mound. The contents of heavy metals in soils within the 10 m area were larger than those in the tailings dumps. With the increase of soil depth, the content of Cu and Zn increased mainly due to the accumulation of tailings for a long time, Heavy metal accumulation. In addition, due to the oxidation of the tailings components containing acidic drainage material, such as sulphur, prompting the surface layer of Cu and Zn by leaching and other downward migration, resulting in the lower Cu, Zn content due to the accumulation of increased [10,11].

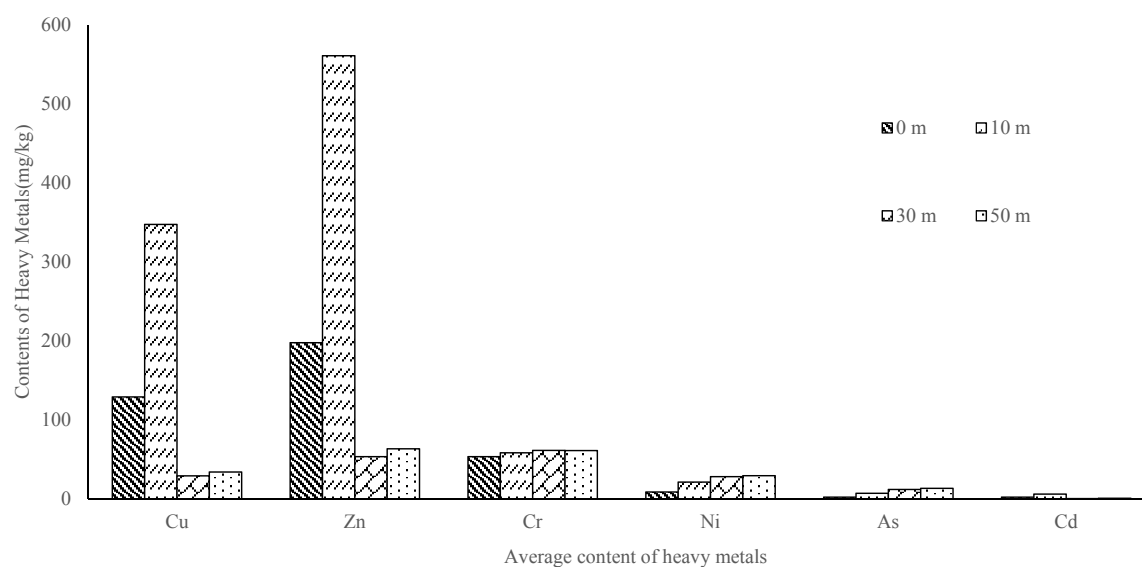


Figure 1. The average content of heavy metals in soil profile at each sampling point

Figure 2 shows the soil pH and organic matter content in the study area. Soil pH is an important physical and chemical parameters of soil, and has an important influence on the availability and fertility of soil trace elements [12]. Combined with Table 1, it can be seen that soil organic matter in the area of ≤ 10 m increases with the increase of soil depth, while the soil organic matter in the area of ≥ 30 m shows the opposite rule. With the increase of the distance, the soil pH and soil organic matter content showed similar laws, which increased with the distance from the tailings pile.

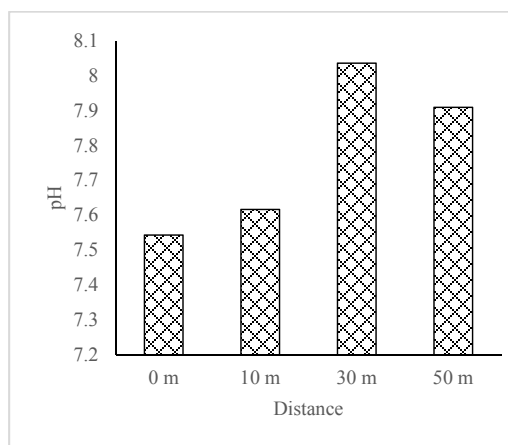


Figure 2. The average content of pH in soil profile at each sampling point.

