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THE CHANGES OF CHEMICAL COMPONENTS OF MINERAL WATERS OF ARTSAKH AS EARTHQUAKE PROGNOSTIC

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As groundwater is considered as a seismic process indicator, the purpose of the study was to detect and assess the direct link between the changes in the chemical composition of the earthquakes and groundwater. A systematic monitoring of the chemical composition of the investigated water has been carried out in the hydro chemical and analytical laboratory of the RA Ministry of Emergency Situations, "Eastern Seismic Protection Service" SNCO. A sample of the monitoring was served in particular the mineral water called "Ttu Jur" of Stepanakert suburb.

Studies show that hydro geochemical indices of underground waters are characterized by complex time-based changes in acid-base conditions, mining, macro- and micronutrient concentrations. The latter confirm the obvious changes in the composition of groundwater during the survey period.

Key words: seismohydrogeochemistry, earthquake, underground water, hydrocarbon, magnesium, sulfur, photoelectrocalorimetric, ion meter

Introduction

Earthquakes and especially its crust researches show that earthquakes are permanent and regular phenomena.

Earthquakes belong to the form of the internal energy of the earth, the results of which are evident abruptly, while their preparatory period lasts for years.

It is known that during the strong earthquake, energy from 10^{19} to 10^{25} erg is produced. According to Professor P.F. Nikiforov 10^{25} is equivalent to 22 billion simultaneous shooting of cannons of 16 inches, or for Verney (Almat) 9.1 magnitude earthquake of 04. 01. 1911 the simultaneous voltages of Dnepr HPS of 226 years running is necessary (assuming its capacity of 50 MW) to get the power [1]: A question arises: is it possible to predict Earthquakes beforehand? when, where, what magnitude? These issues continue to be one of the most important and most problematic issues of modern seismology, and science has some success in this area. By means of special equipment, the smallest earth crust is recorded on seismic stations. The observations have shown that before the earthquake, a number of phenomena occur in the surface of the Earth, first of all, expressed in the presence of electromagnetic currents and the increase in radioactive materials in mineral waters, and especially the amount of radon [2]. Studies have shown that indicators of “earthquakes stat” can be the strange behavior of wildlife, dogs, cats, rats, serpents, lizards, and fish on the eve of the earthquake as well (even two days before) [1].

The progress of science gives less space to unsound assumptions, gives realistic explanations to horrific phenomena of nature and elaborates ways to avoid their devastating activity.

Set of the problem

The article presents qualitative characteristics of earthquake symptoms, based on the principle of periodicity of seismic activation. The purpose of the research was to find out the nature of changes in the behavior of the chemical composition of underground waters in relation to strong earthquakes.

Research results. According to the observations and researches of scientists, it was clear that not only the changes in the earth crust are the prognostics of coming earthquakes, but also the changes of chemical components of ground waters, the ionosphere etc. For this purpose a hydro geochemical and analytic laboratory was opened in the NKR department of RA MES National Service in 2002.

In the laboratory permanent observations are realized which is a systematic control over observed water's chemical components. We work mainly with the mineral water "Ttu jur" near Stepanakert, the permanent observation of chemical component of which gives information about the current seismic situation.

Moreover, those changes of chemical components are the pointers of observed anomalies. In the laboratory the changes of chemical components of 11 ions are determined *(Ca^{2+}, Mg^{2+}, HCO_3^-, Cl^-, SO_4^{2-}, NO_2^-, NO_3^-, NH_4^+, Fe^{2+}, Cu^{2+}, F^-)* and other parameters as well.

In the observed water example the following parameters were determined quantitatively *He, pH, Ca^{2+}, Mg^{2+}, HCO_3^-, Cl^-, SO_4^{2-}, NO_2^-, NO_3^-, NH_4^+, Fe^{2+}, Cu^{2+}, F^-* :

The results from analyses were elaborated with Seishelp and Advance Grapher computer programs and appropriate tables were formed.

The content of Helium *(He)* was determined by special instrument which can determine the solved helium in the watercolor from 5.10^{-6} % to 5.10^{-1}%. Along with Helium the temperatures of air and water were determined and air pressure as well. The main measuring instrument for Helium concentration was magnetic charging indicator (ИНГЕМ):

The concentration of Ftor ion (F^-) was determined by Econic Expert pH-meter–ion meter instrument. The changes of the most mobile, very sensitive and most electromechanical elements of Ftor ion can be the prognostic of seismic events.

The content of Copper ion *(Cu^{2+})* was determined by photo-electro-calorimetric way which, interacting with starch, signet salt, ammonia and nitrate diethyl carbon formed w liquid of yellow color.

We stopped the decision about the concentration of copper ion *(Cu^{2+})* in "Ttu jur" in 2016թ dependent on the circumstance that during the whole period of researches its quantity hasn't changed and no connection was noticed between certain ion quantity and the earthquakes observed in the region.

pH (environment) was determined by the pH-ion meter, a production of *Econic Expert*.

