Analysis of Distribution of Mineral Resources and Status of Soil Pollution in Shaanxi Province

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Abstract. Shaanxi Province has a variety of geological structures and abundant mineral resources. As the main driving force for regional economic development, mineral resources will inevitably cause environmental pollution in the mining process, especially the serious pollution of the mining area and surrounding soil. According to the distribution characteristics of mineral resources in Shaanxi Province, this paper makes a detailed analysis of soil pollution caused by mineral resources.

1. Introduction

Mineral resources refer to the aggregates of minerals or elements that are formed through a series of geological activities and are found in the earth’s crust or exposed on the surface and can be used for human development. As an important material foundation of social development, its use has spread to all aspects of life in modern society. However, the soil has been seriously polluted during the exploration, development and utilization of mineral resources. Soil is the basis of human survival, and once polluted, it will seriously threaten human life and health. According to statistics, 16.1% of the country’s soil is polluted due to human activities such as industry, mining, and agriculture [1].

Due to its unique geographical location, Shaanxi contains various types of geological structural belts, with good metallic conditions and abundant mineral resources [2]. According to the statistics of 1999, 137 kinds of mineral resources were found in Shaanxi Province. Calculating only proven reserves, Shaanxi is at the forefront of the country. The reserves of coal, oil, and natural gas rank fourth, fifth, and fourth in the country, respectively. Shaanxi is a typical northwestern region, and mining is one of its main industries for economic development. According to the statistics of 2011, there are 5,337 mining enterprises in Shaanxi Province. Among them, there are 527 coal mines, two oil and gas companies, 149 ferrous metal mining companies, and 94 precious metals [3]. The distribution of mineral resources is closely related to soil pollution. Often, the distribution area of mineral resources is the area with severe soil pollution [4].
2. Distribution of mineral resources in Shaanxi

Shaanxi is located in the northwestern part of China and has a unique geographical location. It is divided into three natural regions from south to north: the Loess Plateau in northern Shaanxi, the Guanzhong Basin, and the Qinba mountain area in southern Shaanxi. It spans three tectonic units in the Yangtze, North China and Qinling Mountains. The area contains various types of landforms, with complex geological structures, complete formation development, strong tectonic activity, and good mineralization conditions [5].

Energy and minerals are mainly coal, oil and natural gas. Coal mines are mainly distributed in the Weibei area. Especially Tongchuan, Hancheng, Heyang and Chengcheng are known as the "black belts" of Weibei. Oil is mainly distributed in the Ordos Basin in northern Shaanxi, including Jingbian, Dingbian, Yanchang, Yanchuan, and Zichang counties; natural gas mainly exists in Jingbian and Hengshan counties [6]. Non-energy minerals are mainly distributed in central and southern Shaanxi.

3. Distribution of soil pollution

According to the distribution and mining characteristics of mineral resources in Shaanxi Province, its soil pollution can be divided into three blocks: oil-contaminated areas in northern Shaanxi, heavy metal-contaminated areas in Weibei (mainly the Xiaoqinling area), Urban and industrial pollution areas.

3.1. North Shaanxi Petroleum Contaminated Area

The northern Shaanxi region is mainly loess. Loess has a strong ability to absorb and intercept oil. It is one of the main sources of oil pollution in the environment [7]. The surface soil is mainly polluted during the oil collection process. Under the effect of surface runoff, the contaminated topsoil contaminates the water body with oil pollution, thereby contaminating more soil and water bodies. Because of its strong adhesion, the oil that enters the soil is mainly concentrated in the 20-30cm soil, and this part of the soil is also the key part for crops to absorb nutrients. After oil enters the soil, it will reduce the permeability of the soil, affect the respiration of the roots of the soil crops, and cause root decay. Most of the petroleum hydrocarbons are macromolecules, forming an oil film in the soil, affecting the moisture and nutrients in the soil by the crop root at the same time, petroleum pollutants can be absorbed by plants into the fruit, thereby contaminating food crops. At the same time, during the oil extraction process, the drilling wastewater, mud, and well washing wastewater produced contained a large amount of heavy metals, which seriously polluted the nearby soil [8].

The ecological environment in northern Shaanxi is fragile, even after the oil well is closed, pollution will continue to spread for a long time. The transmission of petroleum pollution in soil is divided into point source transmission and non-point source transmission, but mainly point source transmission.

