ЭКОЛОГИЯ ПОЧВ

УДК 635:631.95(749.25)

H.Gh. Ghazaryan[1], S.A. Hunanyan[1], A.L. Mkrtchyan[1]

ECOLOGICAL STATE OF MOUNTAIN-MEADOW AND MEADOW-STEPPE SOILS OF GEGHAMA RIDGE

[1]Scientific Center of Soil Science, Agro-chemistry and Melioration after H.P.P.etrosyan, ANAU branch, 0004, Yerevan, 24, Admiral Isakovave, Republic of Armenia,

e-mail: ghazaryan_soil@yahoo.com

Abstract. The article presents the ecological assessment of the Geghama ridge soils for the content of heavy metals (HM) in them. Based on the results of the research, the presence of heavy metals in various types and subtypes of soils, their distribution pattern and migration along soil layers have been established. A correlation between the content of heavy metal forms in soil, the amount of humus and physico-chemical indicators of soils have been revealed. The content of heavy metals along the soil profile of Gegham ridge is decreasing downward and in some HM (Cd, Cu) it exceeds clarke.

Key words: soil, type, subtype, ecology, heavy metals, ridge.

INTRODUCTION

All known natural chemical elements are present inliving substances (plants, animals, humans), they exist in biosphere'sall components [1]. Many microelements are absolutely necessary for organisms (zinc, iodine, copper, manganese, molybdenum, cobalt, boron, etc.). Without these elements, organisms, even fully supplied with microbiophiles, can not develop normally. However, many scattered elements in anomalously high concentrations are harsh and toxic for plants, animals and humans.

The negative effect of high concentrations of microelements depends not only on the total content, but also on the type of soils and the sort of plants. The content of microelements in soil is the main indicator of its ecological state, since the content of microelements (heavy metals (HM)) in fodder depends on this indicator. Hence, studying the content of microelements in soils has an ecological and sanitary-ecological value.

The purpose of this work is to study the content of heavy metals (Cu, Zn, Pb, Mo, Co, Cd) in mountain meadow and meadow-steppe soils of Geghama ridge. The study of agrochemical indicators and the content of heavy metals in soils was conducted in 2011-2015. For this purpose, stationary sites were chosen at different heights andexpositions and on them the soil cuts are done.

OBJECTS AND METHODS

The subject of the research was the soils of the Geghama ridge. Experimental research was conducted using the field andcameral studies, as well as through laboratory agro-chemical analisys of soil samples by generally accepted agrochemical methods: soils'mechanical composition by Robinson, humus content- by Tyurin, and environment reaction (pH) - with potentiometer.

The content of HM'stotal forms was determined by spectral-emission, neutron -activation methods, and mobile forms were measured by atomic absorption method using a spectrophotometer "AAS-1" [2].

RESULTS AND DISCUSSION

The Geghama ridge is located in the central part of the Republic of Armenia at an altitude of 2100-3600 m above sea level and occupies about 120,000 hectares. Its total length from the northwest to the southeast is about 80 km [3].

Geologically the Geghama ridge a young volcanic formation. Quaternary lavas are widespread on its surface – andesites, andesite-basalts and tufoschaks [4].The territory of research has cold mountain climate, in the upper part of the ridge -

severe alpine highland climate. The climatic conditions in the sub-alpine and alpine zones differ dramatically. The average annual air temperature in the sub-alpine zone is 1-4°, in the alpine zone - from 1° to minus 3°. In the upper part of the ridge the temperature is even lower. The annual amount of precipitation increases from bottom up - 450 to 1000 mm [5].

The vegetation cover is rich with species. In the subalpine zone from *Agrostis*, *Trifolium pratense*, *Trifolium repens*, *Inula*, *Achillea* etc. In the alpine zone, the most common plants are *Festucaovina*, *Trifolium pratense*, *Bromus* etc. [3].

Three vertical soil zones were distinguished within the ridge, in the soil cover of which the following types and subtypes of soils are formed.

