Ivane Javakhishvili Tbilisi State University
Vakhushti Bagrationi Institute of Geography

Scientific Conference

ACTUAL PROBLEMS OF GEOGRAPHY

Dedicated to Prof. Davit Ukleba's
100th anniversary

5-6 November, 2019, Tbilisi

Actual Problems of Geography

გეოგრაფიის აქტუალური პრობლემები

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Karst Caves Origination Conditions in the Zemo Imereti (Chiatura) Structural Plateau, Georgia

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Abstract

Zemo Imereti structural karst region comprises the easternmost part of the limestone strip of Georgia and it is the only platform karst region in Georgia. The peculiarity of the relief of the mentioned plateau, namely, dense and deep (100-250 m) fragmentation, sharp distinction of plateaus, their altitudinal (400-800 m above sea level) distribution, plain surfaces (6-12° sloping), as well as the climatic conditions, positive annual balance of runoff and hydrological regime along with the structural-tectonical conditions of substrate constructed karstified rocks creates favourable conditions for karst development. Unlike the geosynclinal karst zone of Georgia, formation of the mentioned region proceeded under the platform conditions. Existence of this solid platform stipulated the relatively simple tectonic structure of Zemo Imereti Plateau; namely, smooth subhorizontal layout of Cretaceous and Tertiary suites over the Hercynian platform and dominated distribution of stratification fissures, which stipulated formation of hydrodynamic zones and wider development of subhorizontal caves (80% of caves are subhorizontal). Karst caves in the Zemo Imereti Plateau are the product of the evolution of hydrodynamic zones significantly. The evolution starts from Pliocene and is still underway. During this long process the hydrodynamic zones are under the permanent changes: dying-drying of upper zones and conceiving-watering of lower zones. Post-Sarmatian intensive ascending tectonic movements and short-term delay epochs mainly stipulated the storey distribution of represented caves and wide distribution of tunnel type caves. Correlation of relative heights of caves levels and terrace stairs, as well as the absolute heights of caves entrances and karst sources outlets lets us assume that there should be at least 4-5 slow down epochs of ascending tectonic movements.
Key words: platform karst, stratification fissure, subhorizontal karst, caves

Introduction

The Zemo Imereti Plateau's karst region includes the easternmost part of the western Georgia's limestone strip and represents the only platform karst region in Georgia. Morphologically Zemo Imereti Plateau is a structural plateau [1,2,3].

From the relief point of view, the study area significantly differs from the other massifs of Georgia's karst strip and includes a central, relatively high part of the intermountain plain of Georgia. The main part of the plateau surface is located at the height of 500-800 m above sea level. It is characterized by the deep river valleys and the peculiar soft relief of watershed areas. The uniform surface of the plateau is dissected by the Kvirila River and its tributaries (Jruchula, Nekrisi, Bogiristskali, Rganisghele, Katskhura, Buja, Sadzalekhevi and others) deep canyon gorges (100-300 m) and represents relatively small sloped plateaus with plain surfaces.

The boundary of the kart's region of the Zero Imaret structural plateau coincides with the surface contact line of the Cretaceous limestone's with older formations (Bajocian porphyritic suite in the north and east, and the Middle Paleozoic granitoids in the south and west), which is the geological substrate of karst. The Zemo Imereti Plateau is built of the Upper Cretaceous limestones stretched on the Dzirula crystalline massif, which in turn is covered with Tertiary and clay-sandy deposits (Fig. 1). It should be noted that at present the study area is distinguished by the amount and density of karst cavities (more than 120 caves) and the total length of the caves (more than 20 km^2) among the speleological regions of the foothills and intermountain plain of Georgia.

Zemo Imereti (Chiatura) structural plateau is a classic region of deep fragmentation of relief with its deep canyon gorges. This circumstance, obviously has an influence on intensity of karst processes and formation of morpographical peculiarities of speleo-objects; this is because the evolution fissure-karst waters hydrodynamic zones of the region was performed on the background of plateau surface vertical dissection and the gradual lowering of the erosion basis accordingly, as well as the intense depth circulation of waters.