The total petroleum hydrocarbons in the soil around the oil field can reach up to 27 times the local background value. Oil diffuses radially in the soil. The total hydrocarbon content in the surrounding soil decreases with increasing distance from the oil well. At the same time, there was a serious phenomenon of private oil exploitation in the history of northern Shaanxi. During the private mining process, due to outdated equipment, no attention to the environment, the pursuit of maximizing benefits, the use of predatory mining methods caused serious soil oil pollution. Li Xiaoli et al. Compared samples of private oilfields and state-owned oilfields by sampling in 2009, and the results showed that oil pollution existed near the two oilfields, while soil oil pollution was more serious in private mining areas [9].

3.2. Weibei heavy metal pollution area

There are a large number of coal mines and metal minerals distributed in the Weibei area. These minerals will cause different heavy metal pollution during the mining process. During the mining process of coal mines and metal minerals, a large amount of acidic wastewater containing heavy metal ions will be produced during beneficiation and coal washing, and the accumulated tailings will be
released through the dripping of heavy metal ions from rainwater. As the river system spreads, it will pollute the river's ecological environment and banks. During the exploitation of mineral resources, water and heavy metal pollution are first caused, and then the pollutants are transmitted through the water body to contaminate the soil in the watershed.

The most typical and severe environmental pollution caused by the exploitation of mineral resources in Shaanxi Province is the Tongguan gold mine in Xiaoqinling. In 1990, all the atmospheric mercury concentration monitoring in Tongguan area exceeded standards, and the maximum exceeded 38 times. In 2002, the lead, mercury, and iron in the upper reaches of the Haocha River in Tongguan County exceeded the Class I water standard; the lead and mercury in the lower reaches of the River respectively exceeded the Class IV water standard [10]. Farmland soils were mainly polluted by Hg, Cd, and Pb. The exceeding standards were 89.8%, 57.1%, and 12.2%, and 83.6% of the soil in the study area had been polluted by heavy metals of varying degrees. The exceeding standards of the three heavy metals Hg, Cd and Pb in wheat and corn were 39.1% and 44.4%, 39.1% and 33.3%, 47.8% and 33.3%, respectively [11].

The pollution of Hg, Cd and Pb in farmland soils in the study area is serious. The comprehensive pollution index analysis showed that the soil area of polluted farmland in the study area reached 83.6%, and the heavily polluted area reached 30.6%. The ecological hazard of Hg in farmland soil is the largest, the ecological hazard of Cd is the second, and Pb has only a slight ecological hazard.

The farmland around Tongguan County metal smeltery is also seriously polluted by heavy metals. Within the range of 0-120cm of soil in the smeltery plant, the Cd content exceeds the national soil quality standard, and the soil Cd concentration is between 7.91~361.76 mg.kg$^{-1}$. The Cd, Hg, and Pb pollution in the soil of the mining area is serious. The Zn near the stockyard and the production area exceeds the national level III soil quality standard, and the Cd content in the surrounding farmland is higher than the national level III standard [12].

3.3. Urban and industrial pollution areas

Urban soil is an important part of the urban environment. Its pollution mainly comes from the three industrial wastes, urban domestic waste, and automobile exhaust emissions. Pollutants produced enter the soil, resulting in increasingly serious soil pollution. The average content of Co, Cr, Cu, Mn, Ni, Pb, and Zn in the roadside soil in Xi'an is higher than the background value of Shaanxi soil. Cu, Pb, and Zn seriously exceed the standards, followed by Co and Cr, and As, Mn and Ni slightly exceeded. Through data analysis, the sources of As, Mn, and Ni in roadside soil are mainly natural and traffic sources. Cu, Pb, and Zn are mainly from traffic sources, and Co and Cr are mainly from industrial sources [13].

Soils in areas with heavy industry distribution are seriously polluted by heavy metals. The average contents of Zn, Co, Cd, and Hg in the sediments of the Baoji section of the Weihe River are higher than the background values of soil elements in Shaanxi, and Cd and Hg are particularly prominent [14].

The soil around the thermal power plant is seriously polluted by heavy metals, and the heavy metal pollution mainly comes from the combustion of coal. During the combustion of coal, a variety of volatile heavy metal elements will eventually pollute the surrounding soil through media such as smoke, ash and waste water. Hg in the soil around the power plant in Baoji City is seriously polluted and the potential ecological harm is serious [15]. The content of Cu, Pb, Zn, Co, Cr, Mn, Ni, and V in the farmland soil around the power plant is higher than the surface soil background value in Shaanxi, and it is in a state of slight pollution. The comprehensive pollution of heavy metals at each sampling point is mild.