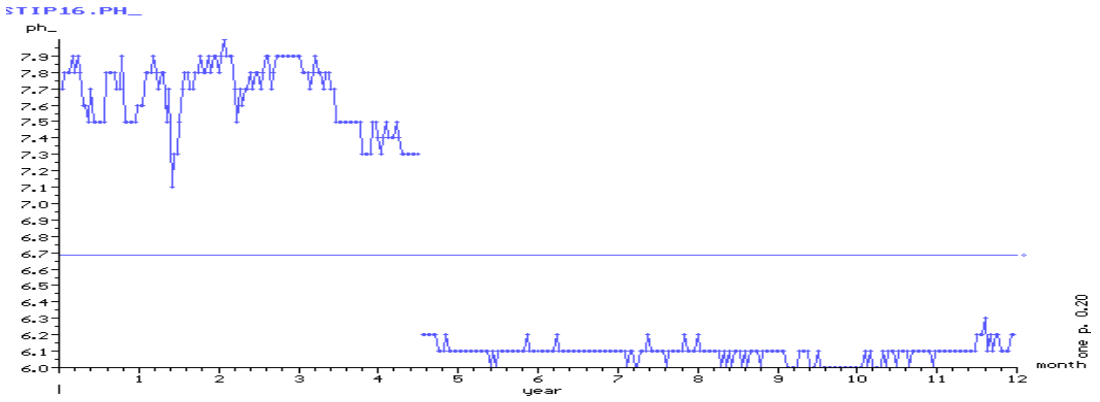

Fig.1. pH (environment) change

The quantitative analysis of Hydrocarbon ion *(HCO_3^-)* was realized by titrimetric way. For the tittering the strong acid 0,1N was used as fix anal and as indicator methyl orange was used.

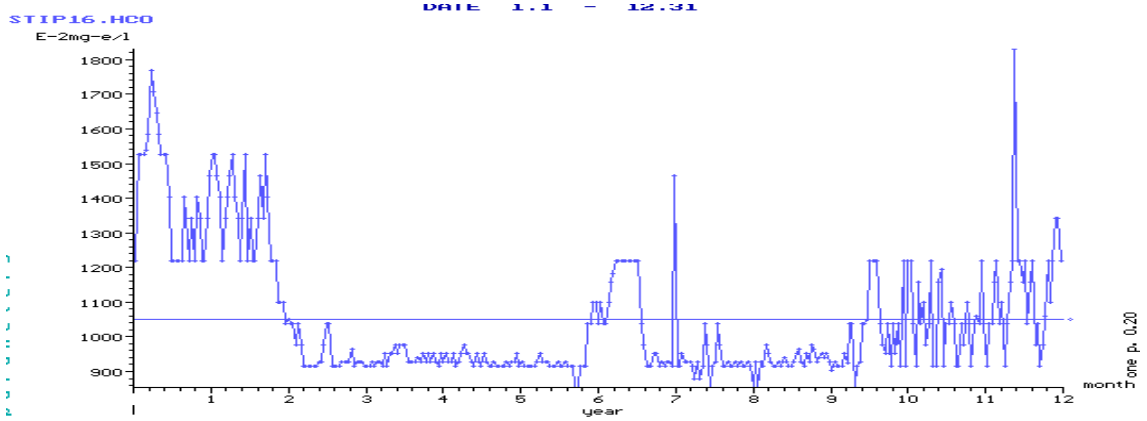

Fig.2. The change of concentration of hydrocarbon ion

The quantitative analysis of Chloride ion (Cl^-) was done by silver-metric method. For tittering we must use the liquid of silver nitrate ($AgNO_3$) 0,02N.

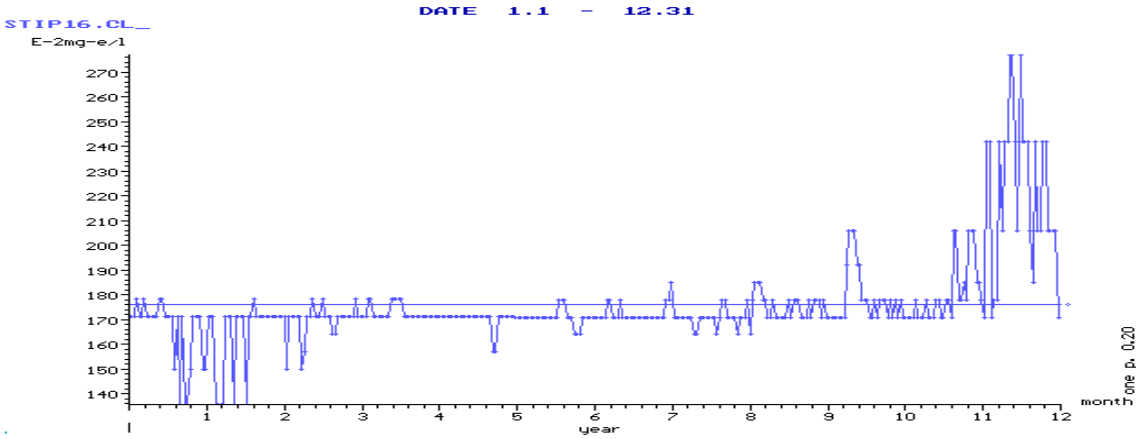

Fig.3. The change of concentration of Chloride ion

The content of Calcium ion (Ca^{2+}) was determined by complexonometric method using trillion B fix anal for tittering. As a indicator it is necessary to use murexid.

