LANDSCAPE SCİENCES

ECOGEOCHEMICAL PROPERTIES OF THE LANDSCAPES OF KARABAKH AND EASTERN ZANGEZUR REGION

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Abstract

Soil and plant samples taken from the territory of East Zangezur during field studies were analyzed using an X-ray fluorescence spectrometer of the Elvax-CEP 01 brand. The results of the analyses showed that only chlorine (Cl) in the area is at the level of Clarke in the Earth's crust, and all other elements are many times (even 10 and a hundred times) more than Clarke. It was determined that sulfate macrocompounds in the region are typomorphic, and sodium, calcium, and magnesium salts predominate in the area. The presence of chemical elements, especially solid metals, in excess of the norm increases the likelihood of the formation of geochemical anomaly foci in the area. Therefore, it is very important to conduct ecogeochemical studies to ensure the ecological safety of the population and biota in the territories liberated from occupation in connection with the “Great Return”. The article analyzes the geochemical structure of the landscapes of Eastern Zangezur.

1. Introduction

The formation of the landscape-geochemical system depends on natural and anthropogenic factors. As a result of Armenia's military aggression and occupation policy, which lasted for 30 years until 2020, anthropogenic factors had a greater impact on the change in the geochemical conditions of the landscapes in Karabakh and Eastern Zangezur. The deployment of military forces, the movement of heavy equipment, the construction of engineering and fortification facilities, the use of numerous explosive equipment and means, prohibited weapons, fires, etc. have resulted in a violation of the geochemical balance of the region [8]. In some areas contaminated with chemical weapons, radioactive substances, and heavy metals, the likelihood of the emergence of geochemical anomalies of anthropogenic origin has increased [1]. Therefore, in connection with the “Great Return”, it is very important to conduct ecogeochemical studies to ensure the ecological safety of the population and biota in the territories liberated from occupation. The study of the geochemical characteristics of landscapes creates a basis for research in the field of geomedicine, assesses more specific natural geochemical variations and human-caused disturbances, identifies geochemical areas of interest for the exploration of mineral resources [6]. And creates a basis for the detection of potentially dangerous areas from a geochemical perspective.

The main purpose of the study is to analyze the geochemical structure of the landscapes of Eastern Zangezur.

2. Material and method

In the study, soil, water and plant samples were taken by employees of the “Landscape and Landscape Planning” department from various points of Zangilan, Gubadli and Lachin districts (Zangilan airport, mined areas of Zangilan, Khanlig gorge of Gubadli, Hakari reservoir area, Hal village road, etc.) (table 1). Field studies were conducted between 500-1500 m altitudes of the area. During the field studies, the method of laying out sections was used in accordance with the specific landscape conditions of the studied area, samples were taken from the genetic layers of the soil, plants and natural waters in the places where the sections were laid, and chemical and spectral analysis of the collected samples was carried out in laboratory conditions. The samples were analyzed using an "Elvax-CEP 01" X-ray fluorescent spectrometer, and tables were compiled on the obtained geochemical indicators.

The analysis of the landscape structure and diseases characteristic of landscape complexes used the indicators of the "Ecogeochemical landscape map of Azerbaijan" [3] and the "Medical ecogeochemical landscape map" [2].

Research area. The relief of the research area consists of plains, plateaus, low, medium and high mountains and ridges. The mountainous part of the Eastern Zangezur region is composed of Mesozoic limestones, schists, sandstones, and the plains and foothills are composed of Cenozoic sediments. The largest morphostructural unit of the area, the Karabakh volcanic plateau, is composed of volcanic eruption materials of the Pliocene-Quaternary period. The climate types prevailing in the area are mildly warm with dry winters, mildly warm with dry summers, cold with dry winters, and mountain-tundra. The region is distinguished by its rich landscape diversity, from partly subnival, alpine and subalpine meadows of the highlands to wormwood-dry steppes of the plains. Information on the geographical location of the samples taken from the area is given in detail in table 1.

3. Analysis and discussion

The geochemical landscape is a paragenetic combination of elementary landscapes associated with the flow of matter and energy, and each geochemical landscape is characterized by the migration of certain chemical elements and compounds [11]. In the classification based on the migration properties of chemical elements by A.T. Perelman, biogenic migration is preferred over water migration, large taxonomic units such as group, type and subtype are distinguished according to the characteristics of the biological cycle, and relatively small taxonomic units such as classes, genera and species are distinguished according to the nature of water migration [11, 12]. According to the migration characteristics of chemical elements and compounds, alluvial (Al), superaquatic (SA), transaccumulative (TAk) and accumulative (Ak) geochemical landscape types are distinguished in the study area. Sulfate-hydrocarbonate-sodium (SO_4-HCO_3-Na), sulfate-calcium-sodium (SO_4-Ca-Na), sulfate-sodium-magnesium (SO_4-Na-Mg) and hydrocarbonate-calcium-sodium (HCO_3-Ca-Na) macrocompounds dominate in the region (table 4).