Mountain-meadow soils occupy the highest position in the zonality system of soils in Geghama ridge. They are in the subalpine and alpine zones under the thick grass cover. The relief is characterized by a large variety: along with large and steep slopes, covered with cumbersome screes and placers, there are small plain plots, steep hills, as well as individual rounded hills with soft curves [4]. The mountain-meadow soils of Geghama ridge are subdivided into three subtypes: mountain-meadow-peaty; mountain-meadow-sod (brown); mountain-meadow lowsodern [3, 4].

Mountain-meadow peaty soils are considered alpine zone from 2700-3600 m above sea level. The main morphological features of mountain-meadow sod-peaty soils are: the presence of a sod-peat layer, brown or dark brown color of humus layers - sometimes with a darker shade, and a medium soil power.

From the data in Table 1 is evident that the maximum humus content in the upper layershave mountain-meadow sod-peaty soils (20.9 %).

Mountain-meadow sod soils are occupying the lower part of alpine and upper part of subalpine zones on the slopes of different exposures and steepness, in the altitudes from 2700-3200 m above sea level. They have high content of humus in the upper layer (13.3 %), mainly, acidic and weakly acidic reaction of the environ (Table 1).

Mountain-meadow low-so dernsoils are mainly in the lower part of subalpine zone. They have black or brown color, fine-grained or have porous-granular structure in the upper layers, and are gradually becoming denser with depth. These soils also have a high content of humus (12.6 %) and have a lightly silty-loam texture light loam texture (Table 1).

Mountain-meadow-steppe soils of the Geghama ridge are formed in the mid-mountain zone, at an altitude of 2100-2700 m above sea level.

Among mountain meadow-steppe soils, two subtypes are distinguished: meadow-steppe chernozem and meadow-steppe typical (brown or chestnut color). Meadow-steppe chestnut color soils of large massesare found on dry slopes, southern, south-western and south-eastern exposures. They are quite rich in humus (8.2 %), they have mediumsilty-loam texture light loam texture) and weakly acidic and neutral reaction of environ (Table 1).

Meadow-steppe chernozem-like soils occupy the lower parts of the massif. Characteristic features of thesesoils'morphologyare: black or brownish color of humic horizons. Meadow-steppe chernozem-like soils are mainlystrong, havemedium-and heavy silty-loam texture Medium-heavy loam texture --andlarge humus content (10.6 %) (Table 1).

One of the main tasks, as mentioned above, was the study of microelements' (HM) content and distribution in Geghama ridge's soils.

Copper - the bulk portion of copper in the earth's crust is relatively small-it is 0.005-0.01 %. In soils the content of copper is several times less than in the earth's crust and is $2 \cdot 10^3$ %.

Numerous studies prove the biological nature of copper accumulation in soils, although chances of such accumulation are different in different soils. The background content of copper's total and mobile formsin Republlic's soils is in the range: in semi-deserts - 15,0-58 and 3,9-9,4 mg/kg; in mountain chernozems - 23-74 and 4.5-14.5; mountain- meadow - 31.0-38.0 and 1.7-5.1; meadow-steppe - 24-40 and 4.2-4.5; brown in forests - 48-52 and 4.9-7.2 mg/kg [5-7].

We determined that the content of total and mobile forms of copper in mountain-meadow and meadow-steppe soils depends on many factors, where the mains are the soil type, humus content, mechanical texture mechanical composition and the reaction of the environ. In the mountain-meadow soils the content of total and mobile copper in the upper humus layers varies between 34.0-44.0 and 4.7-7.5 mg/kg, in meadow-steppe soils respectively 43.0-50.0 and 4.8-4.6 mg/kg, which is, compared to the background content in those soils is more than 3.0-6.0 mg/kg of total copper, and mobile - 1.0 % 1.4 mg/kg, in meadow-steppe soils - by 19.0-10.0 and 0.60-0.10 mg/kg (Table 1). The maximum content of total copper in mountain-meadow sod-peaty and meadow-steppe chernozemlike soils (43.0-50.0 mg/kg) is because of humus (organic matter). The relatively high (2.9 mg/kg) content of mobile copper in mountain-meadow sod-peaty soils, compared to meadow-steppe chernozem-like soils, is undoubtedly associated with the reaction with the environment. It is also evident from the table that the content of the total and mobile forms of copper along the soil profile is gradually decreasing.