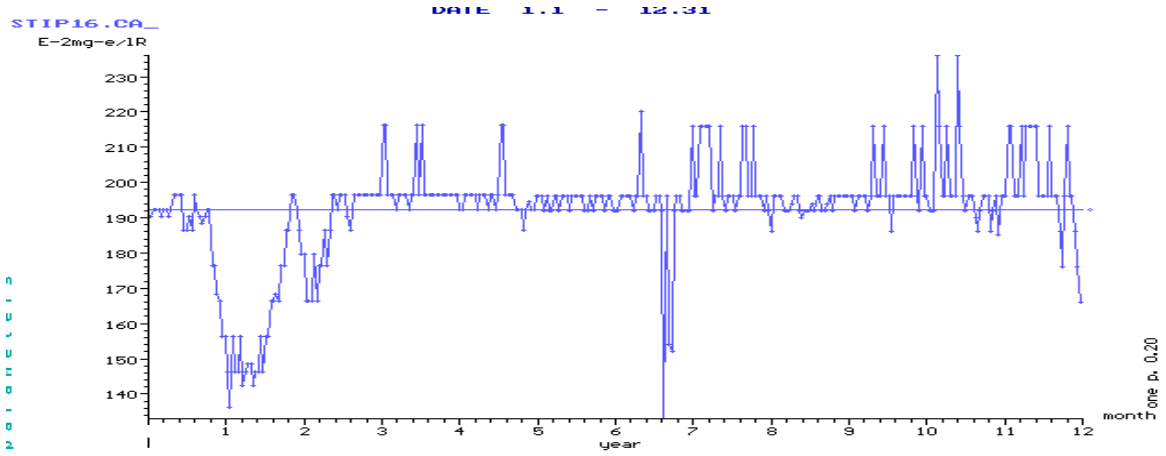

Fig.4. The change of Calcium ion concentration

The content of Magnesium ion (Mg^{2+}) was determined by calculation method taking away the content of calcium from general roughness, and for tittering using trillion B fix anal, and as indicator using erichrome.

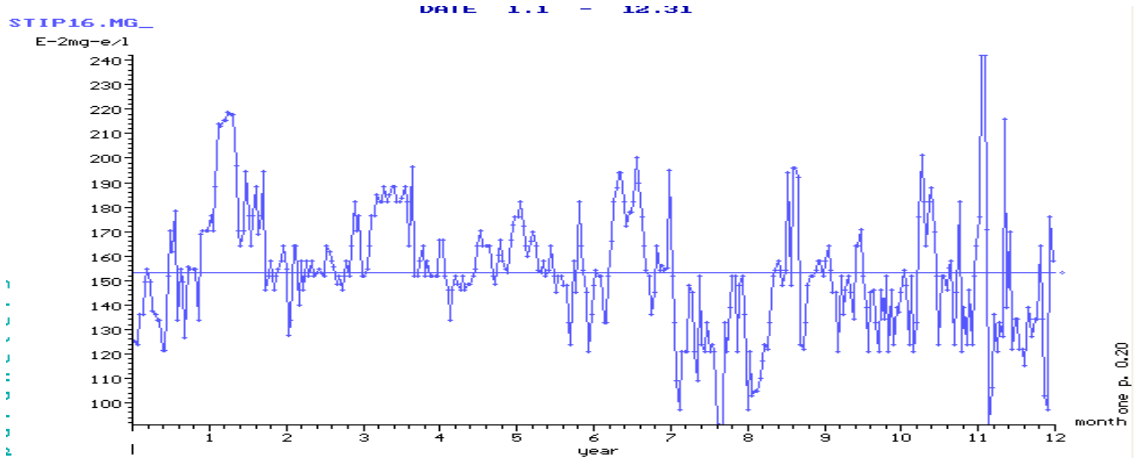

Fig.5. The change of Magnesium ion concentration

The content of Sulfur ion (SO_4^{2-}) was determined by titter metric method for tittering using lead nitrate $[Pb(NO_3)_2]$ liquid of 0,1N.

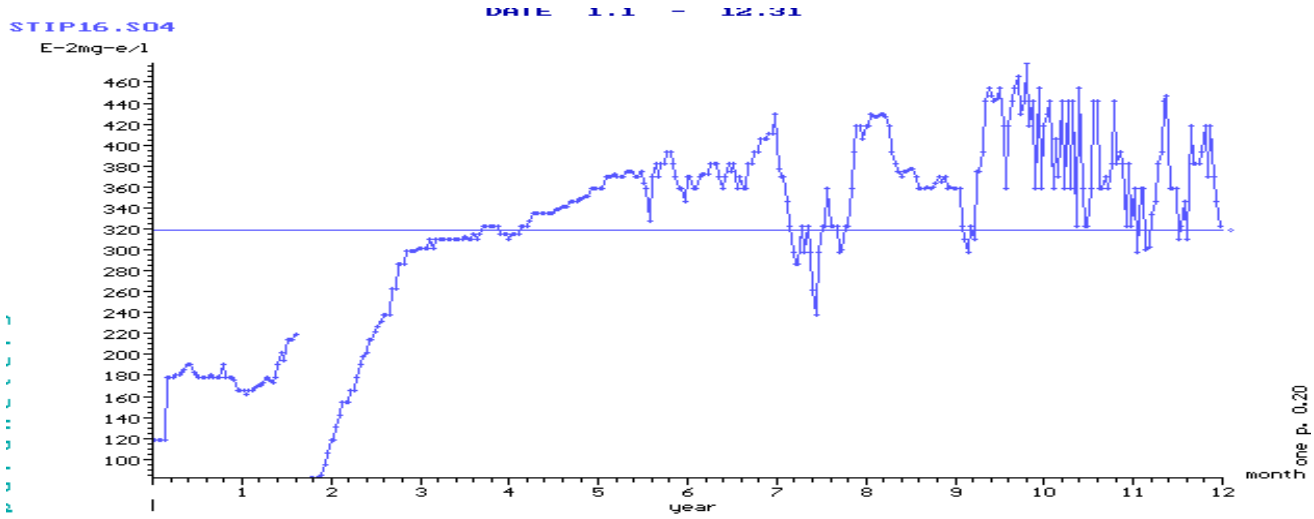

Fig. 6. The change of Sulfur nitrate concentration

The content of Nitrate ion (NO_3^-) was determined by photo-caloric-metric method thus using sodium salicylate, which, interacting with nitrate ion by sulfuric acid had formed yellow liquid.

