

Mercury content in soils on the territory of Mezhdurechensk

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Abstract. The geochemical features of mercury content and distribution in the zone of coal producers have been studied (Mezhdurechensk town). Mercury content in soil (30 samples) was determined by atomic absorption method using mercury analyzer PA-915+ with pyrolytic device. Mercury content in soil samples changed from 0.12 to 0.17 mg/kg, the average value being 0.057 mg/kg. Within the town territory five zones with mercury elevated concentrations in soil were distinguished. 25-year observation period showed a 2.8 time decrease in average mercury content in soil. The major contribution to soil pollution in the urban territory was made by the two factors: local and regional. The mercury content in soil is affected by the emissions from boilers operating on coal as well as coal dust from the open pits near the town.

1. Introduction

Mercury and its compounds are one of the most hazardous ecotoxins or even “superecotoxins” [1]. The relevance of the given issue is supported by its consideration at the international level [2]. The study in mercury transformations and migration in connection with different technogenic processes is of great significance for understanding toxicants’ geochemical cycle in the environment. Along with other media soil is not only deposit environment of mercury and its compounds, but also its source in other ecosystem constituents including water and plants, which defines its further way through trophic chains [3-5]. Under intensive local pollution soil can be a source of secondary mercury emission in the environment [6]. One of the key anthropogenic sources of mercury in the environment is coal producers. At present, coal producers in Kemerovo Oblast are largest enterprises in coal mining of Russia. These enterprises of different capacity surround Mezhdurechensk, which is located 60 kilometers east from Novokuznetsk city and 302 kilometers south-east from the administrative center, Kemerovo city. Mercury is released into the environment in the process of coal mining and combustion as a part of coal dust and combustion products.

The purpose of the given paper is to determine mercury content in soil of Mezhdurechensk town, to reveal technogenic pollution at its initial stage, when it does not pose a serious threat yet, but is of great importance for monitoring and forecasting. There is an opinion that constant exposure to mercury with concentration lower than the maximum permissible concentration (MPC) may also be hazardous for human health [7, 8]. The paper presents the data on spatial distribution of mercury in the territory of Mezhdurechensk as one of the towns located in the vicinity and zone of largest coal producers.

2. Methods and material

2.1. Study area and sampling

Soil samples were taken in May, 2015 from the entire territory of the town in the densely populated areas as well as in vicinity of schools and kindergartens (fig. 1), according to GOST 17.4.2.01-81, GOST 17.4.3.01-83, GOST 17.4.1.02-83, GOST 17.4.4.02-84, GOST 17.4.3.02-85 and methodical guidelines. To select samples the areal monitoring network was used at the scale 1:80000. The total number is 30. Samples were selected by depth traversed technique, at the depth of 5 – 10 cm. The weight of one sample was 1.5 – 2 kg. Then the samples were dried at room temperature 18 – 19°C, large foreign particles were removed. The samples were manually grinded and sieved through the



meshes of 2.5 mm and 1 mm in diameter. 100-150 g of every sample were grinded up to 0.074 mm at the grinding mill.

