

GENERAL CHARACTERISTICS OF THE SALT COMPOSITION OF THE WATERS OF MUD VOLCANOES OF AZERBAIJAN

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Annotation

The article examines the chemical composition of the waters of mud volcanoes in Azerbaijan. It is based on the results of analyses of 65 water samples from the author's collection, as well as material from literary and fund sources.

The mineralization of the waters of mud volcanoes in Azerbaijan varies widely from 5.8 to 84.7 g / l. In the distribution of mineralization of the waters of mud volcanoes by area (Fig. 1), a fairly regular increase in the lower direction is noted from 5.8-8.6 g / l in the northern part of the region to 40-80 g / l in the southern part (Khidirly, Duzdag, Neftchala, Yenikyshlak and others). In the latitudinal direction, the nature of the distribution of mineralization of the volcano waters is quite complex.

The highest mineralization, more than 20 g / l, is characteristic of the waters of mud volcanoes located in the coastal strip: Shishikan, Kotyrylg, B. Kenizdag, Kirdag, Dashgil, Bakhar, Agzybar and others. To the west and east (in the area of the Baku archipelago) the mineralization of the waters of mud volcanoes decreases to 12-13 g / l.

Keywords: mineralization; waters of mud volcanoes; microcomponents; chemical composition; ionic composition.

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The highest mineralization, more than 20 g / l, is characteristic of the waters of mud volcanoes located in the coastal strip: Shishikan, Kotyrylg, B. Kenizdag, Kirdag, Dashgil, Bakhar, Agzybar and others. To the west and east (in the area of the Baku archipelago) the mineralization of the waters of mud volcanoes decreases to 12-13 g / l. Against the background of a more or less regular decrease in the mineralization of the waters of mud volcanoes from the north-west to the southeast, anomalous participation of low and high mineralization is noted. Anomalies of the first kind, characterized by mineralization less than 10 g / l, are noted for the waters of the mud volcanoes Damirchi, Astrakhanka, Gadzhili, Zapadno-Marazinsky, Sundinsky, Zapadno-Persikolsky. Anomalies of the second kind (mineralization more than 40-60 g/l) are noted for mud volcanoes Kotyrylg, Khidirly, etc. (Table 1)

Waters of mud volcanoes are represented by all 4 genetic types: sodium hydrocarbonate (SHC), calcium chloride (CC), magnesium chloride (AM) and sodium sulfate (SN). Alkaline waters of the SHC type are predominant and characteristic of the waters of mud volcanoes of Azerbaijan. The main components are chlorides and hydrocarbonates of alkali metals. Volcanic waters, as well as formation waters, are mainly low-sulfate or sulfate-free.

The chemical composition of mud volcano waters is given in Table 1

The ionic composition (Na^+ , K^+ , Ca^{+2} , Mg^{+2} , Cl^- , So_4^{-2} , HCO_3^- , CO_3^{-2}) is given in mg-eq/100 g of water. Water types: GKN - sodium hydrocarbonate, KH - calcium chloride, KHM - magnesium chloride, CH - sodium sulfate, a + k - mineralization expressed as the sum of anions and cations.

Within the crater field of one volcano, griffons bring to the surface waters of various genetic types. All 4 types of water have been encountered at the mud volcano Hamamdagh. The genetic heterogeneity of the waters brought by separate groups of griffons is associated with the isolation during the griffon-saline stage of the volcano's activity from the formation waters of various stratigraphic horizons of the Cenozoic. Mud volcanic waters are characterized by a mixed nature and are associated with feeding sources located at various depths. During the migration of deep fluids to the Earth's surface, consisting of a mixture of superheated gases and water, there will be a natural enrichment of these fluids with hydrocarbons due to the removal of water from their composition (interaction with formation waters along migration paths and at the surface) and the most chemically active components of this mixture (interaction with waters and rocks along migration paths). This process will be accompanied by the formation of weakly mineralized bicarbonate-sodium (alkaline) waters and the formation of an inversion-type hydrogeological cross-section. We believe that the products coming from great depths may contain both simple hydrocarbons and hydrocarbon radicals. In the presence of a whole complex of conditions necessary for the emergence and activity of mud volcanoes, their formation will occur. Moreover, in the products of the most active mud volcanoes, located in areas characterized by increased geotectonic activity, with a relatively small capacity of the sedimentary cover, gas will be released, consisting mainly of carbon dioxide and hydrocarbons. Another characteristic feature of the groundwater of mud volcanic areas is that, regionally, in the groundwater of structures complicated by modern or buried mud volcanoes, the content of alkali hydrocarbonates, boron increases sharply, and minerali-