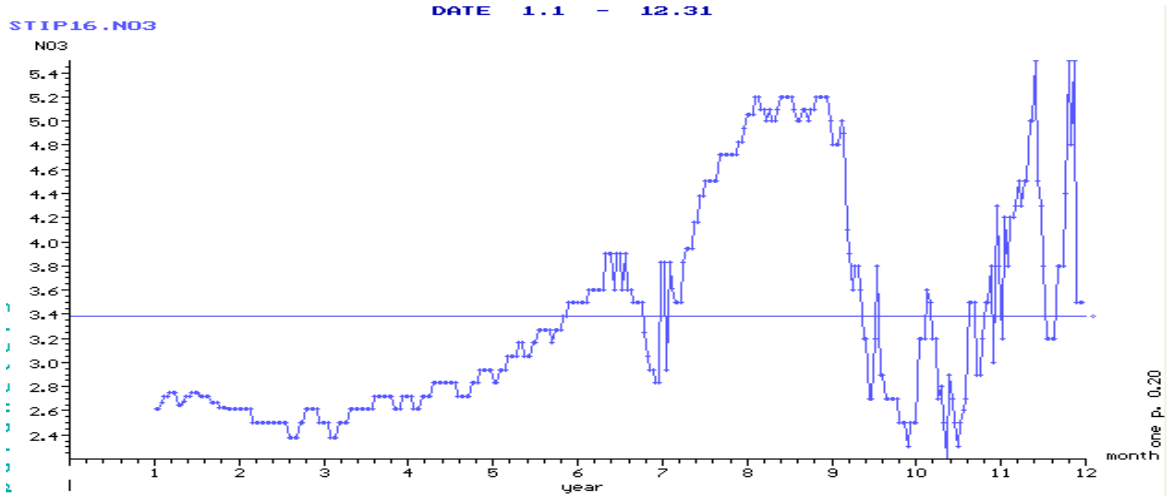

Fig.7. The change of Nitrate ion concentration

To determine the content of Nitrate ion (NO_2^-) Gris's reactive was used.

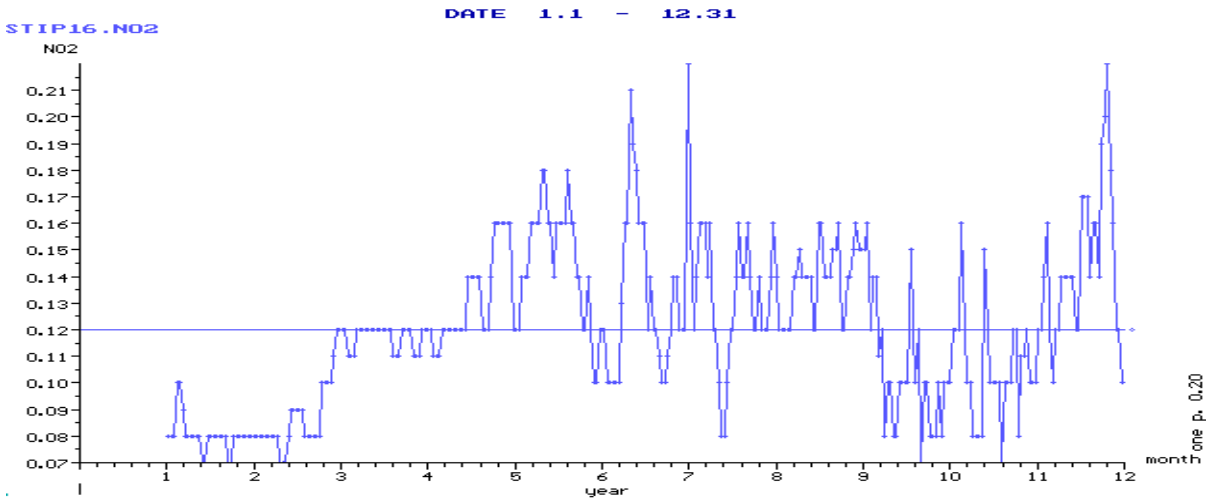

Fig.8. The change of Nitrate ion concentration

The content of ammonium ion *(NH_4^+)* was determined by photo-electrical calorimetric method. Nessler's reactive was used, which interacting with ammonium ion had formed mercuric-ammonium yodium liquid of yellow color.

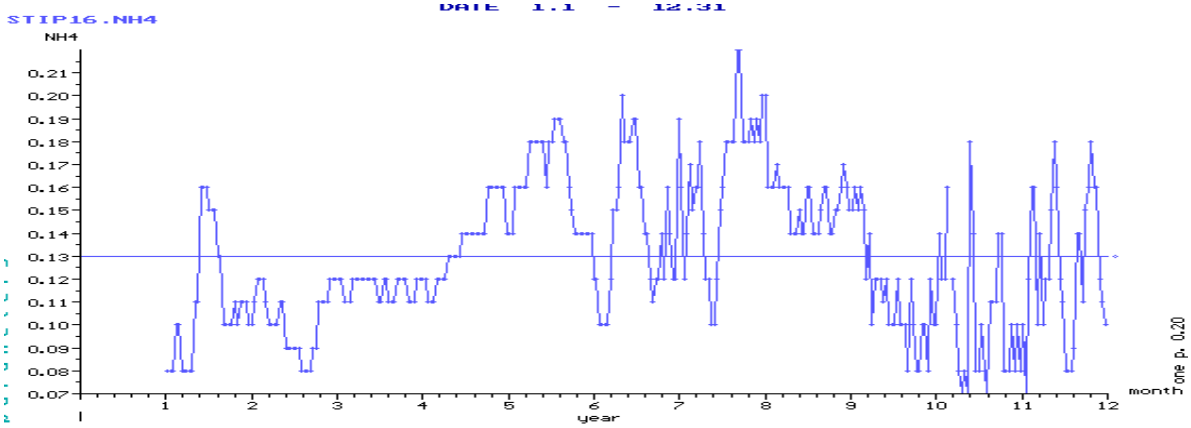

Fig.9. The change of ammonium ion concentration

The content of Iron ion *(Fe^{2+})* was determined by the same instrument, which, interacting with salt acid, rhodium and ammonium per sulfur, had formed red colored liquid.