Table 1

Geographical coordinates of sampling sites

№	Station	Latitude	Longitude
1	Zangilan	$39^{0}04^{/}56.2^{//}$	$46^{0}39^{/}24.8^{//}$
2	Malakeshin	$39^{0}06^{/}49^{//}$	$46^{0}41^{/}18.2^{//}$
3	Malakeshin	$39^{0}06^{/}52.3^{//}$	$46^{0}41^{/}24.4^{//}$
4	Khanlig Valley	$39^{0}50^{/}3^{//}$	$46^{0}43^{/}31^{//}$
5	Khanlig Valley	$39^{0}15^{/}50^{//}$	$46^{0}43^{/}31.0^{//}$
6	Khanlig Valley	$39^{0}15^{/}50.3^{//}$	$46^{0}43^{/}30.8^{//}$
7	Khanlig Valley	$39^{0}16^{/}34.5^{//}$	$46^{0}43^{/}14.5^{//}$
8	Khanlig Valley	$39^{0}16^{/}26.7^{//}$	$46^{0}42^{/}51.8^{//}$
9	Khanlig Valley	$39^{0}16^{/}16.0^{//}$	$46^{0}42^{/}04.2^{//}$
10	Khanlig Valley	$39^{0}16^{/}16.0^{//}$	$46^{0}43^{/}30.2^{//}$
11	Khanlig Valley	$39^{0}15^{/}55.2^{//}$	$46^{0}42^{/}30.5^{//}$
12	Hal village	$39^{0}16^{/}50.0^{//}$	$46^{0}41^{/}31.9^{//}$
13	Hal village	$39^{0}16^{/}13.2^{/}$	$46^{0}41^{/}31.9^{//}$
14	Hal village	$39^{0}16^{/}52.4^{//}$	$46^{0}40^{/}54.1^{//}$
15	Lachin	$39^{0}39^{/}01.7^{//}$	$46^{0}32^{/}27.5^{//}$
16	Lachin	$39^{0}38^{/}06.6^{//}$	$46^{0}32^{/}59.2^{//}$
17	Lachin	$39^{0}35^{/}23.3^{//}$	$46^{0}33^{/}07.7^{//}$
18	Malkhalaf	$39^{0}32^{/}50.8^{//}$	$46^{0}35^{/}07.3^{//}$
19	Gulabird	$39^{0}30^{/}14.3^{//}$	$46^{0}36^{/}26.4^{//}$
20	Khandagh	$39^{0}24^{/}41.1^{//}$	$46^{0}39^{/}18.7^{//}$
21	Ishigli	$39^{0}23^{/}24.4^{//}$	$46^{0}39^{/}57.2^{//}$
22	Mirzanagili	$39^{0}24^{/}27.0^{//}$	$47^{0}16^{/}524.4^{//}$
23	The Third Aghali	$39^{0}11^{/}14.3^{//}$	$46^{0}53^{/}40.9^{//}$
24	The First Alibeyli	$39^{0}07^{/}19.2^{//}$	$46^{0}44^{/}28.2^{//}$

In geochemical classification, landscape types are distinguished according to the ratio of biological productivity to biomass, and each geochemical landscape differs from each other in its structure. The landscapes of Eastern Zangezur are divided into 8 geochemical landscape types according to the volume of biological mass (figure). A brief description of the ecogeochemical conditions of these types is as follows.

Alluvial (Al), superaquatic (SA), accumulative (Ak) migration is typical in the subnival shale landscape. In these landscapes, sulfate-magnesium-sodium (SO_4-Mg-Na) macrocompounds prevail. In the area, As, Pb, B are in excess, Ba, J, F are in deficit (figure, table 4).

Transalluvial (TA) and transaccumulative (TAk) migration is typical for alpine and subalpine meadows and meadow-steppe landscapes. In these landscapes, sulfate-magnesium-sodium (SO_4-Mg-Na) macrocompounds prevail. In the area, Zn, Cu, Pb are in excess, Mn, Ba, Sr are in deficit (figure, table 4). Alluvial (Al), superaquatic (SA) and accumulative (Ak) migration is typical in the beech-alder and oak-alder forest landscapes of the middle and partly high mountains. In these landscapes, sulfate-calcium-sodium (SO_4-Ca-Na) macrocompounds dominate. Zn, Sn, Ag are in excess in the area, while Mn, Ba, Sr are in deficit (figure, table 4).