zation decreases. For the South Caspian Basin, this feature is expressed in the limited distribution of alkaline low-mineralized waters and their confinement to strictly defined areas within anticlinal folds associated with tectonic disturbances and mud volcanoes (Sh.F. Mekhtiev, M.Z. Rachinsky, 1967)

The total salinity of the mud volcanoes of Azerbaijan is 28-1380 mg-eq per 100 g. The waters of the Absheron peninsula and Shamakhi district are most alkaline, the most mineralized and metamorphized waters are noted on the mud volcanoes of the Nizhnekurinsky district. The permanent components of volcanic waters are iodine, boron, bromine. Their content varies widely, reaching 100 mg/l, 480 mg/l and 120 mg/l, respectively, and depends on the chemical composition and mineralization of the waters. High values of boron and iodine - with mineralized.

In recent years in mud volcanic systems of Azerbaijan two main types of water are distinguished: HCO₃-Na with mineralization 8-15 g/l and Cl-Na type with higher water mineralization (up to 80 g/l), formation of mud volcanic waters occurs in the range of formation temperatures (according to Mg-Li geothermometer) from 20 to 140 sec. Depths of water formation are estimated in the range from 1 to 6-7.5 km. At that, average values of "base" temperatures for highly mineralized (up to 80 g/l) waters of Nizhnekurinsk depression are almost 2 times lower than for slightly mineralized waters of Absheron and Gobustan.

The hydrocarbonate ion is distributed in the waters of mud volcanoes of Azerbaijan very unevenly: from tenths to 36% equiv. Analysis of the graphical distribution of the hydrocarbonate ion content in the mud volcano waters (Fig. 1) revealed the following characteristic features of its distribution:

1) The general tendency of decreasing the relative content of hydrocarbonate ion from north to south from 30-36% equiv. in the waters of mud volcanoes: Astrakhanka, Damirchi, Gereldinsky, Tuvinsky, Zapadno-Sheitanudsky and others to 0.1-0.2% equiv. In the waters of the mud volcanoes Tatarmagla, Duzdag, Neftchala, Yenikyshlak, Khydyrly and others.

2) In general, the waters of the Shamakhi-Kobistan region are characterized by increased alkalinity compared to the waters of the Prikurinsk region and the Baku archipelago. As a result, the waters of almost all the mud volcanoes of the Shamakhino-Gobustan region belong to the sodium bicarbonate type. Only in the craters of some of them: Hayrantekyan, Sara Boga, Dashgil, Koturlig, Towragai, Shishkaya, located in the southeastern part of the region, waters of the chlorocalcium type are found, while the waters of the vast majority of mud volcanoes of the Prikurinsk region belong to the chlorocalcium and chlormagnesium types. 3) Against the background of a fairly regular decrease in the bicarbonate ion from north to south, the following positive anomalies are noted here. a) positive:

Chemical composition of waters of mud volcanes of Azerbaijan

	Name of the mud volcano	Me-rea Liza-sion q/l	PH	Microcomponents, mq/l						
				Br	J	B	NH	Li	Sr	As