Table 1

Results from analyses

N/N	Parameter	Average cost(mg/l)	Maximum cost, max (mg/l)	Minimum cost, min (mg/l)
1	**2**	**3**	**4**	**5**
1	Ca^{2+}	192	236	133
2	Mg^{2+}	153	242	91.0
3	HCO_3^-	1052	1830	854
4	Cl^-	176	277,0	135.7
5	SO_4^{2-}	319	478	82.0
6	ph	6,68	8,0	6,0
7	NO_3^-	3.38	5,5	2.20
1	**2**	**3**	**4**	**5**

8	NO_2^-	0,12	0,22	0,07
9	NH_4^+	0,13	0,22	0,07
10	Fe^{2+}	0,15	2,4	2.25
11	F^-	0,03	0,67	0,35

In 2016 46 regularities were noted between the connections of values of water parameters analyses by AEA laboratory and the earthquakes timing registered by "Stepanakert" complex station which were expressed by the changes of concentrations of HCO_3^-, Magnesium Mg^{2+}, Sulfur SO_4^{2-}, Helium He, Calcium Ca^{2+} in water. On the data received after the elaborations of registered seismic events the list of earthquakes happened in the region was formed.

Below more typical examples are given

Table 2

The list of earthquakes noted in 2016

N	lat	long	yy	mm	dd	M	hh	mm	ss	Region
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	38.02	43.17	2016	1	7	3.6	02	02	42	Turkey
2	40.03	48.40	2016	1	8	3.15	00	45	54	Azerbaijan
3	38.42	45.07	2016	1	9	2.4	11	15	57	Iran
4	39.13	44.56	2016	1	11	2.75	02	43	25	Iran
5	39.01	48.27	2016	1	12	4.0	02	39	17	Azerbaijan
6	39.18	48.03	2016	1	12	2.1	17	33	55	Iran
7	39.40	47.55	2016	1	22	3.5	10	43	17	Iran
8	39.40	47.55	2016	1	22	3.5	10	43	17	Iran
9	35.55	53.12	2016	1	26	4.0	04	56	44	Iran
10	38.27	45.03	2016	2	4	2.95	15	53	08	Iran
11	39.42	46.07	2016	2	7	2.0	15	50	52	NKR
12	39.03	45.49	2016	2	11	2.15	02	32	25	Azerbaijan
13	40.24	45.49	2016	2	14	2.65	14	05	07	Azerbaijan
14	39.19	46.13	2016	3	6	1.95	18	02	58	Armenia
15	41.06	44.27	2016	3	9	3.1	12	13	20	Armenia
16	40.17	47.12	2016	3	10	2.2	10	12	40	Azerbaijan
17	40.13	46.51	2016	3	11	1.5	11	40	44	NKR
18	40.56	44.23	2016	3	24	2.7	03	55	04	Armenia
19	40.16	48.45	2016	3	24	3.2	14	09	02	Azerbaijan
20	37.15	47.14	2016	3	24	3.85	19	52	58	Iran
21	40.37	46.54	2016	3	29	2.35	15	37	18	Azerbaijan
22	38.25	46.37	2016	4	1	2.55	09	11	13	Iran
23	40.46	48.11	2016	4	2	3.35	19	06	44	Azerbaijan
24	40.26	46.03	2016	4	4	1.95	05	06	31	Azerbaijan
25	38.53	48.39	2016	4	6	3.1	00	15	01	Azerbaijan
26	39.54	48.28	2016	4	10	2.9	10	33	03	Azerbaijan
27	39.37	48.13	2016	4	14	3.3	07	45	08	Azerbaijan
28	41.51	49.18	2016	4	19	3.9	20	22	45	Azerbaijan
29	40.06	48.15	2016	8	1	5.6	08	46	37	Azerbaijan
30	38.43	48.36	2016	8	3	2.8	15	15	04	Azerbaijan
31	40.04	46.44	2016	8	30	1.9	15	32	25	NKR
32	39.35	46.27	2016	9	29	1.5	12	51	58	NKR
33	38.28	45.07	2016	10	2	2.5	20	10	03	Iran
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
34	41.58	44.07	2016	12	4	3.0	23	24	45	Georgia

35	38.39	44.28	2016	12	6	2.9	20	54	45	Iran
36	38.09	48.01	2016	12	10	2.3	01	56	09	Iran
37	38.37	43.48	2016	12	11	4.3	22	42	54	Turkey
38	42.33	43.24	2016	12	12	3.7	23	37	17	Georgia
39	40.54	48.30	2016	12	13	4.2	00	32	59	Azerbaijan
40	38.31	43.52	2016	12	13	3.7	01	32	00	Georgia
41	41.50	46.10	2016	12	20	4.3	16	40	48	Georgia
42	38.42	48.19	2016	12	20	1.9	21	33	17	Azerbaijan
43	40.6	45.59	2016	12	22	2.4	09	56	18	NKR, Qarvachar
44	38.24	45.24	2016	12	26	2.9	01	55	24	Iran
45	40.27	48.10	2016	12	26	2.8	11	51	54	Azerbaijan
46	39.07	46.10	2016	12	26	1.8	12	46	15	Armenia

In the Graphics of 10-11 we see the changes of Sulfur ion concentration on the eve of earthquakes in 01.08.16, M=5,6 in Sabirabad in Azerbainjan and in 30.08.16, M=1,9, in Askeran region, NKR, in 26.12.16. M=2,8 in Qyurdamir in Azerbaijan, and in Qajaran, Armenia, M=1,8.