Table 2

Microelement composition of soil samples taken from the landscapes of the Eastern Zangezur region

Elements		Average amount, in %		Intensity	Concentration clarke, CC
Atomic N	Chemical symbol	Clarke in the Earth's crust, ECC	Clarke's distribution (CD)		
1	2	3	4	5	6
Opposite Zangilan Airport, 5 cm					
26	Fe	4.65	8,22±3720	29679	0,122±0,0003
37	Rb	0.015	10,71±214,28	1591	0,093±0,005
38	Sr	0.034	4,26±188,88	10579	0,23±0,005
39	Y	0.0029	4,46±72,5	1033	0,224±0,014
40	Zr	0.017	4,05±154,54	7201	0,247±0,0064
50	Rh			679	
65	Tb			306	
Opposite Zangilan Airport 10 cm					
17	Cl	0.017	0,017±0,30	196	58,45±3,33
26	Fe	4.65	7,48±86,7	32318	0,13±0,012
37	Rb	0.015	1,134±11,43	1569	0,88±0,087
38	Sr	0.034	4,97±55,74	8885	0,201±0.018
39	Y	0.0029	4,46±41,43	1025	0,224±0,024
40	Zr	0.017	4,23±47,22	6750	0,236±0,021
50	Sn	0.00025	0,178±1,66	1109	5,6±0,6
65	Tb			603	
Opposite Zangilan Airport 20 cm					
26	Fe	4.65	7,58±3369,56	31792	0,132±0,00029
37	Rb	0.015	9,26±187,5	1798	0,108±0,005
38	Sr	0.034	4,48±200	9828	0,229±0,005
39	Y	0.0029	40,27±725	1124	0,248±0,014
40	Zr	0.017	3,75±154,54	7593	0,266±0,006
65	Tb			369	
Zangilan, mined area 5 cm					
17	Cl	0,017	0,0081±0,312	429	124,027±3,202
25	Mn	0,10	16,077±104,16	216	0,062±0,0096
26	Fe	4,65	6,473±90,396	37661	0,154±0,0110
37	Rb	0,015	5,703±71,43	2935	0,175±0,014
38	Sr	0,034	5,81±77,27	7613	0,172±0,013
39	Y	0,0029	3,26±36,29	1396	0,307±0,027
40	Zr	0,017	3,307±44,74	8638	0,32±0,022
47	Ag	0,000007	0,0125±0,116	771	80±8,57
50	Sn			770	

1	2	3	4	5	6
65	Tb			565	
Zangilan, mined area 10 cm					
17	Cl	0,017	0,0083±0,3439	420	119,89±2,91
26	Fe	4,65	7,42±99,97	33363	0,135±0,010
37	Rb	0,015	6,07±71,42	2814	0,165±0,014
38	Sr	0,034	5,88±75,55	7682	0,17±0,013
39	Y	0,0029	3,58±41,42	1292	0,27±0,024
40	Zr	0,017	3,57±45,94	8179	0,28±
65	Tb			718	
Zangilan, mined area 20 cm					
17	Cl	0,017	0,007±0,341	477	142,72±2,93
26	Fe	4,65	6,96±96,53	33672	0,143±0,0103
37	Rb	0,015	6,75±83,3	2387	0,148±0,012
38	Sr	0,034	5,66±75,55	7545	0,176±0,013
39	Y	0,0029	3,72±41,43	1181	0,27±0,024
40	Zr	0,017	3,53±47,22	7835	0,28±0,021
65	Tb			225	
Gubadli, Khanlig Gorge 5 cm					
17	Cl	0,017	0,0121±0,2828	276	82,36±35,35
26	Fe	4,65	6,94±86,49	34540	0,1441±0,0115
37	Rb	0,015	12,5±125	1315	0,08±0,008
38	Sr	0,034	2,104±2,59	20733	0,475±0,038
39	Y	0,0029	5,68±58	792	0,0175±0,0172
40	Zr	0,017	4,08±48,57	6896	0,244±0,020
41	Nb	0,0021	9,13±70	427	0,109±0,014
42	Mo	0,00011	0,92±5,5	222	1,09±0,18
47	Ag	0,000007	0,012±0,116	756	78,57±8,57
50	Sn	0,00025	0,27±2,5	701	3,6±1,66
65	Tb			510	
Gubadli, Khanlig Gorge 10 cm					
26	Fe	4,65	7,11±2943,03	32912	0,14±0,0016
37	Rb	0,015	12,60±214,28	1283	0,08±0,005
38	Sr	0,034	2,18±125,92	19515	0,457±0,008
39	Y	0,0029	5,47±72,5	807	0,183±0,014
40	Zr	0,017	4,31±154,54	6385	0,232±0,006
65	Tb			457	
Gubadli, Khanlig Gorge 20 cm					
17	Cl	0,017	0,0128±0,324	266	78,09±3,08
26	Fe	4,65	7,81±93,22	31219	0,128±0,0107
37	Rb	0,015	15±150	1126	0,066±0,006
38	Sr	0,034	2,713±31,77	16449	0,368±0,0314
39	Y	0,0029	6,59±58	702	0,152±0,017
40	Zr	0,017	4485±5,151	6436	0,223±0,019
65	Tb			393	
Hakari Reservoir					
17	Cl	0,017	0,0146±0,198	215	68,40±5,04
22	Ti	0,45	11,78±85,227	262	0,084±0,0117
25	Mn	0,10	7,342±64,102	433	0,1362±0,0156
26	Fe	4,65	3,69±58,58	60301	0,27±0,017
37	Rb	0,015	50±375	298	0,02±0,003
38	Sr	0,034	4,141±97,14	9467	0,241±0,016
39	Y	0,0029	3,536±41,43	1141	0,282±0,024
40	Zr	0,017	2,59±38,63	9748	0,384±0,0258
41	Nb	0,0021	9,13±70	383	0,109±0,014
65	Tb			869	