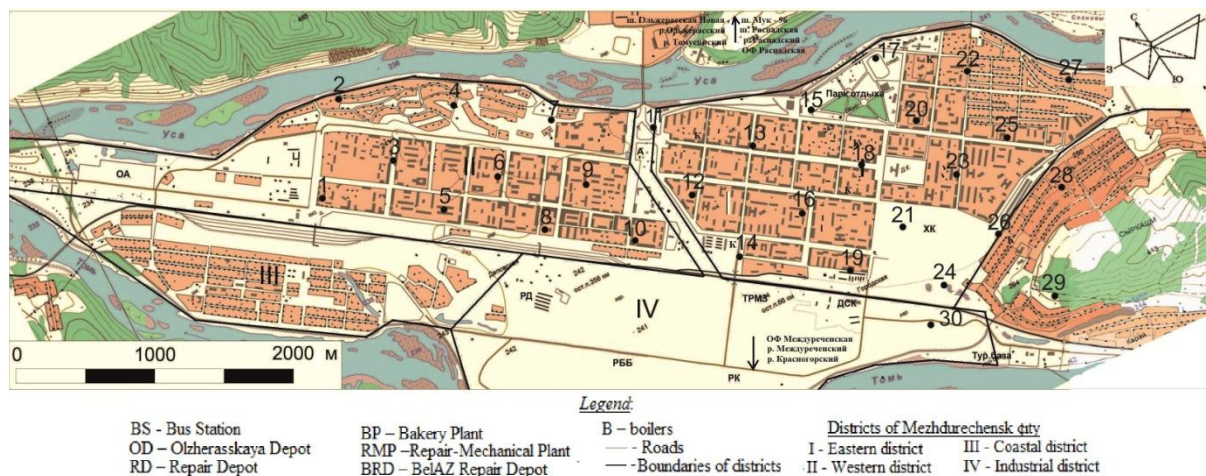


Figure 1. Schematic map of sampling.

2.2. Analysis

Mercury examination was carried out by atomic adsorption analysis using mercury analyzer RA-915+ with PYRO-915 attachment according to the method of PND F 16.1:2.23-2000 M 03-05-2005. As a background for mercury determination in soil the State Standard Sampling (SSS) of soddy-podzolic sandy-loam soil 2500-83 with mercury content 0.29 mg/kg was used. The portions of pre-grinded and dried at room temperature samples were 75.0 ± 0.1 mg. The error range of measurement was 28 % depending on weight fraction of mercury in the samples with the confidence coefficient 0.95 and two parallel measurements.

3. Results and discussion

The data analysis has shown that according to the aerial survey of Mezhdurechensk town site the mercury content in soil samples changes from 0.12 to 0.17 mg/kg, with the average value 0.057 mg/kg (figure 2).

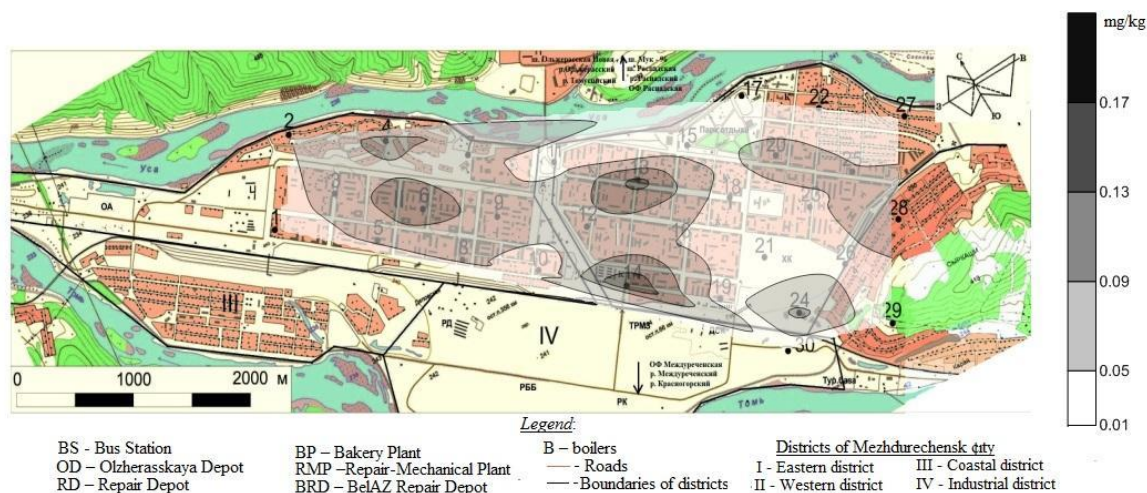


Figure 2. Mercury content in soil of Mezhdurechensk town.