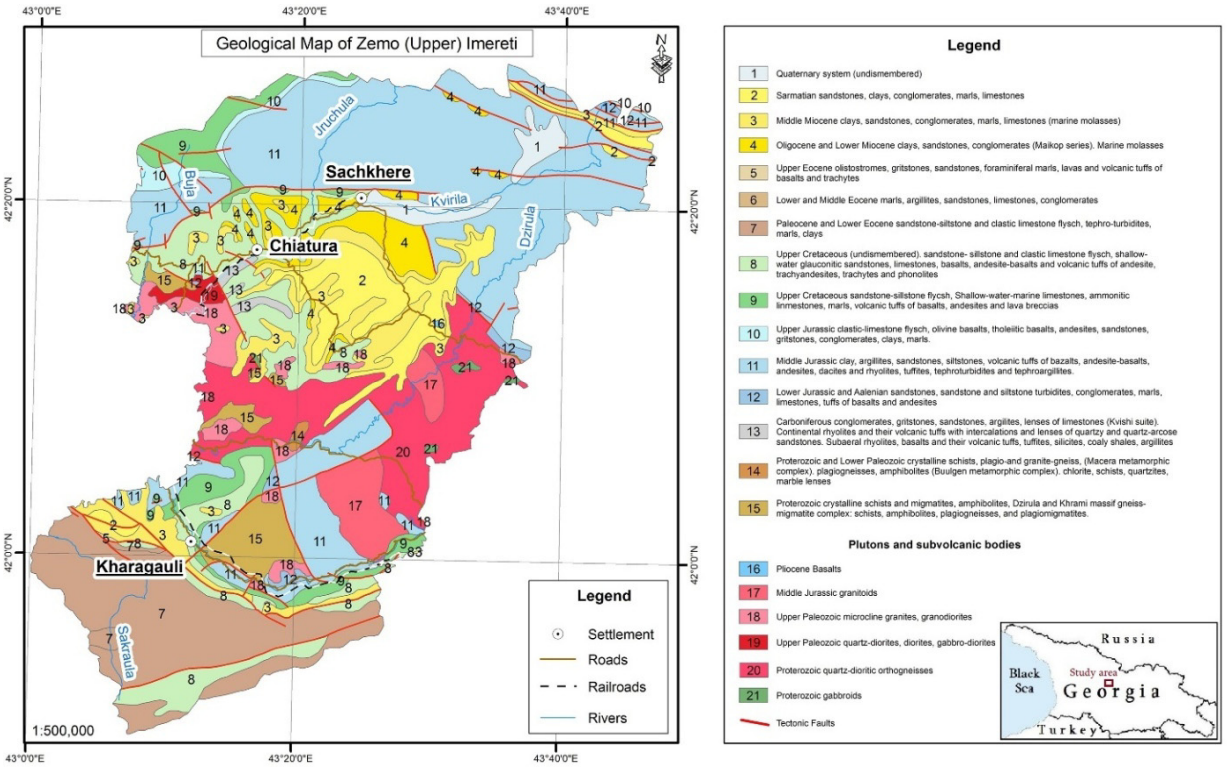

Fig. 1. Geological map of the Zemo Imereti Plateau [4]

The clear evidence is that the vast majority of the caves are opened on the slopes of the river gorges and are often located at different altitudes from the river thalweg. The length of the caves rarely exceeds 1 km. This is the result of a stronger fragmentation of the relief. Activation of karst processes are related to the fragmented areas of the relief - gorges, dingles and dead gorges, the dense network of which is presented within the plateu.

Methods and Materials

In the course of the research, field geomorphological and karst-speleological large-scale surveying of the study area was carried out. Based on the field surveys and large-scale topographical maps, we compiled the maps of the sloped surfaces of the Zemo Imereti Plateau, its hypsometric steps, density of the relief fragmentation and distribution of karst objects. Their analysis enabled us to identify close links between the distribution of karst forms and the above-mentioned relief characteristics.

On the basis of indicator tests (water trace method) a single karst-hydrological system (the Ghrudo hydrogeological system) and individual isolated underground karst flows have been detected.

In the Zemo Imereti Plateau, 4-5 delayed epochs of tectonic movement were distinguished on the basis of the correlation of relative heights of the cave tires and terraced steps as well as the absolute heights of cave entrances and karst sources outlets developed in the river gorges of the study area.

Results and Discussions

The key impact on the karst processes has the inclination of the surface of the relief that stipulates the peculiarities of infiltration and influation of atmospheric precipitations, duration of water impact on karstified rocks, etc.

The experiments carried out by S. Fiodorov (1950) identified that the total value of infiltration is largest (in this case the most favorable conditions for karst development) on slightly sloped (5-10°) surface and decreases with the increase of relief inclination.