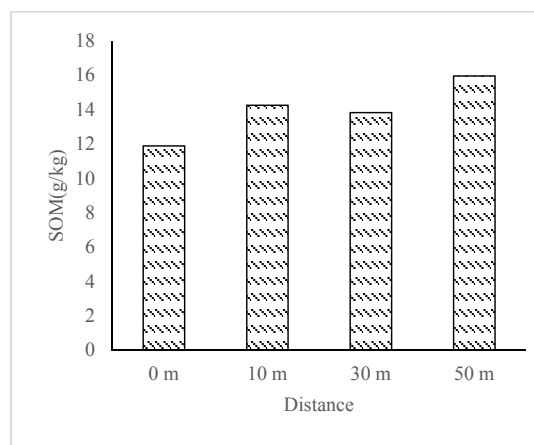
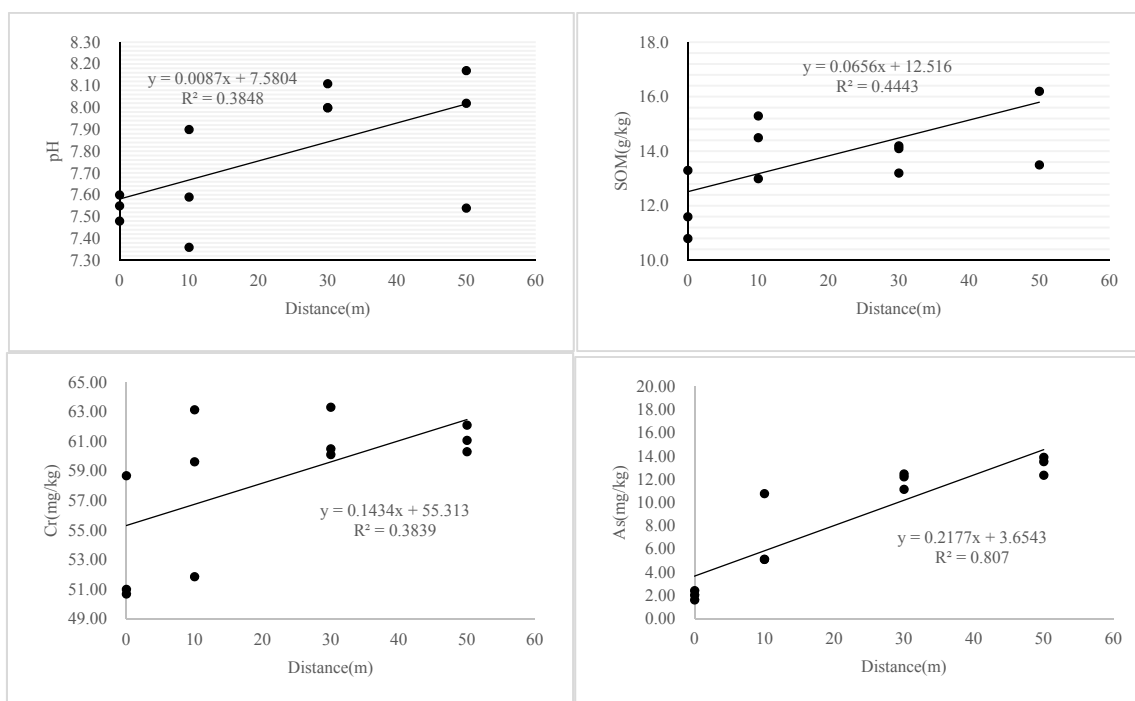


Figure 3. The average content of SOM in soil profile at each sampling point.

3.2. Characteristics of Soil Heavy Metal, pH and Organic Matter with Distance Changes in the Soil around Slag

In this study, soil samples were collected at 0 m, 10 m, 30 m and 50 m away from the slag respectively. Through analysis and analysis, Figure 3 shows the characteristics of soil heavy metals, pH and organic matter along the distance from the slag.