Table 3

Micronutrient composition of plant samples taken from the landscapes of the Eastern Zangezur region

Elements		Average amount, in %		Intensity	Concentration clarke, CC
Atomic N	Chemical symbol	Clarke in the Earth's crust, ECC	Clarke's distribution (CD)		
1	**2**	**3**	**4**	**5**	**6**
Opposite Zangilan airport, various plants					
17	Cl	0.017	0,012±0,64	271	81,98±1,56
26	Fe	4.65	19,82±190,73	12018	0,050±0,005
35	Br	0,00021	0,034±0,323	5165	29,143±3,09
37	Rb	0.015	7,89±71,43	2131	0,126±0,14
38	Sr	0.034	3,201±30,91	13904	0,312±0,032
39	Y	0.0029	18,125±96,66	256	0,055±0,0103
40	Zr	0.017	15,17±13,07	1900	0,06±0,007
50	Sn	0.00025	0,155±1,315	1280	6,44±0,76
Zangilan, (mined area), various grass plants					
26	Fe	4.65	169,46±7881,35	1414	0,006±0,0001
30	Zn	0,0083	3,502±39,52	508	0,285±0,025
35	Br	0,00021	0,283±3,5	637	3,523±0,285
37	Rb	0.015	48,38±500	354	0,0206±0,002
38	Sr	0.034	2,54±73,91	17891	0,394±0,0135
47	Ag	0,000007	0,175±0,0162	613	61,43±5,714
Khanlig Gorge, various herbaceous plants					
26	Fe	4.65	60,319±4843,75	3864	0,016±0,00021
30	Zn	0,0083	2,98±36,08	580	0,0334±0,277
35	Br	0,00021	0,0067±0,3	25985	148,47±3,33
37	Rb	0.015	5,41±136,36	3074	0,184±0,007
38	Sr	0.034	5,059±170	8671	0,157±0,06
40	Zr	0,017	154,54±850	190	0,006±0,0012
47	Ag	0,000007	0,009±0,14	1031	107,14±7,142
Khanlig Valley, various plants 2					
26	Fe	4,65	59,83±12916,6	4018	0,016±0,00007
35	Br	0,00021	0,089±1,75	2018	11,14±0,571
37	Rb	0,015	5,45±125	3152	0,183±0,008
38	Sr	0,034	5,41±154,54	8413	0,185±0,0064
40	Zr	0,017	130,7±850	219	0,007±0,012
Khanlig Valley, various plants plant 1					
26	Fe	4,65	78,51±9300	3146	0,013±0,00010
30	Zn	0,0083	0,47±46,11	388	2,12±0,022
35	Br	0,00021	0,15±2,33	1200	0,64±0,43
37	Rb	0,015	20,27±300	876	0,049±0,003
38	Sr	0,034	2,87±91,89	16290	0,35±0,010
40	Zr	0,017	73,91±850	404	0,013±0,0011
Hal village road 1					
17	Cl	0,017	0,0112±1,035	295	88,60±0,965
26	Fe	4,65	36,59±337,44	6546	0,027±0,0029
30	Zn	0,0083	2,95±21,84	600	0,338±0,046
35	Br	0,00021	0,043±0,396	4128	23±2,52
37	Rb	0,015	5,35±48,38	3176	0,186±0,0206
38	Sr	0,034	2,535±23,77	17771	0,39±0,04
40	Zr	0,017	36,17±283,33	798	0,027±0,0035
Hal village road 2					
26	Fe	4,65	34,85±8773,58	6896	0,0286±0,00011
30	Zn	0,0083	3,62±3,95	490	0,276±0,025

1	2	3	4	5	6
37	Rb	0,015	3,401±100	5027	0,294±0,01
38	Sr	0,034	2,43±100	18591	0,410±0,01
40	Zr	0,017	21,25±340	1379	0,047±0,0029
47	Ag	0,000007	0,011±0,175	901	90±5,71
Hakari reservoir, mountain meadow flowers					
26	Fe	4,65	16,34±22,14	15341	0,061±0,00004
37	Rb	0,015	13,27±250	1332	0,075±0,004
38	Sr	0,034	6,46±226,66	7249	0,155±0,0044
40	Zr	0,017	10,625±283,33	2849	0,09±0,0035
48	Cd	0,000013	0,0156±0,26	1170	63,84±3,85
Khanlig village, various herbaceous plants					
17	Cl	0,017	0,007±0,972	427	131,69±1,03
26	Fe	4,65	28,09±305,32	8189	0,035±0,0033
30	Zn	0,0083	6,241±41,5	271	0,160±0,0241
37	Rb	0,015	3,88±40,54	4196	0,26±0,025
38	Sr	0,034	2,38±26,35	18081	0,42±0,038
40	Zr	0,017	23,28±212,5	1200	0,043±0,0047
49	İn	0,000025	0,028±0,25	940	35,6±4

Transalluvial (TA), superaquatic (SA) and accumulative (Ac) migration are typical in semi-arid forest landscapes of the low and middle highlands. Hydrocarbonate-calcium-sodium (HCO_3-Ca-Na) macrocompounds prevail in these landscapes. Pb, V, Cu are in excess in the area, Ti, Sr are in deficit (table 4).