The surfaces of 6°-12° inclination located in the study area occupy significant area (600 km^2) and most of the forms of karst relief is associated with them [1]. Indeed, the plain and slightly inclined surfaces are distinguished with considerable distribution of corrie valley, karst sinkholes, wells, shafts and caves, which, along with other conditions, are the result of long-lasting impacts of atmospheric precipitations on slightly sloped surfaces. Such surfaces are favorable for area infiltration and influation of precipitations, which also leads to deepen karstification.

Based on the study of altitudinal distribution of the caves originated on the southern slope of the Greater Caucasus, it has been identified [5] that a significant (28%) part of the studied caves of western Georgia are concentrated within the 500-900 m interval. The plateau-like surfaces of the study area correspond to this step (500-800 m) with the ideal conditions for karst phenomena development. In addition, the snow cover appears and melts several times during winter in the above-mentioned hypsometric interval, and mostly the liquid atmospheric precipitations are common. It is promoted by the positive average temperature of January, which drops below zero higher than 800-900 m above sea level. Therefore, the favorable climatic conditions are created at the mentioned altitude for the formation of aggressive waters with low temperatures.

The region is provided with atmospheric precipitations throughout the year; e.g., Chiatura (1237 mm/year), Korbouli (1477 mm / year) (Tab. 1).

Tab. 1. Meteorological Elements of Zemo Imereti [6]

Weather Stations	Height above sea level, m	Air temperature, °C			Relative humidity		Annual cloudiness by general cloudiness, %	Precipitations, mm			Number of rainy days	Moisture coefficient
		Coldest month	Warmest month	Average annual	Driest month	Average annual		Summer	Winter	Annual		
Kharagauli	280	3,2	23,0	13,2	69	73	61	308	391	1366	161	1,9
Chiatura	348	1,8	23,2	13,0	–	–	–	224	345	1237	152	2,0
Sachkhere	415	1,3	22,6	11,7	69	76	65	172	284	904	140	1,9
Korbouli	793	-0,3	20,2	10,0	72	76	65	253	528	1477	161	2,1
Mt. Sabueti	1245	-3,9	16,2	6,3	79	83	70	226	327	1101	181	1,7

Based on the intercomparison of atmospheric precipitations and evaporation data [6], the balance of annual runoff can be found to be positive everywhere within the study area, which causes the active course of karst processes throughout the year, especially in the cold period of the year.

The structural-tectonic conditions of the substrate-building karstified rocks have a special role in the origination and development of the karst caves of Zemo Imereti Plateau. Unlike the geosynclinal karst zone of Georgia, the above mentioned region was formed in platform conditions. The existence of a solid platform caused a relatively simple tectonic structure compared to the Zemo Imereti Plateau; namely, the calm subhorizontal layout [7] (Fig. 2) of Cretaceous and Tertiary suites (with a common thickness of 500-550 m) located on the Hercynian platform and dominant development of layer fissures that stipulated the formation of hydrodynamic zones and extensive development of sub-horizontal caves (80% of the caves are sub-horizontal).

The study area is located in the vertical ascending area. The modern geomorphological cycle (origin and development of erosive, karst and other forms) in the upper Imereti Plateau and surrounding areas started after Miocene [8,9]. Post-Miocene tectogenesis was strong in the folded zone of the Caucasus, and the activity on the Zemo Imereti platform was largely reflected in vertical (epirogenetic) uplifting, accompanied by small faults and wavy folds of local importance.