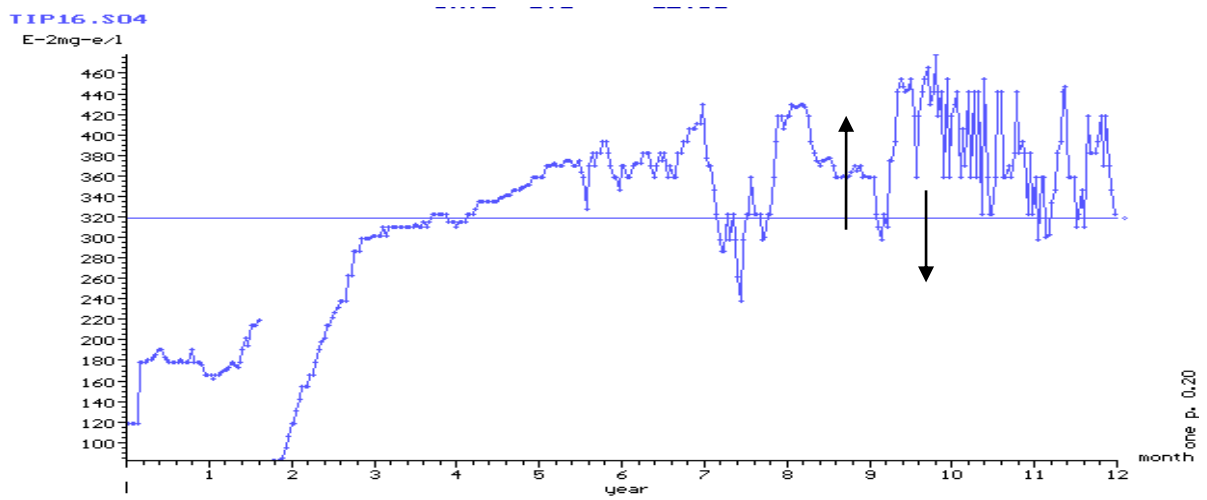

Fig.10. The change of Sulfur ion concentration

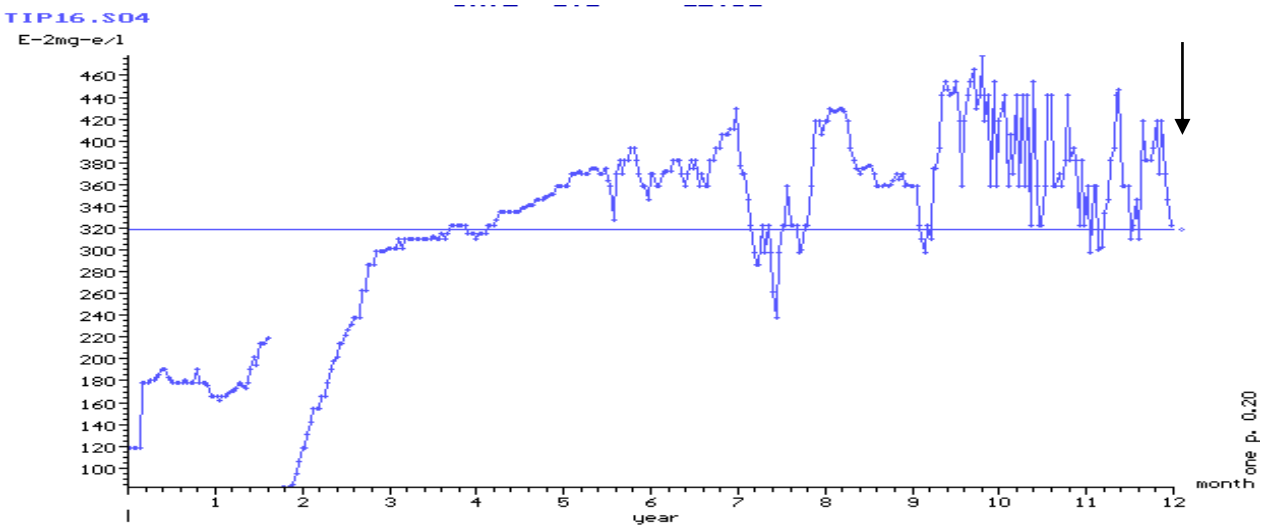

Fig.11. The change of Sulfur ion concentration

In Graphics 12-13 we see the changes of hydrocarbon ion concentration oon the eve of the earthquake in 08.01.16, M=2,4 in the territory of Turkey and NKR, in 01.08.16, M=5,6 in Sabirabad region of Azerbaijan and in Askeran region, NKR, in 13.12.16թ., M=4,2 in Shamakhi, Azerbaijan.