4. Soil pollution prevention measures in Shaanxi Province

Soil pollution in Shaanxi Province is mainly distributed in the oil distribution areas in northern Shaanxi, as well as the metal mineral and energy mineral distribution areas in the Guanzhong area. Many of these pollutions are problems left over from history. In the early mining process, due to lack of supervision, private mining was common, resulting in serious soil pollution in the area. Therefore,
the government must strengthen management to prevent the phenomenon of private chaos. At the same time, in the future mineral mining, local governments and enterprises cooperate to supervise and manage the mining of mineral resources. This requires strengthened cooperation among various regional departments, and at the same time each mining enterprise needs to raise awareness of environmental protection, reasonably mine mineral resources, and control the environmental pollution caused by the mining process within the environmentally acceptable range.

Pollutants are easily diffused through river water systems. Therefore, during the mining process, it should be avoided to the extent possible that pollutants enter the river water system, resulting in the widespread diffusion of pollution. Do good jobs of prevention, improve the protection of the environment during the mining process, and invest in environmental protection. For already contaminated soil, carry out necessary repair work. Combine the currently mature soil remediation technologies, such as physical methods, chemical methods, and biological methods to repair contaminated soil. At the same time, according to different situations, multiple repair methods can be reasonably selected to jointly repair the soil of the contaminated site.

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References
[1] Ministry of Environmental Protection, Ministry of Land and Resources. (2014) Bulletin of national survey of soil pollution.
[2] Wang Yubao, Li Guoping. Several exploiting problems in the exhaustible resources of Shaanxi, China Mining Magazine. 11 (2003) 25-28.
[3] Xiang Maoxi, He Weizhong, Li Yonghong. An Analysis of Geological Environment Problems of Mines in Shaanxi, Ground Water. 36 (2014) 89-91.
[4] Li Xuanqiong, Li Yongshu, Lu Zheng. The Distribution Characteristics of Metal Pollution Generated by Mineral Resource Exploitation-Illustrated by a Copper Mine Region in Yalong River Basin, Conservation and Utilization of Mineral Resources. (2016) 56-63.
[5] Gong Minhuan. A Study on Exploitation and Utilization of Mineral Resources in Shanxi Province, China’s Manganese Industry. 34 (2016) 76-78.
[6] Ma Xiaomei. Study on the development and utilization of Shaanxi energy and mineral resources in the 20th century. Northwest University, 2006.
[7] LIN Q, MENDELSSOHN I A. The combined effects of phytoremediation and biostimulation in enhancing habitat restoration and oil degradation of petroleum contaminated wetlands, Ecol Eng. 10 (1998) 263-274.
[8] Wang Chunjiang. Questions and answers on environmental protection knowledge of onshore oil and gas fields: Petroleum Industry Press, Beijing, 2000, pp. 63-164.
[9] Li Xiaoli, Liu Guobin, Xu Mingxiang. Features of Oil Pollution of Soil and Surface Water in Northern Shaanxi Oilfield, China, Research of Soil and Water Conservation. 16 (2009) 145-148.
[10] Chen Shebin, Xu Youning, He Fang, etc. Analysis of Environmental Pollution and Harm of Tongguan Gold Mining Area, Northwestern Geology. (2003) 172-175.
[11] Wang Shuang, Li Ronghua, Zhang Jiaiqiang, et al. Assessment of the heavy metal pollution and potential ecological hazardous in agricultural soils and crops of Tongguan, Shaanxi Province, China Environmental Science. 34 (2014) 2313-2320.
[12] Li Ronghua, Shen Feng, Li Xiaolong, et al. Theoretical Research and Immobilization Practice of Heavy Metal Polluted Soil in a Closed Lead-Zinc Smelter and Surrounding Farmland in Tongguan, Shaanxi, Journal of Agro-Environment Science. 34 (2015) 1269-1276.
[13] Chen Jinghui, Lu Xinwei, Zhai Meng. Sources and potential risk of heavy metals in roadside soils of Xi'an City, Chinese Journal of Applied Ecology. 22 (2011) 1810-1816.
[14] Wang Lijun, Lu Xinwei, Lei Kai, et al. Heavy Metal Pollution in Surface Sediment of Wei River (Baoji), China, Journal of Agro-Environment Science. 30 (2011) 334-340.

[15] Wang Lingqing, Lu Xinwei, Wang Lijun, et al. Evaluation of Hg Pollution of Soil Around the Baoji Coal-fired Power Plant, Chinese Journal of Soil Science. (2007) 622-624.