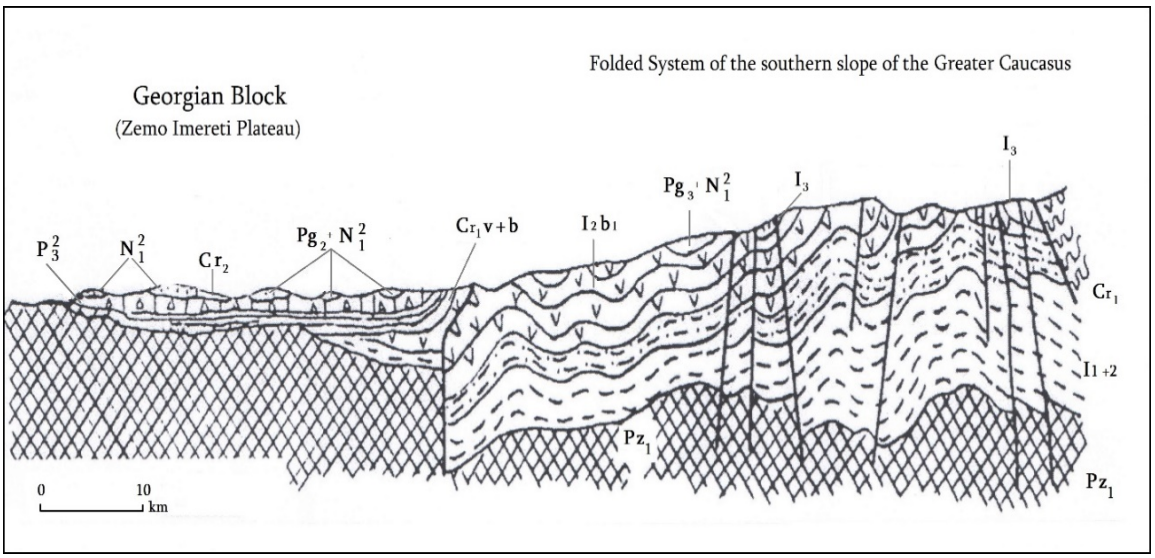

Fig. 2. Geological cross-section of the folded system of the southern slope of the Greater Caucasus and block of Georgia [7]

The Post-Miocene uplifting is still underway in the study area. Neotectonic movements have played an important role in the evolution of erosive fragmentation and karst-origination processes, as well as the evolution of vertical hydrodynamic zones of fissure-karst waters. Along with the ascending tectonic movements, the rivers have developed deep canyon valleys that created favorable conditions for the depth circulation of waters. The wide distribution of disjunctive dislocations on the Zemo Imereti plateau has defined the formation of independent streams, which common base is the Kvirila River. In addition, individual karst caves and vaucluse sources channels formed in the early stages were unified into the hydrogeological system of Ghrudo, which was confirmed by our indicator tests [10,11,12,13] (Fig.3). It is still impenetrable, though the development of karst cavities is intense in its basins.

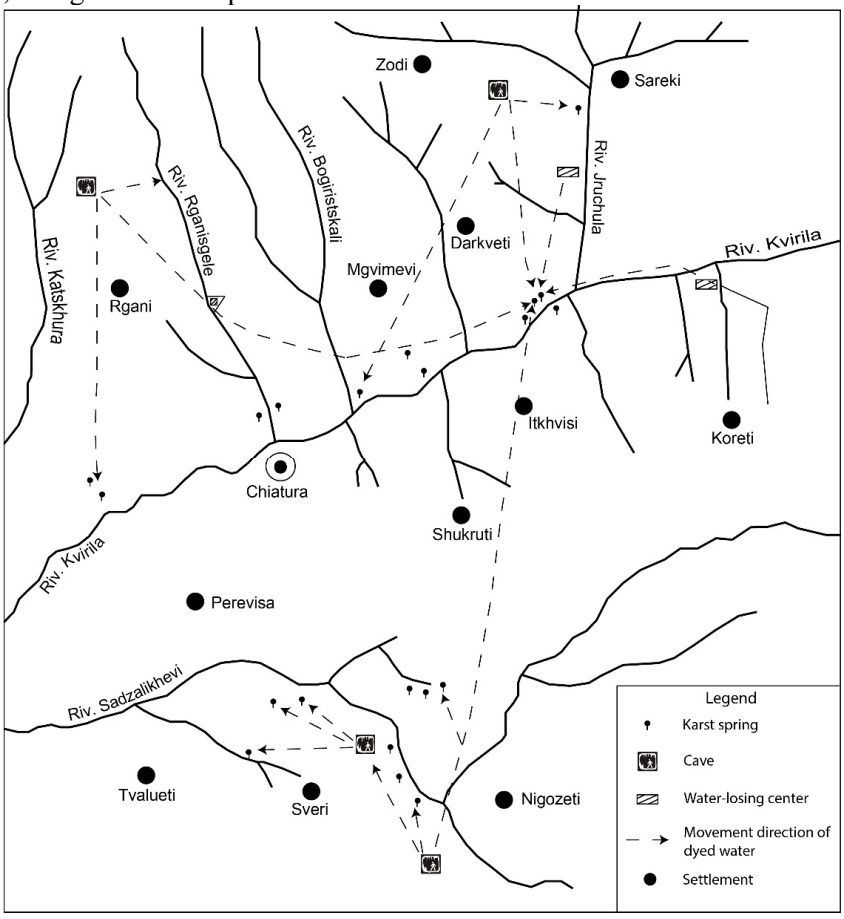

Fig. 3. Groundwater flow movement scheme obtained by indicator tests conducted in the Chiatura structural plateau

Ascending tectonic movements seem to be periodical and it was alternated with the epochs of delays; it is obvious by floor-like distribution of caves in the Kvirila, Jruchula and other river gorges (Fig. 4).