Alluvial (Al) and superaquatic (SA) migration are typical for arid forest, forest-shrub and shrub-steppe landscapes of the low highlands. Sulphate-hydrocarbonate-sodium (SO_4-HCO3-Na) macrocompounds prevail in these landscapes. Ag, B, Cu, Hg are in excess in the area, Co, Ti, Zr are in deficit (table 2, 3).

Transalluvial (TA), transaccumulative (TAc) and accumulative (Ac) migration are typical in the forest-steppe and steppe landscapes of the low and middle highlands. For these landscapes, sulfate-calcium-sodium (SO_4-Ca-Na) macrocompounds prevail. Cu, V, B, Sr are in excess in the area, and Ba, Ni, Zr are in deficit (table 2, 3).

Alluvial (Al) and superaquatic (SA) migration are typical for the dry steppe, steppe and arid-denudation landscapes of the low highlands and depressions. Sulphate-calcium-sodium (SO_4-Ca-Na) macrocompounds prevail in these landscapes. Cu, Mo, Ni, Pb are in excess in the area, and Mn, Ti, Ba, Sr are in deficit (table 2, 3).

Transaccumulative (TAk) and accumulative (Ac) migration is typical for the post-forest steppe and intrazonal landscapes of the denudation-accumulative plains. In these landscapes, sulfate-calcium-sodium (SO_4-Ca-Na) macrocompounds prevail. In the area, B, V, Pb, Co are in excess, Sr, Zr, Rb, Fr are in deficit (table 2, 3).

According to the results of the analysis of geochemical landscape types, sulfate macrocompounds in the area are typomorphic. Hydrocarbonate compounds are found only in semi-arid forests of the low and middle highlands (HCO_3-Ca-Na) and in arid-forest, forest-shrub and shrub-steppe landscapes of the low highlands (SO_4-HCO_3-Na). The elements copper (Cu), rubidium (Rb), zirconium (Zr), vanadium (V), boron (B), silver (Ag) are more typical for the region. Deficiencies of manganese (Mn), zirconium (Zr), titanium (Ti), fluorine (F), nickel (Ni), cobalt (Co), barium (Ba), zinc (Zn), mercury (Hg) were observed in the area (table 2, 3).

It should be noted that the structural analysis of the ecogeochemical conditions of the East Zangezur region is based on existing maps, scientific literature and field research materials conducted in 2023-2024. However, relatively different results were obtained in the analysis of samples taken from the areas where field research was conducted. According to the results of spectral analyses, chlorine (Cl) is a deficit element only in a 10 cm cross-section sample opposite the Zangilan airport in the area and is at the Clarke level in the Earth's crust. According to the results of spectral analyses, all the remaining elements are many times (even 10 and a hundred times) more abundant than in the Clarke. The most common microelements in the area are iron (Fe), rubidium (Rb), iodine (Y) in the area opposite the Zangilan airport, iron (Fe), rubidium (Rb), manganese (Mn) in the mined areas of Zangilan, iron (Fe), rubidium (Rb), niobium (Nb) and strontium (Sr) in the Khanlig gorge, titanium (Ti) and manganese (Mn) in the Hakari reservoir area (table 2, 3). These data play a valuable indicator role in studying the mineral and raw material reserves of the area, as well as in conducting geological exploration work.

3.1. The effect of biochemically active microelements on living organisms. Human health is mainly determined by the amount of chemical elements in the environment (soil, plants, rocks, water, atmosphere, etc.) [10]. The presence of certain macroelements and microelements in the landscape in excess or less than the norm poses a threat to the life and health of living organisms, especially humans, whose permanent habitat is in geochemical anomalies [7]. According to studies, up to 20 of the 118 elements in the periodic table (silver (As), beryllium (Be), cobalt (Co), chromium (Cr), cadmium (Cd), mercury (Hg), lead (Pb) and molybdenum (Mo), etc.) are dangerous for humans and their surrounding natural environment. Also, along with microelements, the very high concentration of metals such as copper (Cu), zinc (Zn) and aluminum (Al) in the environment is also a source of danger to the health of living organisms [4, 5, 11].

Microelements such as copper (Cu), zinc (Zn), lead (Pb), molybdenum (Mo), iron (Fe) are most common in the study area. These elements are included in the group of biogenic microelements. Biogenic elements are chemical elements that are constantly included in the composition of organisms and are necessary for their life [4, 10]. Biogenic microelements increase the activity of various enzymes, create conditions for the synthesis of sugar, starch, proteins, nucleic acids, vitamins, enzymes. The effect of these elements, which are more common in the area, on the human body has been sufficiently described in the scientific literature.