1	Nardara-nahtarma	16.0	8.4	45.8	22.8	110.0	5.4	0.36	0.13	0.020
2	sheitanud	10.04	8.5	37.3	19.7	197.6	9.0	0.83	0.21	0.010
3	Damirchi	8.6	8.5	34.6	36.7	427.0	7.2	1.28	2.71	0.005
4	Cheildag	11.7	8.7	40.0	15.1	120.3	16.2	0.45	1.10	0.060
5	Cheilakh-torma	36.5	9.0	90.6	65.4	448.0	8.6	0.42	3.05	0.060
6	West sheitanud	13.4	8.0	26.6	16.9	179.6	16.2	0.84	2.54	0.054
7	Dah-mardan	13.5	8.5	53.3	9,0	157.2	9.0	0.35	2.12	0.005
8	Durandag	13.2	7.8	45.3	12.1	161.5	5.4	0.18	4.23	0.005
9	Solokhai	16.8	8.5	66.6	8.2	119.0	7.2	0.44	4.21	0.025
10	SW Solokhai	13.0	8.5	53.3	14.1	163.9	9.0	0.17	4.23	0.060
11	SE Solokhai	23.1	8.0	103.9	28.2	67.4	16.2	0.28	11.0	0.010
12	Kushchu	18.8	7.4	67.0	14.4	35.0	5.4	0.42	5.92	0.020
13	Hay-rantekyan	38.9	9.0	189.1	56.4	262.7	9.0	0.15	8.46	0.040
14	Mishovdag	18.0	8.0	48.0	17.1	70.0	9.0	0.12	22.0	0.060
15	Kirovdag	13.1	7.8	52.9	12.3	60.0	7.9	0.07	6.77	0.040
16	Hamamdag	24.2	9.0	77.2	20.2	52.2	16.2	0.17	22.0	0.052
17	Bayandovan	26.8	8.9	101.5	26.2	117.8	5.8	0.46	29.6	0.040
18	Duzdag	40.5	8.0	103.9	25.8	140.2	10.8	0.09	25.3	0.060
19	Khydyrli	81.6	6.8	163.2	46.0	44.4	19.8	1.21	43.8	0.005
20	About Bulla.Yu.	17.2	8.0	61.3	22.6	121.2	9.0	0.61	7.61	0.020

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The first is confined to the extreme northwest of the Shamakhi-Kobyst region: mud volcanoes Astkhanka and Damirchi (HCO₃-30-36% eq.). The second is located in the central part of the region: Geraldinsky, Tuvan, Zapadno-Sheitanudsky. Karkishlar (29-31% eq.). The third is located in the Absheron region: Lokbatan (29%-eq.). b) negative: the first is located in the eastern part of the Shamakhi-Kobistan region: Shishkan (1.4%-eq.); the second is in the southeastern part of this area and in the adjacent part of the Caspian Sea: B.Kanizdag, Kotyrylg, Duvanny Island (up to 1%-eq.), in the northwestern part Prikurinsky region: Kirlykh (0.3-0.8%-eq.), M.Kharamy (1.3%-eq.), Neftyanaya Balka (0.1%-eq.). Thus, the waters of the mud volcanoes of Azerbaijan are mostly chloride-bicarbonate, sodium and sodium chloride belong to the sodium bicarbonate type. In the northernmost part of the Shamakhi-Kobyst region, sodium bi-