A correlation between humus content in the soil and the amount of copper ($r = 0.68 \pm 0.013$) is revealed.

Zinc - the zinc content in the lithosphere is 0.004-0.008%, in soils - 85 mg/kg [1, 2]. The average content of total and mobile zinc in forest brown soils and mountain chernozems of the republic varies between 57.0-68.0 and 4.4-4.5 mg/kg, and in mountain-meadow and meadow-steppe soils, according to G.A. Amirjanyan [6], is 38; 44 and 3.0; 4.2 mg/kg respectively.

Our research determined that the content of total and mobile zinc in the upper humus layerof mountain meadow soils of Geghama ridge is in the range of 39-50 and 3.4-4.8 mg/kg, in the meadow-steppe soils- 51.0-54.0 and 3.6-4.0 mg/kg respectively. A high content of totalmobile zinc is typical for meadow-steppe soils, which is 13.0-10.0 and 0.6-0.8 mg/kg more than in the control. The main factors controlling the mobility of zinc in soils are the same as for copper. There is a correlation between zinc content and the reaction of the environment ($r= 0.70 \pm 0.09$).

Molybdenum - the content of molybdenum in the soil according to A.P. Vinogradov [1] is $2{\cdot}10^{-4}$%. It is in the soil in primary minerals with aluminosilicate oxalates in organic combination and is-water-soluble. According to E.S. Kazaryan [5], the content of total and mobile molybdenum in mountain-meadow and meadow-steppe soils is 0.81; 1.6 and 0.25; 0.30 mg/kg.

As the data in Table 1 show, the content of total and mobile molybdenum in the upper humus layers of various subtypes of mountain meadow soils is 1.3-1.6 and 0.32-0.40 mg/kg, and on meadow-steppe soils are 1.7-1.9 and 0.49-0.54 mg/kg, respectively. The content and distribution of molybdenum forms along the soil layers decreases, which indicates the presence of organic substance. A correlation was found between molybdenum content and the amount of humus ($r = 0.69 \pm 0.11$).

Cobalt. The bulk of cobalt in the earth's crust is 0.002-0.01 %. In nature, it is mainly in combination with arsenic or sulfur: minerals of cobalt сипейс - Safflorite ($CoAs_2$), cobalt sheen ($CoAs$), linetite (Co_3S_4).

The average content of cobalt in soils is $8\cdot10^{-4}$%. The level of cobalt content in soils is closely related to its content in soil-forming solids [6].

The content of total and mobile forms of cobalt in mountain-meadow and meadow-steppe soils of the republic varies between 12.0-13.0 and 3.0-3.6; 14.0-16.0 and 3.2-3.6 mg/kg [6, 7].

The results of our research indicate that the content of total and mobile forms of cobalt in mountain-meadow and meadow-steppe soils of the Geghama mountain ridge varies between 12.0-14.0 and 3.6-3.7; 15.0-17.0 and 3.7-3.8 mg/kg (Table 1).

In the studied soils, the content of cobalt forms is insignificant in comparison with the background parameters (Table 1), however, its quantity is larger than the clarke (8 mg/kg). There is no correlation between soils'main indicators and the content of cobalt forms.

