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M.Sh.Akhmetkaliyeva<sup>1</sup>, L.R.Sassykova<sup>1\*</sup>, Y.A.Aubakirov<sup>1</sup>,  
A.S.Zhumakanova<sup>2</sup>, S. Sendilvelan<sup>3</sup>

<sup>1</sup>al-Farabi Kazakh National University, Almaty, Kazakhstan;

<sup>2</sup>JSC “D.V.Sokolsky Institute of Fuel, Catalysis & Electrochemistry”, Almaty, Kazakhstan;

<sup>3</sup>Educational and Research Institute, University, Chennai-600095, Tamilnadu, India

\*e-mail: [larissa.rav@mail.ru](mailto:larissa.rav@mail.ru)

## RESEARCH OF THE CONTENT OF ZINC AND LEAD IN THE LIGHT-CHESTNUT SOILS ON THE TERRITORY OF ISLANDS “POLKOVNICHII” (KAZAKHSTAN)

**Abstract.** The aim of the work was to study and evaluate the main regularities of distribution of zinc and lead compounds in light chestnut soils. The study was carried out to assess the impact of man-made pollution on the environment and monitoring of soil pollution. The objects of research were the natural typical light chestnut soils of “Polkovnichii” island, located in the city of Semipalatinsk (Semey), Kazakhstan. For the monitoring, samples of all available genetic horizons of the soil section were applied. It is established that with increase in content of physical clay in the soil the maintenance of a bulk form of lead increases. With increase in maintenance of a humus in the soil the tendency to increase in maintenance of a bulk form of Zn is observed. The total lead content varies from 4.91 to 12.24 mg/kg; the total content of zinc is in the range of 14.84-23.67 mg/kg. It has been revealed that, according to the level of the average content of the mobile form of zinc, the researched soils are related to the average soils provided by these elements. The authors conclude that it is necessary to study the effect of the physical and chemical properties of the region’s soils on the effectiveness of zinc fertilizers and to continue research in this direction.

**Keywords:** light chestnut soils, zinc, lead, “Polkovnochii” island, Semipalatinsk.

### Introduction

The soil produces minerals from the substances which are contained in it, the introduced fertilizers, pollinators. The minerals which are contained in them pass into plants. Therefore the plants going to food reflect features of microelement structure of this soil and its geological structure. Emissions of industrial plants also contain harmful impurities deposited on the soil. So, in the soil around the enterprises of non-ferrous metallurgy there are oxides of lead, tin, molybdenum, arsenic, etc.; around factories of ferrous metallurgy contain zinc, lead, phenol, arsenic, sulfur [1-3]. Excess of minerals, such as mercury, lead, cadmium or selenium, obtained from vegetable or animal food, can cause the human body poisoning, whereas copper deficiency, iron, manganese, zinc, iodine, fluorine, cobalt and molybdenum cause a variety of problems related to nutrition [4, 5-8]. In natural, uncontaminated reservoirs and in places where there are no enterprises for production and processing of minerals and where mineral substances are not brought in the soil as fertilizers or growth factors of plants, minerals contain, as a rule, in thousand or ten-thousand shares of milligram on water liter.

At the solution of practical questions of environmental protection from anthropogenic pollution the important place is taken by data on the content of toxiferous ingredients in soils of the concrete region. At pollution level assessment as background usually take uncontaminated territories with a similar soil cover for which concentration of heavy metals are known. The way of analogy in this case is very difficult to observe, since city soils are urban soils, strictly speaking there are no analogues in natural conditions. In this regard, there is an urgent problem of finding a local urbanized background that could be used to assess the level of soil contamination.

The aim of the work was to study and evaluate the main regularities of distribution of zinc and lead compounds in light chestnut soils.

The natural typical light chestnut soils of “Polkovnichii” island (fig. 1), located in the city of Semipalatinsk (Semey), Kazakhstan, were chosen as objects of research. The city of Semey is divided by the Irtysh River on left-bank and right-bank. In the middle of the Irtysh River there is an island “Polkovnichii” (fig.2). The original and present name of the island is associated with the name of Matvei Ivanovich Geytsig, the lieutenant colonel (later Colonel), who was appointed commandant of the Semipalat fortress in 1787. The name of the island “Polkovnichii” is mentioned in plans from the 19th century [8]. The island “Polkovnichii” is one of the main sights of Semey. During its long history, it experienced different periods. To restore the island to its former glory, it is necessary, first of all, to change its consumer attitude to natural resources. Today, the fate of the Polkovnichii’s Island is also worried about environmentalists, public figures, and law enforcement agencies.