Copper (Cu) is found in the human body mainly in the form of complex organic compounds in an amount of 70-120 mg, and approximately 30% of this is accumulated in the liver and brain, and the rest in the muscles, bones, blood and kidneys. Excess copper in the body for one reason or another causes depigmentation of the skin, the development of a skin disease called vitiligo. Copper deficiency causes fatigue, constant and causeless headaches, bad mood, and irritability [4, 11].

The main natural compounds of zinc (Zn) are the mineral galme ($ZnCO_3$) and the zinc sulfide (ZnS) compound, from which it is possible to obtain free zinc. This element is involved in the formation of hormones of the pituitary gland, adrenal glands and pancreas. It is necessary for the normal development and functioning of the sensory organs (taste, vision, smell) [4, 5, 11].

Excess zinc in the human body creates conditions for the division and growth of cancer cells. Zinc deficiency slows down the normal growth of plants and animals, leading to the existence of dwarf plants and animals [10].

Lead (Pb) accumulation in the human body causes various clinical symptoms. The ionic mechanism of lead toxicity causes significant changes in various biological processes such as cell adhesion, intracellular and intercellular signaling, protein folding, maturation, apoptosis, ion transport, enzyme regulation, and neurotransmitter release [9].

The initial manifestation of poisoning with this element is anemia. In later stages, abdominal pain and encephalopathy syndrome occur. Excess lead in the body also prevents hemoglobin synthesis and the absorption of calcium, which is necessary for the development of bone tissue.

Molybdenum (Mo) enters the body through plant foods and is more toxic than molybdenum in inorganic compounds. The main part of this element is concentrated in bone tissue, liver, kidneys, brain, pancreas and thyroid glands [4].

Molybdenum activates a number of enzymes necessary for the metabolism of proteins, fats and carbohydrates in the body, promotes body development and growth, strengthens dental tissue, protects teeth from destruction and helps prevent caries. Molybdenosis is observed in humans and animals in geographical regions where there is an excess of molybdenum in the soil. Molybdenosis resembles a kind of gout, arthrosis, polyarthralgia are observed [4, 5, 9, 13].

Hypertension, blood pressure instability, functional disorders of the nervous system, metabolic disorders are observed in workers in molybdenum production. Diseases such as atrophic rhinitis, gastritis, cardiovascular dystonia are observed in those who work in such conditions for a long time [4, 9, 13].

Iron (Fe) is an essential element for almost all living systems [9]. The organs in the body where iron accumulates the most are the liver and spleen. “Iron fasting” has a severe impact on the body. First of all, the synthesis of hemoglobin, an iron-containing protein in red blood cells, is disrupted, as a result of which less oxygen reaches organs and tissues, and the heart, brain and kidneys are primarily affected [13]. Iron toxicity in cells causes iron-mediated tissue damage, which includes cellular oxidative and reduction mechanisms and their toxicity to intracellular organelles such as mitochondria and lysosomes [9]. In nature, various iron medicines (iron-lactate, iron-glycerophosphate, iron 2 sulfate, feramide, hemistimulin, etc.) are used in the treatment of diseases associated with iron deficiency, as well as to strengthen the body [9].

As a result of long-term research in Azerbaijan, correlative relationships between a number of diseases typical for individual landscape complexes and the concentration of various macroelements and microelements have been identified, and a corresponding "Medical-ecogeochemical landscape map" has been compiled [2]. Accordingly, based on the compiled landscape map of the Eastern Zangezur region, it was possible to group diseases typical for landscape types as follows:

- In alpine and subalpine meadows and meadow-steppe landscapes, there is a risk of a very wide spread of oncological and endemic goiter diseases, and a wide spread of nervous diseases and fluorosis diseases.
- In the beech-alder and oak-alder forest landscapes of the middle and partly high mountains, a very wide spread of endemic goiter, dental caries, a wide spread of oncology, and a weak spread of nervous diseases are expected.
- In the semi-arid forest landscapes of the low and middle highlands, there are opportunities for endemic goiter, dental caries, fluorosis, and low prevalence of oncological diseases.
- In the forest-steppe and steppe landscapes of the low and middle highlands, there is a danger of widespread brucellosis, widespread endemic goiter, hypertension, and nervous diseases.
- In the arid forest, forest-shrub and shrub-steppe landscapes of the low highlands, there is a danger of widespread oncology, cardiovascular diseases, and respiratory diseases, widespread hypertension, dysentery, digestive system diseases, brucellosis, and low prevalence of conjunctivitis diseases are characteristic.
- In the dry steppe, steppe, and arid-denudation landscapes of the low highlands and depressions, there are geochemical conditions for widespread respiratory diseases, widespread dental caries, dysentery, brucellosis, hypertension, and low prevalence of conjunctivitis diseases.
- In the post-forest steppe and intrazonal landscapes of denudation-accumulative plains, dental caries, digestive system diseases, cardiovascular and respiratory diseases are widespread, dysentery, nervous diseases, brucellosis, hypertension, conjunctivitis diseases are low.

