Impact Factor:					
	ISRA (India) = 6.317	SIS (USA) = 0.912	ICV (Poland) = 6.630
	ISI (Dubai, UAE) = 1.582	РИНЦ (Russia) = 3.939	PIF (India) = 1.940
	GIF (Australia) = 0.564	ESJI (KZ) = 8.771	IBI (India) = 4.260
	JIF = 1.500	SJIF (Morocco) = 7.184	OAJI (USA) = 0.350

SOI: 1.1/TAS DOI: 10.15863/TAS

International Scientific Journal

Theoretical & Applied Science

p-ISSN: 2308-4944 (print) **e-ISSN:** 2409-0085 (online)

Year: 2024 **Issue:** 04 **Volume:** 132

Published: 08.04.2024 **http://T-Science.org**

Issue Article

Badri Mkheidze
Georgian Technical University
Institute of Hydrogeology and Engineering Geology,
Head of Hydrogeology Department,
Principal Researcher, Ph. D., Tbilisi, Georgia

Zurab Kakulia
Georgian Technical University
Institute of Hydrogeology and Engineering Geology,
Principal Researcher, Ph. D., Tbilisi, Georgia

Avtandil Songhulashvili
Georgian Technical University Institute of Hydrogeology and Engineering Geology
Researcher, master's degree Tbilisi, Georgia

Inga Nanadze
Georgian Technical University Institute of Hydrogeology and Engineering Geology
Researcher, master's degree Tbilisi, Georgia

Manana Kopadze
Georgian Technical University Institute of Hydrogeology and Engineering Geology
Researcher, master's degree Tbilisi, Georgia

Lasha Khvichia
Georgian Technical University Institute of Hydrogeology and Engineering Geology
Analytical Chemist, Master's degree, Tbilisi, Georgia

Ludmila Glonti
Georgian Technical University Institute of Hydrogeology and Engineering Geology
Senior Researcher, Ph. D., Tbilisi, Georgia

ABOUT THE CHEMISTRY OF GENESIS AND HYDRODYNAMICS OF MINERAL WATERS OF THE SOUTHERN SLOPE OF THE CAUCASUS

Abstract: *The present paper shows, on the one hand, a close relationship between the genesis of the chemical composition of the carbonated mineral waters of the southern slopes of the Caucasus and hydrodynamic processes, and, on the other hand, between the lithology and tectonics of the rocks of the region. In particular, alkaline or the so-called sodic waters are formed in Lower and Middle Jurassic shale strata, alkaline-saline ones - in Bajocian volcanic-sedimentary formations, and saline-alkaline and partially alkaline-saline ones - in Upper Jurassic - Lower Cretaceous carbonate flysch. Due to the lithological features of the region, the circulation of mineral waters takes place mainly in fractured, fractured-veined and fractured-porous aquifers.The dischargeof these waters almost entirely depends on the flow of carbon dioxide and the so-called "gas-lift" effect.*

Key words: *Caucasus, carbonated waters, genesis, hydrodynamics.*

Language: *English*

Citation: Mkheidze, B., et al. (2024). About the chemistry of genesis and hydrodynamics of mineral waters of the southern slope of the caucasus. *ISJ Theoretical & Applied Science, 04 (132),* 150-153.

Soi: http://s-o-i.org/1.1/TAS-04-132-14 ***Doi***: https://dx.doi.org/10.15863/TAS.2024.04.132.14
Scopus ASCC: *1906.*

Introduction

According to the concept of modern geotectonic division, the southern slope of the Caucasus is a fold system of the Caucasian segment of the Alpine-Himalayan mobile belt [1]. The hydrogeological peculiarities of theyoung fold tectonic unit, along with other factors, are determined by the nature of its geological structure.

The southern slope is distinguished by the abundance of exit points of carbonated mineral waters of different chemical composition. Since the end of the 19th century, researchers have become interested in them. Mainly, the springs that were relatively easy to access have been studied. S. Chikhelidze [2] collected the related material availablein the printed sources and geological funds, added the results of his own research and published them as one paper in 1961.

A long time has passed since the on-site research of mineral waters of the region was conducted. During this time, as a result of natural events and human economic activities, it is not excluded that in some cases the location of springs and the chemical composition of waters have been changed. Considering the abovementioned, in 2018-2022 we conducted a monitoring study of the mineral waters of the region. Correspondingly, it was found out that: a) as a result of landslides or floods several springs were covered with proluvial or alluvial material; b) Gas-saturated mineral water flowed from boreholes dug for different purposes, and sometimes even erupted in the form of a fountain (borehole in the valley of the river Nakra (Fig. 1)).

Figure 1. The Borehole in River Nakra Valley.

The gaseous component of the mineral waters of the southern slope is represented only in the form of carbon dioxide [3, a]. As it is known, when CO_2 dissolves in water it forms carbonic acid that is considered to be a weak acid. However, it has sufficient power to precipitate sedimentogenic salts from sedimentary rocks and to leach chemical elements, primarily sodium, from the friction material in faultzones. As a result, the infiltration fresh water becomes mineralized.

The chemical composition of the mineral waters of the region is determined after carbon dioxide passes through them.The saturation of infiltration waters with CO_2 leads to the intensification of the leaching of rock layers and the processes of precipitation of the absorbed complex. As a result of leaching mainly sodiumcan enter the groundwater through finely dispersed (shale) fissured rocks, as well ascalcium, magnesium, and rarely iron through porous fissured ones (stones, carbonates, etc.); through the precipitation of the absorbed complex from the porous rocks mainly chlorine and sodium are transferred into the water.