carbonate-chloride waters are widespread. In the Prikurinsky region, in the central and southern parts, waters are mainly of the chlor-quartz type, with sodium chloride in composition. Waters of the sulfate-sodium and chlormagnesium types have an extremely limited distribution and are noted in a number of griffins of volcanoes: sulfate-sodium: Durandag, Ingabel; chlormagnesium- Hayrantekyan, Zap.Koturdag and others. Waters of various types are characterized by different ratios between silkworm metals (nCa/nMg) and sulphate content. In waters of the sodium bicarbonate type, the value of the nCa/nMg coefficient is significantly less than unity and on average ranges about 0.3. In waters of the chlorocalcium type, it is almost always greater than unity and increases to 2-3. Similarly, different types of water differ dramatically in the content of sulfates. The value of the nSo_4/nCe 0.1 coefficient is minimal (0-0.13) in waters of the calcium chloride type and maximum (up to 21.6) in waters of the sodium bicarbonate type. The waters of Azerbaijan's mud volcanoes contain a number of trace elements: boron, bromine, iodine, ammonium, lithium, strontium, and arsenic. Boron is one of the characteristic microelements of the hill waters and is contained in them in an amount from 31 to 448 mg/l. Five zones with different boron content in the waters of mud volcanoes are quite clearly distinguished: I The zone characterized by a maximum boron content (more than 400 mg/l) and a high boron-chlorine ratio (more than 2000) includes the Damirchi and Astrakhan volcanoes located in the northwestern part of the Shamakhi-Kobyst region, as well as the Cheilakhtarma mud volcano located in the central part of the same area. However, the increased boron content (448 mg/l) in the waters of the Cheilakhtarma volcano is apparently related to the surface concentration of water as a result of evaporation, as evidenced by increased mineralization (36.5g/l), which is not typical of the waters of this zone, and the value of B/Ce_{104} , equal to 506, while in the waters of the Damirchi and Astrakhan mud volcanoes this ratio is much higher: 2587 and 3880, respectively. The water of the Cheylakhtarma mud volcano is concentrated, apparently, 2-3 times. Zone II is characterized by a boron content of 300 to 400 mg/l and is widespread in the northwestern and central parts of the Shamakhi-Kobistan region. Zone III with a boron content of 200-300 mg/l also covers a small group of volcanoes studied: Sundi, Hayrantekyan, Bahar, etc. Thus, the analysis of boron distribution showed that its maximum content is observed in the waters of the mud volcanoes of the Shamakhino-Kobystansky district and has a fairly pronounced tendency to decrease from the northwest to the southeast in the direction of increasing the general salinity of the waters and reducing their alkalinity. In the Prikurinsk region, there is a further decrease in boron content, but up to a certain limit to the south, the concentration of boron increases in the brines of mud volcanoes Byandovan, Duzdag. BROMINE is also distributed unevenly in the waters of Azerbaijan, but the limits of fluctuations in its concentrations are much narrower: 18.6 – 189.1 mg/l. The lowest bromine content (less than 50 mg/l) is characterized by the waters of mud volcanoes in the northwestern and central parts of the Shamakhi-Kobyst region: Astrakhan, Damirchi, Western Sheitanud, Sundi, Cheildag. and others. The area comprising these volcanoes stretches in a strip from Damirci in the extreme northwest of the region to Utalga in the southeast, in accordance with the decrease in water mineralization in this direction, as mentioned above.

IODINE. Even smaller amounts (6.6—65.4 mg/l) contain iodine in the waters of mud volcanoes in the studied area. It was not possible to establish any patterns and its distribution across the

region. Its maximum concentrations (more than 50 mg/l) were found in waters of various mineralization and types. In general, the ratio between boron, bromine, and iodine in the waters of mud volcanoes in Azerbaijan is different, and this difference is due to the chemical composition of the resulting waters. STRONTIUM . Strontium was found in amounts from 0.10 to 207.87 mg/L , with an average of about 10 mg/l. The waters of mud volcanoes in almost the entire territory of the Shamakhi-Kobyst region are characterized by the lowest concentrations of strontium (up to 5 mg/l). Only in the waters of the Lirdag, Shakihan, Utaalchi, and Solakhai mud volcanoes, distributed in the eastern part of the region, the strontium content increases to 10 and even 15 mg/l. The highest strontium concentrations (more than 20 mg/l) were found in the sedimentary waters of the Prikurinsk depression.

Conclusion:

Thus, the analysis of the actual material shows that the waters of mud volcanoes mainly belong to the sodium bicarbonate type with a mineralization of about 15-20 g/l. The most characteristic basic and microelement composition of waters in the regional plan are the following: a) there is a decrease in mineralization in the direction from the northwest to the south; b) in the same direction, the waters of the bicarbonate –chloride-sodium composition are replaced by chloride – bicarbonate – sodium, finally in the southernmost part of the territory they become chloride – sodium. c) these changes are accompanied by a decrease in the contents of boron and lithium in the waters and carbon dioxide in the gases of mud volcanoes and an increase in the concentration of bromine and strontium.

In general, the mud volcanic waters of Azerbaijan are characterized by a fairly diverse composition, which indicates that they belong to different aquifers and have different degrees of post-sedimentation changes.

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