Under these circumstances five zones with elevated mercury content were distinguished, three of which are located in the Eastern region, but two – in the Western one (fig. 2). Mercury content in the first zone (point № 4) is 0.104 mg/kg, in the second one (point № 6) is 0.116 mg/kg, in the third one (point № 13) is 0.148 mg/kg, in the forth one (point № 14) is 0.173 mg/kg, in the fifth one (point № 24) is 0.102 mg/kg. The first zone is located in the country part of the town where detached houses with stove heating are located, using coal as a fuel. The second, third, and fifth zones are located in vicinity of boilers that heat these zones. The fact can explain development of mercury elevated concentration zones in this part of the town. The forth zone is included in the industrial site in vicinity of the transport repair factory.

Thermal industry is still one of the major sources of mercury in the environment, which is proved by the example of Western Siberian cities and towns [9-11]. The unique properties of mercury (low melting point (-38.9°C) and high vapour pressure (boiling point 356.66°C) demonstrate the fact that it can exist only in the form of elementary mercury vapour Hg^0 at coal burning points. Regarding these properties an important feature of mercury is its volatility. Mercury emissions from coal combustion depend on the volume of burning fuel, combustion conditions, and mercury content in coal. According to [12], the average mercury content in Kuzbass coal changes from 0.01 to 0.1 g/t. However, in some coal fields, in the south-eastern part of Kuznetsk Basin particularly (pits Olzherassk, Mezhdurechensk, Tomusinsk), mercury content is several times higher: 0.3, 0.5, 0.6 g/t, respectively.

The comparison of mercury content in soils of some areas in the south of Western Siberia (figure 3) has revealed that at present the average mercury content in Mezhdurechensk town is 1.63 times lower than in Kemerovo Oblast and nearly equal to the average mercury content in Altai Territory [13]. It also should be noted that in comparison with the conducted research (1991, [14]) mercury content decreased 2.8 times.

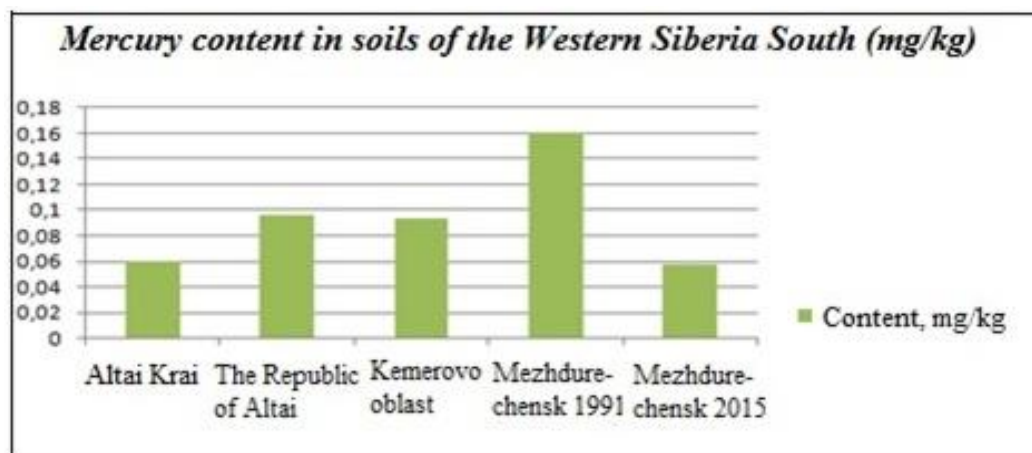


Figure 3. Mercury content in soil of some areas in the south of Western Siberia (mg/kg).

4. Conclusion

As a result of research performed it was stated that in the territory of Mezhdurechensk town five zones are distinguished with elevated mercury content in soil, three of which are located in the Eastern region, but two – in the Western one. The mercury content in the first zone – 0.104 mg/kg, in the second – 0.116 mg/kg, in the third – 0.148 mg/kg, in the forth – 0.173 mg/kg, in the fifth – 0.102 mg/kg. Besides, it was established that the major contribution to soil pollution in the territory of Mezhdurechensk town is made by the two factors: regional and local. The regional factor includes fallouts from coal mine development and explosion due to pollutants' transport. The local factor comprises boilers and enterprises located in the territory of Mezhdurechensk town as well as vehicles exhausts.

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