*Cadmium.*The average concentration of cadmium in the lithosphere is about $1\cdot10^{-5}$%. The stable state of the element is in the natural environment - Cd^{+2}. Its prevalence in magmaticand sedimentary rocks does not exceed 0.3 mg/kg. The average content of cadmium in soils differs little from its content in the lithosphere. The amount of this element in the main soil-forming rocks ranges from 0.04 to 0.25 mg/kg [1]. The background content of cadmium in the mountain-meadow and meadow-steppe soils of the republic does not exist, except for technogenic zones. Numerous studies have established that the leading process in binding Cd to soils is the competing adsorption on clays [7].

At pH> 7.5 cadmium in the soil ceases to be readily mobile [7]. Cadmium is the most mobile in acidic soils (pH 4.5-5.5), while in alkaline soils it is relatively inert.

Our studies have established that the content of total and mobile forms of cadmium in the upper humus layers of mountain-meadow soils varies in the range of 0.34-0.61 and 0.06-0.09 mg/kg, in meadow-steppe soils - 0,69-0.82 and 0.04-0.09 mg/kg and exceeds clarke and LPC.

The maximum content of total cadmium has been recorded in mountain-meadow low-steppe soils (0.61 mg/kg), and the mobile form in mountain-meadow sod-peaty subtypes (0.09 mg/kg), which is undoubtedly due to the reaction of the environ. In meadow-steppe soils, the highest content of total cadmium (0.82 mg/kg) was found in meadow-steppe typical subtypes of soils, which is greater by 0.12 mg/kg than meadow-steppe chernozem-like, and the minimum content of mobile forms of cadmium (0.04 mg/kg) was found in meadow-steppe chernozem-like soils (Table 1). The relatively low content of the mobile form of cadmium in subtypes of meadow-steppe soils is undoubtedly due to the reaction of the soil environ. Between the soils'agrochemical indicators and the content of cadmium forms a correlation is observed ($r = 0.68\pm0.15$).

Lead is one of the most common and toxic elements that pollute the surrounding environment. The mass fraction of lead in the earth's crust is $1.25\cdot10^{-3}$-$2.0\cdot10^{-3}$%. The average content of lead in soils is $n\cdot10^{-3}$% [1, 6]. The level of lead in soils, as a rule, is determined by the content of the element in the soil-forming rocks.

Migration and distribution in the soil profile occur under the influence of soil formation factors and are due to the intensity of the biological cycle of the element. The background content of the total and mobile form sofland in mountain-meadow and meadow-steppe soils is 13.0; 20.0 and 2.5; 3.4 mg/kg [7].

Our research has established that the content of total lead in mountain-meadow and meadow-steppe soils and their subtypes varies between 17-22 and 22-23 mg/kg, the mobile form 2.7-4.5 and 3.7-3,8 mg/kg, which is 4.0 to 11.0 and 1.0 to 1.3 compared to the background parameters; 0.3-1.4 and 0.3-0.4 mg/kg.