Figure 1 – An island “Polkovnichii”, Semey, Kazakhstan, 070000



Figure 2 – General view of the island location map

For tests were taken samples of all of the genetic horizons of the soil profile. Definition of macrocomposition of all tests of soils (pH, a humus, CO<sub>2</sub> of carbonates, granulometric composition) was carried out by standard methods [9].

Among the heavy metals as studying objects lead and zinc have been taken. The choice of these elements is due to two factors: firstly, the physiological importance of zinc in living organisms and in particular for plants, and second - the lack of information on the biogeochemistry of these elements on the island “Polkovnichii” needed to solve a number of scientific and practical issues [10, 11].

Lead (Pb) is a metal that has long been extracted and used by man in various spheres of economic activity. Just as long ago, the negative impact of lead on human health is known: already in the II century of BC signs of “saturnism”, lead poisoning of the organism, were described. In urban conditions, the most studied is lead contamination: it is more where there is more humus (the soil of the city is parks, gardens, squares, transport arteries). In the soils of transport highways lead is detected even at great depths.

Zinc (Zn) is one of the most important trace elements: it is part of the enzymes that lead and regulate many vital processes. Zinc increases the heat and frost resistance of plants. With its lack in the soil, the inorganic phosphates are slowed down into organic plant compounds. On the other hand, a significant increase in the content of zinc in the components of the environment and foodstuffs negatively affects living organisms, accompanied by a deterioration in human health. Plants have a different ability to absorb zinc from the soil. Of all heavy metals, zinc is the most mobile element and is well absorbed by plants.

The content of heavy metals in the explored soils was determined on the KFK-3 device by a photocolometric dithizone method by G.Ya.Rin`kis's recipe [9, 12, 13]. The reproducibility of the method was equal to  $\pm 4.2\%$ . Selection of fractions of Pb and Zn was carried out by method of parallel extraction. All analytical data were processed by mathematical analysis and mathematical statistics in soil science according to E.A.Dmitriev [14].

### Results and discussion

Results of the performed researches (table) show that the average total content of lead in the general set of soil samples of the investigated territory in 1.2 time, of zinc – is 2.4 times lower than their clark contents in soils.

Table - The total content of lead and zinc in the light chestnut soils of “Polkovnichii” island (in mg/ kg)

Metal	$K_v$ ,	$M \pm m$ ,	V, %	Clark in a soil [15]	Clark in the lithosphere [15]	Maximum concentration limit in the soil [5]
Pb	4.91 – 12.24	$8.32 \pm 1.05$	34.0	10.00	16.0	100
Zn	14.84-23.67	$20.86 \pm 1.37$	17.0	50.00	83.0	300

Note:  $K_v$  - a range of a variation,  $M \pm m$  – an arithmetic average and its mistake, V – variation coefficient.

The studied heavy metals on magnitude of the average total content are arranged in such a way:  $Zn > Pb$ . On value of coefficient of a variation (in %) heavy metals in the researched soils are located in the following decreasing order:  $Pb (34) > Zn (17)$ .

It was found that the content of total forms of heavy metals on a profile of soils is distributed unevenly. The maximal content of lead is characteristic of the illuvial horizon of  $B_1$ , minimum – of the humic horizon A. The maximal content of a total form of Zn is characteristic of the humic horizon of  $A_n$  and the humic and accumulative horizon of  $A_1$ , minimum – of the transitional horizon of BC. The increased content of a total form of Zn in the humic and humic and accumulative horizons is explained by the increased contents in them of the maximum quantity of a humus, and also higher value pH. In turn, the increased content of a total form of lead in the illuvial horizon  $B_1$  is explained by the increased contents in this horizon of the maximum quantity of physical clay (<0.01 mm), possible carbonaceous and alkaline geochemical barriers.