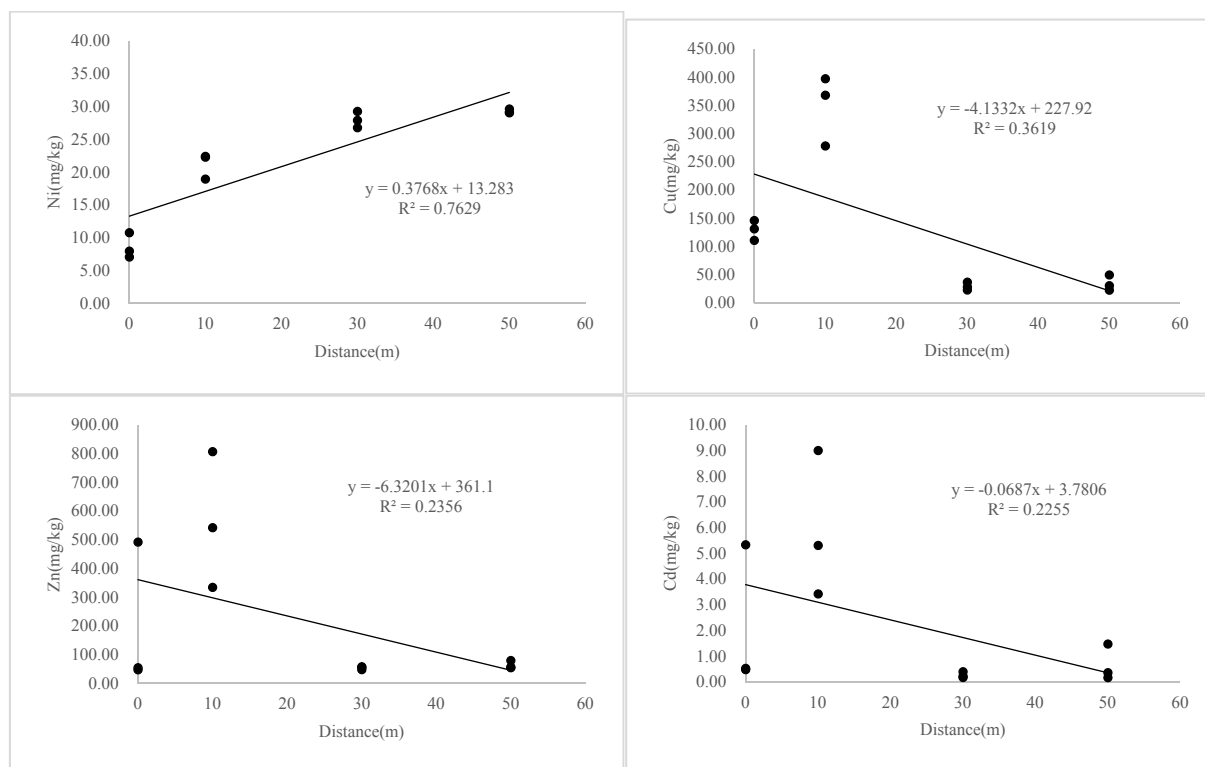


Figure 4. Characteristics of Soil Heavy Metal, pH and Organic Matter with Distance Changes in the Soil around Slag

As can be seen from Fig. 3, the contents of soil pH, organic matter, Cr, As, Ni and other heavy metals are higher with distance from the slag stack, whereas heavy metals such as Cu, Zn and Cd show opposite laws. The farther away from the slag stack, the higher the value. Among them, heavy metal elements such as Cu, Zn and Cd are in line with the expectation. The closer the soil is to the slag heap, the higher the heavy metal content in the soil. The smaller the plant coverage from the residue, the higher the content of soil organic matter with the farther the residue. In addition it may be due to long-term rainfall leaching, resulting in Cr, As, Ni and other heavy metals migrate easily.

3.3. Correlation between Heavy Metals, pH and Organic Matter in Soils around Slag

Soil pH and organic matter are both important physical and chemical properties in soil. Analyzing the correlation between them and the contents of heavy metals in soil can not only explain the migration and transformation rules of different forms of heavy metals [13], but also can be used for soil remediation and land use in mining areas. Development to provide a scientific basis.

Table 2 shows that soil organic matter content is positively correlated with Ni and As, indicating that Ni, As and other elements in the soil increase with the increase of soil organic matter content. The main causes of this result are: formation of soil organic matter and heavy metal ions compound, thereby reducing the bioavailability and mobility of heavy metal elements, making the activity of heavy metal ions in soil decreased, eventually leading to increased levels of heavy metals in the soil [14-15]. There was a significant negative correlation between soil pH and Cu, positive correlation with Ni, As and so on, but significant positive correlation with Cr. Yang Xifei et al [16] through the study of heavy metal pollution in paddy field results show that: in weak acid conditions, water-soluble heavy metal ions more active, more easily absorbed by plants and enrichment, which is consistent with the results of this study. However, there is a significant negative correlation between pH and Cu in soil, contrary to previous studies. Studies have shown that soil pH has a significant impact on the migration and biological effects

of Cu. Free Cu is negatively correlated with soil pH. As soil pH increases, the available Cu content decreases. This is in agreement with the study by Li et al. The results are consistent [17].

Table 2. Correlation matrix of soil heavy metals and soil organic matter and pH

Project	pH	SOM	Cu	Zn	Cr	Ni	As	Cd
pH	1	0.224	-0.582*	-0.543	0.750**	0.681*	0.670*	-0.541
SOM		1	-0.079	0.084	0.474	0.676*	0.579*	0.129
Cu			1	0.894**	-0.326	-0.339	-0.437	0.880**
Zn				1	-0.226	-0.248	-0.356	0.994**
Cr					1	0.802**	0.724**	-0.257
Ni						1	0.950**	-0.263
As							1	-0.371
Cd								1

4. Conclusion

(1) The content of organic matter in the soil around the tailings in Tongguan mining area is generally moderate, the content is between 10.8 ~ 18.2 g/kg, the soil pH is weakly alkaline with the content of 7.48 ~ 8.17,

(2) Cr, Ni, As and other heavy metals did not exceed the "National Soil Environmental Quality Labeling" (GB156183-1995), but the content of heavy metals such as Cu, Zn and Cd were seriously exceeded. Therefore, it has a more serious impact on agricultural production and human health.

(3) There was a significant positive correlation between soil organic matter content and Ni, as, soil pH and Cu showed a significant negative correlation with Ni, as and other significant positive correlation, and Cr was extremely significant positive correlation. Through the relationship between soil organic matter, pH and heavy metal content, it shows that soil organic matter and pH value are important indexes that affect heavy metal content in soil.

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