Table 1 – Heavy metal contentin Geghamaridge's soils, mg/kg

Soil type, Section #	Hori-zon-tal, cm	Humus, %	pH, H_2O	Phys. clay	Cu		Zn		Mo		Co		Cd		Pb	
					total	mobile	total	mobile	total	mobile	total	mobile	total	mobile	total	mobile
Mountain-meadow sod (brown), # 2	0-12	13,3	5,6	19,6	34,0	4,7	44,0	3,4	1,3	0,40	12,0	2,6	0,34	0,06	17,0	2,8
	12-23	6,2	5,2	20,0	23,5	4,7	37,0	2,0	1,0	0,26	11,0	2,3	0,25	0,04	13,0	2,4
	23-48	3,1	5,7	15,0	20,0	3,2	38,0	1,8	1,0	0,28	9,0	0,71	0,30	0,05	14,1	1,3
Mountain-meadow sod turf, # 1	0-6	20,9	4,8	13,2	44,0	7,5	39,0	4,1	1,6	0,32	9,9	1,7	0,39	0,04	22,0	3,5
	6-20	12,6	4,3	17,4	29,0	4,2	37,0	4,3	1,1	0,19	7,8	0,51	0,30	0,03	15,0	4,5
	20-51	4,3	4,0	29,7	34,0	2,3	40,0	1,9	0,78	0,17	7,2	0,40	0,30	0,03	11,0	1,7
Mountain-meadowlow-sodernel, # 3	0-10	12,6	6,6	25,0	36,0	5,4	48,0	4,6	1,5	0,39	14,0	2,4	0,50	0,09	20,0	2,7
	10-24	7,3	6,7	34,1	28,0	3,0	42,0	2,9	1,2	0,34	11,0	3,1	0,25	0,02	12,0	2,4
	24-43	3,7	6,5	40,0	24,0	2,6	35,0	2,0	1,1	0,18	12,0	4,0	0,18	0,02	9,0	2,0
Mountain-meadowlow-sodernel, # 4	0-13	12,6	6,1	32,6	36,0	7,0	50,0	4,8	1,5	0,39	14,0	3,0	0,61	0,07	20,0	3,9
	13-34	7,3	6,7	35,3	30,0	4,1	36,0	2,9	1,2	0,25	7,8	1,6	0,28	0,04	17,0	3,0
	34-50	2,1	6,5	27,0	24,0	2,8	32,0	2,0	1,2	0,17	12,0	1,7	0,31	0,06	12,0	1,7
Mountain-meadow-steppecherno-zems, #5	0-15	10,6	6,6	34,6	50,0	3,6	51,0	4,8	1,7	0,54	16,0	3,9	0,69	0,09	21,0	3,7
	15-42	4,2	6,3	33,4	31,0	4,2	44,0	4,3	1,7	0,38	17,0	3,0	0,47	0,06	15,0	3,2
	42-69	2,6	6,8	29,0	25,0	3,1	38,0	2,6	1,5	0,32	10,0	1,2	0,28	0,04	9,0	1,8
Meadow-steppe typical, # 6	0-11	8,2	6,2	36,0	44,0	4,0	54,0	4,6	1,9	0,49	18,0	3,7	0,82	0,06	23,0	3,8
	11-26	3,9	6,4	40,0	31,0	4,2	49,0	4,2	1,6	0,51	13,0	3,1	0,34	0,01	18,0	3,1
	26-54	1,8	6,6	28,4	28,5	3,1	34,0	1,9	1,4	0,30	15,0	1,6	0,30	-	7,0	2,4

The maximum content of total lead in mountain-meadow soils is registered in mountain-meadow sod-peaty subtypes (22.0 mg/kg). The high content of mobile lead is also typical for mountain-meadow sod-peaty soils - 4.5 mg/kg, which undoubtedly depends on the reaction of the environ (pH), since the absorption sorption processes of lead confinement by soils are largely due to the presence of organic matter in them. The correlation is establishedbetween the content of the total and mobile forms of lead and humus quantity (r = 0, 70 ±0,014).

CONCLUSIONS

Based on the conducted research one can draw the following conclusions:

1. The content of heavy metal forms in the soils of the Geghama ridge exceeds background: copper - by 3.0-10.0 and 0.1-1.4 mg/kg; zinc - by 1,3-10,0 and 0,6-0,8; lead - by 1,0-9,0 and 0,3-1,4; molybdenum - by 0.1-0.79 and 0.07-0.4 mg/kg;

2. The accumulation and distribution of heavy metals in soils are mainly due to humus (organic matter), the mechanical texture - mechanical composition and reaction of the environment;

3. By their content in the soils of Geghama ridge heavy metals are presented as follows: Zn>Cu>Pb>Co>Mo>Cd;

4. The bulk of heavy metals accumulate in the upper humus layers of the soil and their content gradually decreases with depth.

REFERENCES

1 Vinogradov A.P. Geochemistry of rare and dispersed chemical elements in soils. – Moscow: Publishing House of the USSR Academy of Sciences, 1987. – 235 p.

2 Ivanov D.N., Lerner L.A. Atomic Absorption Method for Determination of Micronutrients in Soils and Plants / In: Methods for the Determination of Microelements insoils, plants and waters. – Moscow: Kolos, 1974. – P. 242-263.