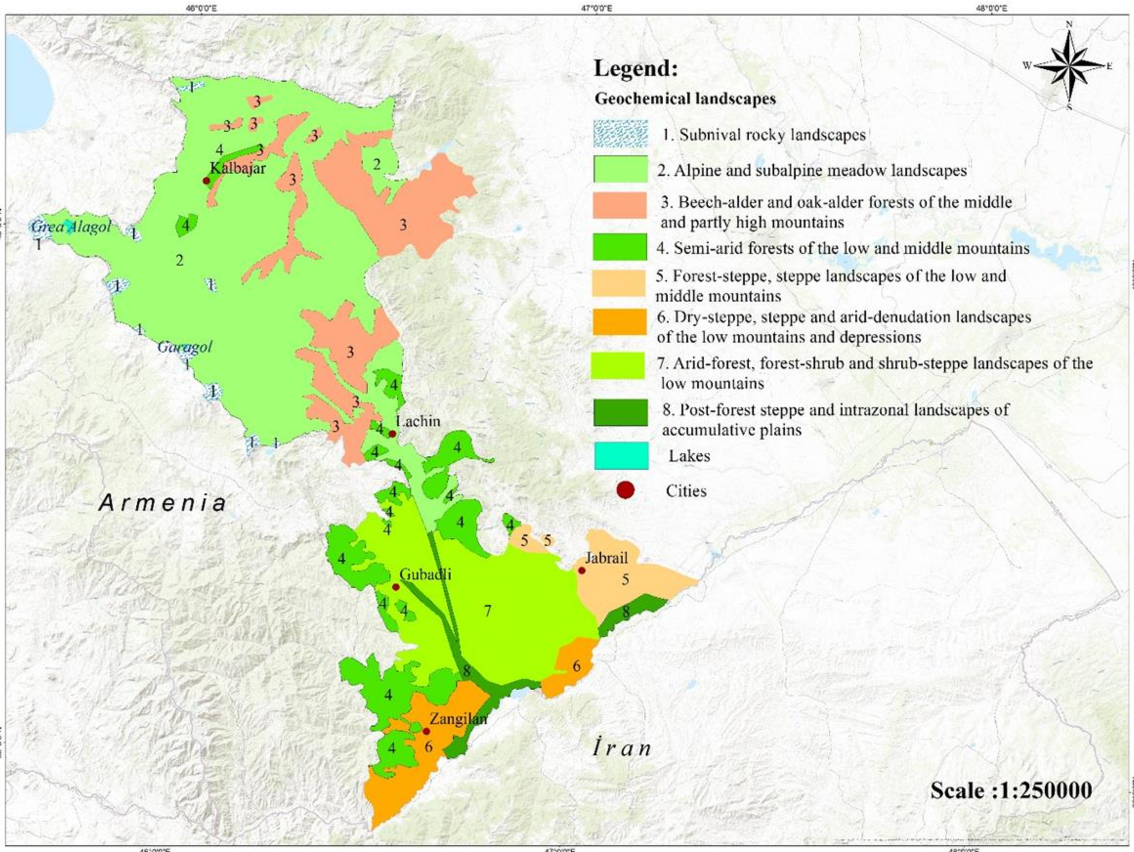

Fig. Ecogeochemical landscapes of the Eastern Zangezur region (map legend is given in table 4)