Fig. 4. a) Sameleklde and Taroklde caves; b) Jruchula cave

Here the caves in different stages of the evolution are located in 4-5 tiers. At the same time, the epochs of delays have been distinguished for a short duration, which is obvious by a wide distribution of undeveloped caves of tunnel (or hole) type and weakly (fragmentarily) terraced steps in river gorges.

Conclusions

Considering the analysis of the actual material, the dominant distribution of sub-horizontal caves in the layered limestones on the Zemo Imereti Plateau can be explained by widely distribution of layered fissures. Opening of mentioned fissures are related to the discharge of internal tension in the rocks, which is caused by washing of higher located limestone suites located and deep erosion dissection of the massif. Along with the layered horizontal fissures the wide distribution of inter-suites vertical fissures is also notable (especially in the suites near the surface), which karstification leads to the development of the steps of lower heights in caves.

Thus, the calm layout of suites on the Zemo Imereti structural plateau identifies the long-term impact of water on the rocks along the layered fissures, while the inter-layer vertical fissures lead to development of corridors from cavities, as well as the penetration of waters into the fissures of the lower located horizontal suites. This fact should have been caused such a large distribution of multi-storied caves with steps on the Zemo Imereti Plateau.

Archaeologically dated cultural layers in the caves of the study area, and especially the litho-bio-stratigraphical analysis [3] of the cave terrigenous sediments (pelitic-alleurolitic mass) carried out by us, gave us the opportunity to identify the cave age. Sedimentation of terrigenous sediments located today at a higher hypsometric step in the Zemo Imereti Plateau began in the Middle-Upper Pleistocene, and the formation of the above-mentioned caves was mainly completed. At the last stage of the modern geomorphological cycle (in Holocene), temporary flows are an important factor that actively participates in the formation and expansion of underground cavities.

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ზემო იმერეთის (ჭიათურის) სტრუქტურულ პლატოზე კარსტული მღვიმეების წარმოშობის პირობები, საქართველო

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[2] საბუნებისმეტყველო მეცნიერებისა და ინჟინერიის სკოლა, ილიაუნი, თბილისი, საქართველო

რეზიუმე

ზემო იმერეთის სტრუქტურული პლატოს კარსტული რაიონი მოიცავს დასავლეთ საქართველოს კირქვული ზოლის უკიდურეს აღმოსავლეთურ ნაწილს და წარმოადგენს ერთადერთ ბაქნურ კარსტის რეგიონს საქართველოში. აღნიშნული პლატოს რელიეფის თავისებურება, კერძოდ, ხშირი და ღრმა (100-300 მ) დანაწევრება, პლატოების მკვეთრი გამოყოფა, მათი სიმაღლითი გავრცელება (400-800 მ), ვაკიანი ზედაპირები (6-120), ასევე კლიმატური პირობები, ჩამონადენის დადებითი წლიური ბალანსი და ჰიდროლოგიური რეჟიმი სუბსტრატის ამგებელი კარსტვადი ქანების სტრუქტურულ-ტექტონიკურ პირობებთან ერთად ფრიად ხელსაყრელ პირობებს ქმნის კარსტის განვითარებისათვის.