3 Ovsepyan I.M. On Soils of Geghama Massif and Their Acidity // Proc. Institute of Soil Science and Agrochemistry. – Yerevan: Armgosizdat, 1963. – Vol. II. – Pp. 177-189.

4 Edilyan R.A. Soils of the Armenian SSR. – Yerevan: "Hayastan", 1976. – 383 p.

5 Kazaryan E.S. Microelements in the meadow-pasture economy of the Armenian SSR: dis. Doctor of biological science. – Yerevan, 1965.

6 Amirdzhanyan Zh.A. Microelements in the soils of the Republic of Armenia and the effectiveness of the application of microfertilizers: the dissertation abstract on the scientific degree competition dc.kh. – M., 1963. – P. 56.

7 Hunanyan S.A. Migration of molybdenum, zinc, cobalt, copper in soils in the vicinity Vanadzor Chemical Plant of the Republic of Armenia // Journal «Soil science and agrochemistry». – Almaty, 2012. – №3. – P. 75-77.

ТҮЙІН

УК. Казарян[1], С.А.Унанян[1], А.Л. Мкртчян[1]

ГЕГАМ ЖОТАСЫНЫҢ ТАУ-ШАЛҒЫНДЫ ЖӘНЕ ШАЛҒЫНДЫ-ДАЛА ТОПЫРАҒЫНЫҢ ЭКОЛОГИЯЛЫҚ ЖАҒДАЙЫ

[1]НАУА филиалы "Т.Петросян атындағы топырақтану, агрохимия және мелиорация ғылыми орталығы", 0004, Ереван, Адмирал Исаков көшесі, 24, Армения Республикасы, e-mail: ghazaryan_soil@yahoo.com

Мақалада Гегам жоталарының топырағының құрамындағы ауыр металдардың (АМ) құрамына қарай экологиялық баға берілген. Зерттеу нәтижелерін негізге ала отырып, топырақтың әр түрлі типтерінде және типшелерінде ауыр металдардың болуы, оларды бөлу заңдылығы және топырақтың горизонт бойынша жылжуы бекітілген.

Топырақтағы ауыр металдардың формалары арасындағы корреляциялық байланыс, гумус саны мен физика-химиялық көрсеткіштері анықталған. Гегам жоталарындағы топырақтың профилі бойынша ауыр металдардың құрамы жоғарыдан төмен қарай төмендесе, кейбірінде АМ (Cd, Cu) кларк бойынша асып түседі.

Түйінді сөздер: топырақ, тип, типше, экология, ауыр металдар, жотасы.

РЕЗЮМЕ

У.К. Казарян[1], С.А.Унанян[1], А.Л. Мкртчян[1]

ЭКОЛОГИЧЕСКОЕ СОСТОЯНИЕ ГОРНО-ЛУГОВЫХ И ЛУГОВО-СТЕПНЫХ ПОЧВ ГЕГАМСКОГО ХРЕБТА

[1]Научный центр почвоведения, агрохимии и мелиорации им. Г.П. Петросяна, Филиал НАУА, 0004, г. Ереван, пр. Адмирала Исакова 24, Республика Армения,

e-mail: ghazaryan_soil@yahoo.com

В статье дается экологическая оценка почв Гегамского хребта по содержанию в них тяжелых металлов (ТМ). Основываясь на результатах исследований установлены наличие тяжелых металлов в различных типах и подтипах почв и закономерность их распределения и миграции по почвенным горизонтам. Выявлена корреляционная связь между содержанием форм тяжелых металлов в почве, количеством гумуса и физико-химическими показателями почв. Содержание тяжелых металлов по профилю почв Гегамского хребта снижается сверху вниз и у некоторых ТМ (Cd, Cu), оно превышает кларк.

Ключевые слова: почва, тип, подтип, экология, тяжелые металлы, хребет.