Table 4

Ecogeochemical landscapes

Groups	**Types**	**Sorts**					**Macro-compounds**	**Excess elements in the numerator, deficit elements in the denominator**
By volume of biological mass	**According to the ratio of biological productivity to biomass**	**Due to the migration characteristics of chemical elements**						
High mountain landscape	1.Subnival rocky landscapes	Al		A		Ac	So_4-Mg-Na	$As_{3,7}$ $Pb_{2,3}$ $B_{2.0}$ $Ba_{0,4}$ $J_{0,03}$ F0,02
Mountain-meadow landscape	2.Alpine and subalpine meadow landscapes		T A		TAc		So_4-Na-Mg	$Pb_{5,8}$ $Cu_{4,8}$ $Zn_{3,5}$ $Mn_{0,4}$ $Sr_{0,1}$ $F_{0,03}$
Mountain-mountain landscape	3. Beech-alder and oak-alder forests of the middle and partly high mountains	Al		A		Ac	So_4-Ca-Na	$Zn1_{0,5}$ $Sn_{3,9}$ $Ag_{3,3}$ $Mn_{0,5}$ $Ba_{0,4}$ $Sr_{0,3}$
	4.Semi-arid forests of the low and middle mountains-		A	A		Ac	HCO_3-Ca-Na	$Pb_{12,3}$ $V_{8,5}$ $Cu_{6,1}$ $Sr_{0,4}$ $Ti_{0,3}$ $Sr_{0,2}$
Landscape of semi-arid mid- and lowland mountains	5. Forest-steppe, steppe landscapes of the low and middle mountains		T A		TAc	Ac	So_4-Ca-Na	$Cu_{9,6}$ $V_{7,9}$ $B_{5,8}$ $Sr_{4,2}$ $Ba_{0,6}$ $Ni_{0,3}$ $Ba_{0,2}$ $Zr_{0,1}$
Arid and semiarid landscapes of the lowlands	6. Dry-steppe, steppe and arid-denudation landscapes of the low mountains and depressions	Al		A			So_4-Ca-Na	$Mo_{10,2}$ $B_{8,9}$ $V_{6,3}$ $Cu_{8,9}$ $Zn_{0,4}$ $Ba_{0,3}$ $Zr_{0,1}$
	7.Arid-forest, forest-shrub and shrub-steppe landscapes of the low mountains	Al		A			SO_4- HCO_3-Na	$Ag_{7,3}$ $B_{6,3}$ $Cu_{5,6}$ $Hg_{3,4}$ $CO_{0,6}$ $Ti_{0,4}$ $Zr_{0,1}$
	8.Post-forest steppe and intrazonal landscapes of accumulative plains				TAc	Ac	So_4-Ca-Na	$B_{10,0}$ $V_{2,4}$ $Pb_{2,3}$ $Co_{2,4}$ Se $Z_{0,1}$ $Rb_{0,07}$ Fr0,04

Analysis of the "Medical-ecogeochemical landscape map" shows that the number of diseases increases from high mountains to lowland landscapes in accordance with geochemical conditions in the region. There is a threat of a very wide spread of oncological, endemic goiter, dental caries, cardiovascular diseases, respiratory diseases, and brucellosis diseases in the area. The absence of widespread diseases is characteristic of the arid forest and forest-shrub landscape of the low and middle highlands, the dry steppe, steppe, arid-denudation landscape of the low highlands and depressions, and the post-forest steppe landscape of the denudation-accumulative plains. It was determined that dysentery and conjunctival diseases are the least common in the area.

4.Conclusion

1. The conducted analyses made it possible to relatively accurately determine the general ecogeochemical background of the landscape of the study area. 2. The geochemical analysis of landscape types determined that sulfate macrocompounds in the study area are typomorphic, and hydrocarbonate compounds are found in the semi-arid forests of the low and middle highlands (HCO_3-Ca-Na) and in the arid-forest, forest-shrub and shrub-steppe landscape of the low highlands (SO_4-HCO_3-Na). The elements copper (Cu), rubidium (Rb), zirconium (Zr), vanadium (V), boron (B), silver (Ag) are more typical for the region. 3. A comparative analysis of the available literature materials and the results of field studies showed that while previous studies in the study area showed a deficiency of many elements (manganese (Mn), zirconium (Zr), titanium (Ti), fluorine (F), nickel (Ni), cobalt (Co), barium (Ba), zinc (Zn), mercury (Hg)), currently these elements are many times higher than normal. The excess of chemical elements, especially heavy metals, increases the likelihood of geochemical anomalies in the area. This is a potential long-term source of danger for all living things. 4. In order to better understand and assess the impact of war on nature and reduce negative ecological impacts, it is important to conduct continuous geochemical studies in the area.

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QARABAĞ VƏ ŞƏRQİ ZƏNGƏZUR REGİONU LANDŞAFTLARININ EKOGEOKİMYƏVİ XÜSUSİYYƏTLƏRİ

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Xülasə. Çöl tədqiqatlarında Şərqi Zəngəzur ərazisindən götürülmüş torpaq və bitki nümunələrinin "Elvax-CEP 01" markalı rentgen-fluoressent spektrometri vasitəsilə analizi aparılmışdır. Analizlərin nəticələri göstərdi ki, ərazidə yalnız xlor (Cl) Yer qabığındakı klark səviyyəsindədir və digər bütün elementlər klarka nisbətən dəfələrlə (hətta 10 və yüz dəfələrlə) çoxdur. Müəyyən olundu ki, regionda sulfatlı makrobirləşmələr tipomorfdur və ərazidə natriumlu, kalsiumlu, maqneziumlu duzlar üstünlük təşkil edir. Kimyəvi elementlərin, xüsusilə ağır metalaların normadan çox olması ərazidə geokimyəvi anomaliya ocaqlarınıın yaranma ehtimalını artırır. Buna görə də "Böyük qayıdış"la əlaqədar olaraq işğaldan azad olunmuş ərazilərdə əhalinin və biotanın ekoloji təhlükəsizliyinin təmin olunması üçün ekogeokimyəvi tədqiqatların aparılması çox vacibdir. Məqalədə Şərqi Zəngəzur landşaftlarının geokimyəvi strukturu təhlil edilmişdir.

Açar sözlər: Şərqi Zəngəzur, landşaft, kimyəvi elementlər, miqrasiya, geokimyəvi birləşmələr, xəstəliklər