According to numerous researches, organic matter and its components form various complex compounds with heavy metals [6, 11], and the fine-grained mineral phase is the strong adsorbent of heavy metals [7]. Results of the carried out researches show that with increase in content of physical clay in the soil the content of a bulk form of lead increases, and also with increase in content of a humus in the soil the tendency to increase in content of a bulk form of Zn takes place. Reaction of aqueous soil slurries in the humic and humic and accumulative horizons is neutral. Namely at values pH, the close to neutral, the maximum of absorption of heavy metals by organic matter and clay minerals is reached [7, 16]

Amplitude of fluctuation of content of elements in the soil is a little various: for lead accumulation in the top horizon of the soil sharply increases with a depth, on the contrary, accumulation in the humic and accumulative horizon which gradually decreases is characteristic of Zn. It indicates that lead in the researched soils is less mobile metal, is capable to form steady compounds with finely dispersed mineral phase of the soil. It should be noted that zinc in these investigated soils relates to metals less mobile in the soil; a key role in this belongs to an organic substance capable of forming stable complexes with zinc, which is very important and has great practical significance for the management of migration and bioavailability of this element in the soil. The research of the work showed that the observed the unequal correlation between the total content of heavy metals and indicators of humus, soil pH and physical clay. A positive reliable correlative dependence of content of a total form of lead only on availability of physical clay is revealed. In the investigated light chestnut sandy loam soils reliable positive correlative dependence between the total content of Zn and existence of a humus, and also value pH is found. The established level of total contents in soils of the studied urbanized background is much lower than the recommended maximum permissible limits. V.V.Kovalsky established the threshold concentrations of some elements in soils according to their possible pathological influences on farm animals [17]. When compared with these threshold concentrations total zinc content is within the lower threshold boundary. The investigated light chestnut soils of "Polkovnichii" island are characterized by low total zinc content in comparison with soils of different regions [12, 13, 16, 17]. According to gradation to Ya.V.Peyv and G.Ya.Rin`kis [9, 12-14], by the level of average content of the mobile form of Zn the researched soils belong to the medium soils accordingly presence of this element.

Data on the background content of zinc and lead in the studied soils are very valuable, give the possibility of systematic observations in this natural region and improve the objectivity of the evaluation of the emerging environmental conditions. In recent years farmers to the soil introduce Zn-containing fertilizers therefore carrying out a research of influence of physical and chemical properties of soils of the region on effectiveness of zinc fertilizers has applied value. Thus, as a result of the research it was found that the studied soils are characterized by deficiency of zinc content and by the level of the average content of mobile forms of zinc belong to the medium soils by the presence of this element. This must be considered when using zinc-containing fertilizers into the soil. It is necessary to carry out detailed investigation of the influence of physical and chemical properties of the soil in the region on the effectiveness of zinc fertilizers, and to continue research in this direction.

### Conclusion

The researches on the soils of the territory of the island "Polkovnichii" (Kazakhstan) for an assessment of the main regularities of distribution of forms of finding of Zn, Pb in light chestnut soils were carried out. It is found that the total content of lead fluctuates from 4.91 to 12.24 mg/kg, the average value is equal to 8.32 mg/kg, the coefficient of a variation is equal to 34.0%; the total content of zinc is in limits of 14.84-23.67 mg/kg, the average value is equal to 20.86 mg/kg, the coefficient of a variation is twice less, than for lead and amounts 17%. Average total content of lead in 1.2 times, zinc - 2.4 times lower than their clark contents in soils. The total content of zinc in the soils of investigated area is located within the lower threshold limits. Migration of forms of finding of lead and zincum on a profile of the soil happens nonuniformly: accumulation of zinc is noted in the top horizons of the soil – humic A<sub>n</sub> and the humic accumulative horizon of A<sub>1</sub>. It indicates the leading role of soil organic matter in accumulation of this element. Lead accumulation occurs in the illuvial horizon B<sub>1</sub> of the investigated soils, due to the increased content of physical clay in this horizon.