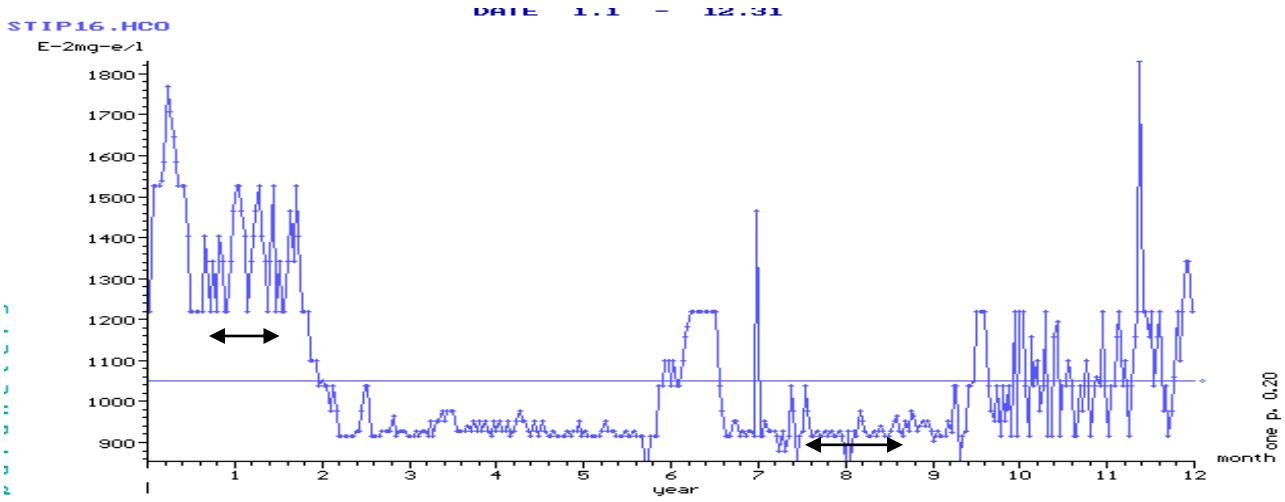

Fig.12. The changes of hydrocarbon concentration

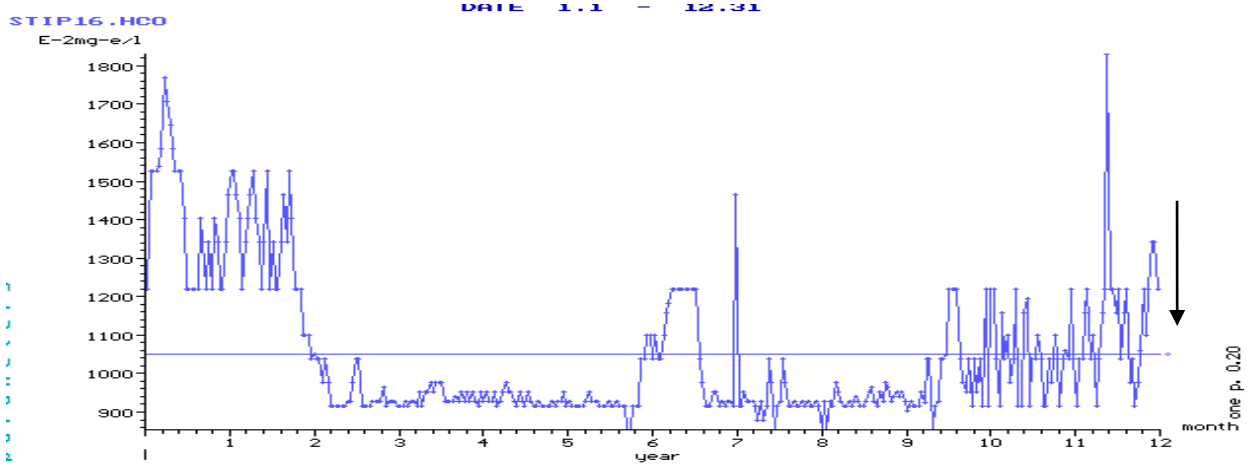

Fig.13. The change of hydrocarbon ion concentration

In Graphics 14-15 the change of Magnesium ion concentration is shown on the eve of earthquakes in 08.01.16 M=2,4, NKR and Azerbaijan towns of Sabirabad in 01.08.16. M=5,6 and Lerik in 29.12.16 M=3,8.

The earthquake of 3.6 magnitude in 2017, March 6, in Qarvachar region became the reason of exploring the mineral water near Zuar of the same region.

On March 7 mineral water of "Taq jur" was analyzed for the purpose of investigating the changes of water parameters values. As a result the rise of HCO_3^-, magnesium Mg^{2+}, Sulfur SO_4^{2-} ions concentartions was noted.

On March 22 the mentioned wateer was also analyzed. The results received can'r be compared with the results got on March 7 as these values were lower.

We hope that the coordination and completion of these two waters laboratory researches will help us to give more complete description about the connection between the chemical changes and registered seismic events.