საქართველოს გეოსინკლინური კარსტული ზონისაგან განსხვავებით, აღნიშნული რეგიონის ფორმირება ბაქნურ პირობებში მიმდინარეობდა. სწორედ მყარი ბაქნის არსებობამ განაპირობა ზემო იმერეთის პლატოს შედარებით მარტივი ტექტონიკურია გებულება. სახელდობრ, ჰერცინულ ბაქანზე განლაგებული ცარცული და მესამეული წყებების წყნარი სუბჰორიზონტალური წოლა და დაშრევების ნაპრალების გაბატონებული განვითარება, რამაც ხელი შეუწყო ჰიდროდინამიური ზონების ფორმირებას და სუბჰორიზონტული მღვიმეების ფართო განვითარებას (მღვიმეების 80% სუბჰორიზონტულია). კარსტული მღვიმეები ზემო იმერეთის პლატოზე მნიშვნელოვანწილად ჰიდროდინამიკური ზონების ევოლუციის პროდუქტს წარმოადგენს. ეს ევოლუცია ზედა პლიოცენიდან იწყება და დღესაც გრძელდება. ამ ხანგძლივი პროცესის მანძილზე ჰიდროდინამიკური ზონები განიცდიან მუდმივ ცვლილებას: ზედა ზონების კვდომა-გამშრალებას და ქვემოთ განლაგებული ზონების ჩასახვა-გაწყლიანებას. სარმატული საუკუნის შემდგომ განვითარებულმა ინტენსიურმა აღმავალმა ტექტონიკურმა მოძრაობებმა და მცირე ხანგრძლივობის მქონე შეყოვნების ეპოქებმა ძირითადად განაპირობა აქ წარმოდგენილი მღვიმეთა სართულებრივი განლაგება და გვირაბის ტიპის მღვიმეთა ფართო გავრცელება. მღვიმეთა დონეების და ტერასული საფეხურების შეფარდებითი სიმაღლეების, აგრეთვე, მღვიმეთა შესასვლელების და კარსტული წყაროების გამოსასვლელების აბსოლუტური სიმაღლეების კორელაცია საშუალებას იძლევა დავუშვათ, რომ აღმავალ ტექტონიკურ მოძრაობათა შენელების ეპოქა სულ ცოტა 4-5 მაინც უნდა ყოფილიყო.

Reference

[1] Lezhava Z. The Karst of Zemo Imereti Plateau and Its Surrounding Areas. Publishing House Universali, Tbilisi, Georgia. 2015. (In Georgian).
[2] Lezhava Z., Tsikarishvili K., Asanidze L., Chikhradze N., Chartolani G. and Sherozia A. Karst Relief Development History of Zemo Imereti Plateau. Georgia, Caucasus. Open Journal of Geology, 9. p. 201-212. 2019.
[3] Asanidze L., Chikhradze N., Lezhava Z., Tsikarishvili K., Polk J., Chartolani G. Sedimentological Study of Caves in the Zemo Imereti Plateau, Georgia, Caucasus Region. Open Journal of Geology, 7, 465-477. 2017.
[4] Gudjabidze G, E. Geological map of Georgia, Scale 1:500 000. (Editor: Gamkrelidze et al.). GeorgianState Department of Geology and National Oil Company Saqnavtobi. Tbilisi, Georgia. 2003. (in Georgian).
[5] Tintilozov Z, K. Karst caves of Georgia (Morphological analysis). Tb. 1976.
[6] Javakhishvili S, h. Climatography of Georgia. Tbilisi. 1977.
[7] Gamkredidze P, D. The structure and development of the western part of the southern slope of the Greater Caucasus and the Georgian block. Geotectonics, № 4, Tbilisi. 1969. (in Russian).
[8] Maruashvili L, I. Modern relief and geomorphological history of the Zemo Imereti Plateau. Works of the Vakhushti Institute of Geography of the Academy of Sciences of Georgian SSR, vol. 10. 1958.
[9] Maruashvili L, I. Zemo Imereti Plateau. In the book: Geomorphology of Georgia, Tb. 1971.
[10] Lezhava Z., Gigineishvili G., Tintilozov Z. Study results of karst waters underground routes on Chiatura structural plateau. Vakhushti Bagrationi Institute of Geography. Scientific Summary Session, Tbilisi. 1989.

[11] Lezhava Z., Tsikarishvili K., Asanidze L., Bolashvili N., Chikhradze N., Chartolani G. Ecological investigation of karst weters in the central part of Georgia. Lap Lambert academic publishing. Germany. 2017.
[12] Lezhava Z., Bolashvili N., Tsikarishvili K., Asanidze L., Chikhradze N. Hydrological and Hydrogeological Characteristics of the Platform Karst (ZemoImereti Plateau, Georgia). 14th Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst. Rochester, USA. pp. 93-100. 2015.
[13] Lezhava Z., Gigineishvili G., Tabidze D., Tintiliozov Z., Kipiani Sh., Tsikarishvili K. The new data on karst-hydrogeological peculiarities of the Chiatura Plateau. Vakhushti Bagrationi Institute of Geography. Scientific Summary Session, Tbilisi. 1990.