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**М.Ш. Ахметқалиева<sup>1</sup>, Л.Р. Сасықова<sup>1\*</sup>, Е.А. Әубәкіров<sup>1</sup>, А.С. Жұмақанова<sup>2</sup>, <sup>3</sup>С. Сендивелан**

<sup>1</sup>әл-Фараби атындағы Қазақ ұлттық университеті, Алматы қ., Қазақстан;

<sup>2</sup>Д.В. Сокольский атындағы Жанармай, катализ және электрохимия институты, Алматы қ., Қазақстан

<sup>3</sup>Ғылыми-зерттеу институты, университет, Chennai-600095, Тамил Наду, Үндістан

### **«ПОЛКОВНИЧИЙ» АРАЛЫНДАҒЫ АШЫҚКАШТАНДЫ ТОПЫРАҚ ҚҰРАМЫНАН МЫРЫШ ЖӘНЕ ҚОРҒАСЫН МӨЛШЕРІН ЗЕРТТЕУ**

**Тірек сөздер:** ашыққаштанды топырақ, мырыш, қорғасын, мониторинг, «Полковничий» аралы, Семей.

**Аннотация.** Жұмыстың мақсаты ашыққаштанды топырақ құрамынан мырыш және қорғасын қосылыстарының таралуының негізгі заңдылықтарын бағалау мен зерттеу болып табылады. Зерттеу қоршаған ортаға техногенді ластаушыларды бағалау мен топырақтың ластануына мониторинг жасау үшін жүргізілді. Зерттеу нысаны ретінде Семей қаласының маңында орналасқан «Полковничий» аралының табиғи ашыққаштанды топырағы алынды. Мониторинг жасау үшін генетикалық горизонталды топырақтың барлық үлгісі қолданылды. Топырақ құрамында физикалық саздың мөлшері артқан сайын қорғасынның валдық түрінің үлесі де артады. Топырақ құрамында гумус мөлшері артқанда мырыштың валдық түрі артағыны байқалды. Қорғасынның валдық мөлшері 4,91-ден 12,24 мг/кг, ал мырыш мөлшері 14,84-23,67 мг/кг болады. Зерттелген топырақта мырыштың орташа қозғалмалы түрі топырақты осы элементпен қамтамасыз етудің орташа деңгейіне жататыны анықталды. Аймақтың топырағының физикалық-химиялық қасиетіне мырыштың тұнбайтындығы тиімділігіне жеткілікті зерттеу қажет деген тұжырымға келіп, бұл бағыттағы зерттеуді жалғастыру керек.

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**М.Ш. Ахметқалиева<sup>1</sup>, Л.Р. Сасықова<sup>1\*</sup>, Е.А. Аубакиров<sup>1</sup>, А.С. Жұмақанова<sup>2</sup>, <sup>3</sup>С. Сендивелан**

<sup>1</sup>Казахский национальный университет им. аль-Фараби, Алматы, Казахстан;

<sup>2</sup>АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского», Алматы, Казахстан;

<sup>3</sup>Научно-исследовательский институт, Университет Ченнай-600095, Тамилнаду, Индия

### **ИССЛЕДОВАНИЕ СОДЕРЖАНИЯ ЦИНКА И СВИНЦА В СВЕТЛО-КАШТАНОВЫХ ПОЧВАХ НА ТЕРРИТОРИИ ОСТРОВА «ПОЛКОВНИЧИЙ» (КАЗАХСТАН)**

**Аннотация.** Целью работы является изучение и оценка основных закономерностей распределения соединений цинка и свинца в светло-каштановых почвах. Исследование проводилось для оценки влияния техногенного загрязнения на окружающую среду и мониторинг загрязнения почв. Объекты исследований – это естественные типичные светло-каштановые почвы острова Полковничий, находящегося в черте города Семипалатинск (Казахстан). Для мониторинга были использованы образцы всех имеющихся генетических горизонтов почвенного разреза. Установлено, что с увеличением содержания физической глины в почве увеличивается содержание валовой формы свинца. С повышением содержания гумуса в почве наблюдается тенденция к увеличению содержания валовой формы цинка. Валовое содержание свинца колеблется от 4,91 до 12,24 мг/кг; валовое содержание цинка находится в пределах 14,84-23,67 мг/кг. Выявлено, что по уровню среднего содержания подвижной формы цинка исследуемые почвы относятся к средним по обеспеченности этими элементами почвам. Авторы делают вывод, что необходимо провести исследования влияния физико-химических свойств почв региона на эффективность цинковых удобрений и продолжить исследования в этом направлении.

**Ключевые слова:** светло-каштановые почвы, цинк, свинец, мониторинг, остров «Полковничий», Семипалатинск.