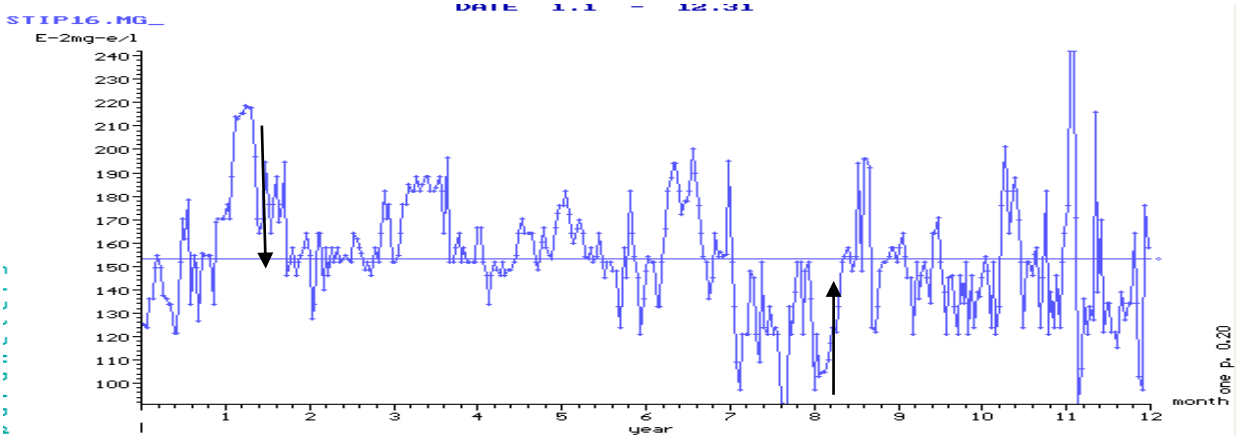

Fig.14. The changes of Magnesium ion concentration

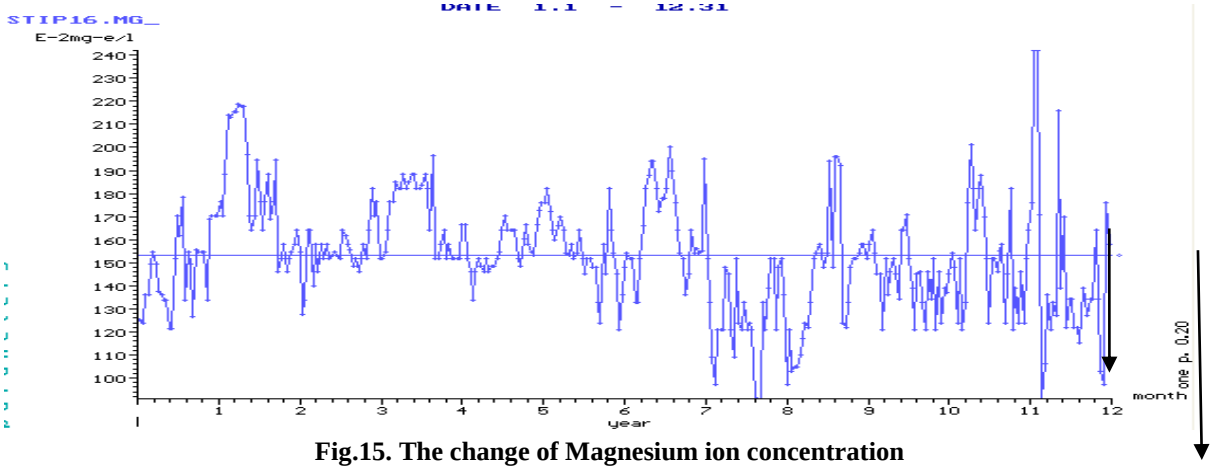

Fig.15. The change of Magnesium ion concentration

Conclusion

In the article we represented shortly the hydro geochemical characteristics of ground waters in the Artsakh Republic region. Starting upon the results of hydrodynamic processes research, the following graphics of chemical elements were achieved as HCO_3, SO_4, Mg. Typical effective signs determining the macro components of mineral waters are considered to be the rising or falling of the concentrations of latters which allows us to fix the anomaly changes of water component.

We may judge from the micro component content changes of mineral waters that in Artsakh region the geodynamic processes are active.

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ԱՐՑԱԽԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ՀԱՆՔԱՅԻՆ ՋՐԵՐԻ ՔԻՄԻԱԿԱՆ ԲԱՂԱԴՐՈՒԹՅԱՆ ՓՈՓՈԽՈՒԹՅՈՒՆՆԵՐԸ ՈՐՊԵՍ ԵՐԿՐԱՇԱՐԺԻ ՆԱԽԱՆՇԱՆ

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[1]ՀՀ ԱԻՆ Սեյսմիկ Պաշտպանության Արևելյան Ծառայություն ՊՈԱԿ
[2]Շուշիի Տեխնոլոգիական Համալսարան

Քանի-որ ստորգետնյա ջրերը համարվում են սեյսմիկ պրոցեսների ինդիկատոր, հետազոտության նպատակն էր ի հայտ բերել ու գնահատել երկրաշարժերի և ստորգետնյա ջրերի քիմիական բաղադրության փոփոխությունների միջև անմիջական կապը: Արցախի Հանրապետության գործնեություն իրականացնող ՀՀ ԱԻՆ «Սեյսմիկ Պաշտպանության Արևելյան ծառայություն» ՊՈԱԿ-ի հիդրոերկրաքիմիական և անալիտիկ լաբորատորիայում իրականացվել է մշտադիտարկում՝ հետազոտվող ջրերի քիմիական բաղադրության

սիստեմատիկ վերահսկողություն: Մշտադիտարկման նմուշ է ծառայել մասնավորապես ք. Ստեփանակերտի արվարձանի «Թթու Ջուր» կոչվող հանքային ջուրը:

Ուսումնասիրությունները վկայում են, որ ստորգետնյա ջրերի հիդրոերկրաքիմիական ցուցանիշները բնութագրվում են թթվահիմնային պայմանների, հանքայնացման, մակրո- և միկրոէլեմենտների կոնցենտրացիաների բարդ տարածաժամանակային փոփոխություններով:

Վերջիններս հաստատում են հետազոտությունների իրականացան ժամանակահատվածում ստորգետնյա ջրերի բաղադրության ակնհայտ փոփոխությունները:

Բանալի բառեր. սեյսմոհիդրոերկրաքիմիա, երկրաշարժ, ստորգետնյա ջուր, հիդրոկարբոնատ, մագնեզիում, սուլֆատ, ֆոտոէլեկտրոկալորիմետրիկ մեթոդ, իոնաչափ

ХИМИЧЕСКИЙ СОСТАВ ИЗМЕНЕНИЯ МИНЕРАЛЬНОЙ ВОДЫ В АРЦАХСКОЙ РЕСПУБЛИКЕ КАК ЗНАК ЗЕМЛЕТРЯСЕНИЯ

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Так как подземные воды являются индикатором сейсмических процессов, целью исследования являлось выявление и оценка непосредственной связи между землетрясении и изменениями химического состава подземных вод. В основу работы положены результаты мониторинга подземных вод на территории Республика Арцах, образцом для мониторинга служит в основном минеральная вода Тту джур города Степанакерта. В результате мониторинговых исследований, производимых на территории Республики Арцах, зафиксировано изменение химического состава подземных вод, связанное с влиянием сейсмических событий.

Гидрохимические показатели подземных вод характеризуются сложными пространственно-временными изменениями минерализации, кислотно-щелочных условий, содержаний концентраций макро- и микрокомпонентов.За период мониторинга, исследования подтверждают очевидные изменения в составе подземных вод.

Ключевые слова: сейсмология, водород, землетрясение, подземные воды, гидрокарбонат, магний, сульфат, фотоэлектрокалориметрический метод, ионометр