A close relationship between the chemism of mineral waters and the lithology of geological formations is clearly revealed, especially in waters of medium mineralization (5.0 - 15.0 g/l). The following regularities have been found: a) Alkaline or soda waters (with $NaHCO_3$ content more than 75% eq.) are almost all related to Lower and Middle Jurassic shale

strata; b) Alkaline-saline waters (with approximately equal content of HCO_3 and NaCl) -to Middle Jurassic (Bajocian) volcanogenic-sedimentary formations and c) Saline-alkaline waters (NaCl> HCO_3) -to the Upper Jurassic-lower Cretaceous carbonate flysch. Of course, there are exceptions. In particular, in places where there are layers of sandstones in the shale stratum. Sedimentogenic NaCl gets into ground water. Less mineralized (M<3.0 g/l) waters associated with carbonate flysch, they are mostly calcium or calcium-magnesium.

As a result of the mixing of medium mineralized waters with groundwater, the quantity and flow rate of low mineralized waters of various chemical composition often exceeds the quantity of the first ones.

It should be noted that within the fold system of the Caucasus southern slope, bad hydrogeological conditions have developed for the circulation of underground waters. This is caused, on the one hand by low filtering properties of the rocks and on the other hand by intensive sedimentation and disturbance of geological formations, in which layers are often overturned. Here, the integrity of the layers and the alternation of water-permeable and waterproof horizons, characteristic of "quiet" folded zones, are broken, and therefore there is no place for the circulation of pressurized groundwater.

The presence of fissure, fissure-vein and porous-fissure reservoirs in open hydrogeological structures determines the nature of the hydraulic processes of the region. Discharge of deep circulating groundwater (flowing to the surface of the earth) occurs in fault and shear zones, especially at fault junctions. The upward circulation of groundwater in the South Slope fold system is entirely dependent on the abundant flow of CO_2. The water-gas suspension formed during their mixing flows to the surface due to the “gas lift” effect.

From the hydrogeological point of view, the southern slope has unfavorable conditions for the infiltration and circulation of the groundwaters, which is caused, on the one hand, by the low water permeability of the rocks of the region and, on the other hand, by the intense folding and disjunctive disturbances of the geological formations. Here the layers are often upside-down (overturned), and sometimes they are recumbentwith transverse-slip and oblique-slip faults. Based on the lithological characteristics of rocks fractured, fractured-veined and fractured-porous aquifers (water-bearing horizons) can be observed here.

Natural exit points of mineral waters in the region are usually associated with fault zones, especially with the knots of intersecting faults.The upward movement and surface runoff (discharge) of these waters is almost entirely due to the abundance of deep carbon dioxide in the fold system of the Southern Slope.The specific weight of the suspension formed as a result of the saturation of mineral water with CO_2 is <1.0 t/m^3, and it appears in the form of an ascending spring due to the natural "gas-lift" effect.

Due to the special role of carbon dioxide in formation and distribution of mineral waters of the region, the issue of its genesis cannot be ignored. Earlier it was stated that CO_2 is of abyssal origin.This is true, but the source of its formation is unclear. A. Vinogradov expressed a more or less justified opinion on this issue [4]. He believed that carbon enters the earth's crust as a result of global processes of mantle degassing.

As mentioned above, exit points of CO_2-saturated waters are spatially linked to fault zones. Particularly intense gas flow is observed in the areas of magmatism centers of Tertiary, often of Holocene period. Such as: the effusives of Keli Plateau, the cones of extinct volcanoes preserved in the form of peaks (especially in the upper reaches of the Terek River). It seems that on the southern slope of the Caucasus we have CO_2 of two origins: the first one - coming from the mantle, andthe second one -released from carbonaceous rocks as a result of contact metamorphism. Based on previously conducted carbon isotope studies, it was concluded that most of the carbon associated with the carbonated waters of the region is of the mantic origin, while the ones of the metamorphic origin are relatively small in number and are represented locally only [3, b].

Mineral waters of the southern slope are very attractive in terms of consumption due to their chemical composition, which determines their pleasant taste and medicinal properties. The analogues of the approved mineral waters, such as “Borjomi”, “Sairme”, “Essentuki” can be found here [5]. Some of them were bottled ("Utsera", "Kazbegi", etc.). Several balneological resorts operated here as well. Currently, the level of using valuable natural resource of the region – carbonated mineral waters – is very low. The industrious businessman can bring a lot of benefits both to himself and to the region. Along with mineral waters, there are excellent natural conditions for establishing balneological resorts and creating a wide network of mineral water bottling enterprises.

Finally, based on the actual identical nature of the geological structure and the history of the development of young-fold systems, it can be assumed that the regularities of the chemistry of genesis and hydrodynamics of carbon dioxide mineral waters of the southern slope of the Caucasus- of one of the components of the Alpine folded belt, are the same for other zones of this belt.

References:

1. Gamkrelidze, E. (2013). *Geological Structure and Development. Monogr: Geography of Georgia.* Tbilisi University", Tbilisi, 55-73 (in Georgian).
2. Chikhelidze, S. (1961). Mineralnye vody Gruzii, Prirodnye resursy Gruzinskoi SSR. *Academia Nauk SSSR*, Moskva, **3**: 40-439 (in Russian).
3. Buachidze, G., & Mkheidze, B. (1989). *Prirodnye gazy Gruzii*. Metsniereba, Tbilisi: a) 42-60; b) 107-121 (in Russian).
4. Vinogradov, A. (1964). Gazovyi rejim Zemli. Kimia zemnoi kory, *Academia Nauk SSSR*, Moscow, 3:167-181 (in Russian).
5. Mkheidze, B. (2001). *Structural-hydrogeological Characterization of Prospective Deposits of Mineral Waters of the Southern Slope of the Caucasus.* Proceed.: "Problems of Hydrogeology and Engineering Geology of Georgia", Publ. “Metsniereba”, Tbilisi, 19-37 (in Georgian).