



Karst of Georgia

6

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Abstract

This chapter reports a very diverse underworld of Georgia. The caves and cavities of Georgia have been attracted of human's attention from time immemorial. Very interesting scientific findings occurred in the process of studying the caves of Kudaro, Tsona, Jruchula, Dzdzuana, Tsutskhvati, Tskaltubo ("Tetra"), Satsurblia, and other caves. Even more impressive is the fact that out of ten karst abysses with the depth over 1000 m, registered in the area of the former USSR, nine are located in Georgia (Abkhazeti).

Georgia is one of the unique regions of the earth according to the distribution of the karst rocks. In Georgia all stages and sub-stages of the Upper Jurassic, as well as the Cretaceous system and the Lower Paleogene are being karsted, which is stipulated by the geological and geotectonic structure of the territory of Georgia and the history of its geological development. The underworld of Georgia is very diverse—karst caves

and abysses, with which people are connected from time immemorial. The karstified (relatively easily soluble in water) rocks, in which the cave abysses are formed, occupy more than 10% of the territory of Georgia (Asanidze et al. 2019, 2021). It is noteworthy that Georgia is one of the most outstanding countries in the world with the abundance of these wonderful phenomena (Lezhava et al. 2020, 2021).

The caves and cavities of Georgia have been attracted of human's attention from time immemorial. They are often referred to in ancient Georgian chronicles and literary monuments (Juansheri, Rustaveli, Sul Khan-Saba Orbeliani, Vakhushti Bagrationi, etc.), in foreign researchers and travelers' writings (Strabo, Archangelo Lambert, Dubois de Montpereux, Eduard Alfred Martell, etc.).

Karst relief of Georgia required a planned and systematic study and their economic development. For this purpose in 1958, the establishment of the Laboratory of Karstology and Speleology (Head—Dr. Shalva Kipiani) in the Vakhushti Bagrationi Institute of Geography of the Academy of Sciences of Georgia and the Speleological Commission (Chair—Acad. Niko Ketshkhoveli) at the Georgian Academy of Sciences Presidium, created the foundation for systematic research of geographic regularities of karst in Georgia.

The total length of surveyed and cadastered karst caves in Georgia is about 280 km, and the depth—90 km. Most of them (> 950) are located

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in Abkhazeti, in the limestone massifs of Bzipi, Arabika, Gumishkha-Psirtskha, Gumista-Panavi, and Tsebelda. At present, among the 500 sub-horizontal caves, 341 (68.2%) caves are of about 100 m long, 127 (25.4%) caves—within 100–500 m, 25 (5%) caves—501–2000 m and 7 (1.4%) caves—more than 2000 m long (Tsikarishvili and Bolashvili 2013) (Table 6.1).

Among them is the Europe-wide known Akhali Athoni Cave System, which was discovered in 1961 by Georgian researchers (Zurab Tatashidze, Shalva Kipiani, Arsen Okrojanashvili, Boris Gergedava, and Givi Smir), the initiator of complex survey and improvement project was the Institute of Geography. For this merit, a group of research scientists (Zurab Tatashidze, Shalva Kipiani, and Arsen Okrojanashvili) was awarded with the state prize of the USSR in 1977.

A large part of more than 500 registered horizontal caves is spread in the vicinity of the densely populated settlements of western Georgia. Such caves have always been of interest to a

person. Initially, it was conditioned by practical necessities: our distant ancestors used them for living, shelter, and later for the cult purposes. This is proven by the discovery of the early epoch stone age and the late feudal centuries human dwellings by Georgian researchers.

Very interesting scientific findings occurred in the process of studying the caves of Kudaro, Tsona, Jruchula, Dzudzuana, Tsutskhvati, Tskaltubo (“Tetra”), Satsurbliia, and other caves. These caves turned out to be the archaeological sites of world importance (Fig. 6.1).

In the Jruchula Cave, the rich archaeological material of Paleolithic time has been found, such as animal bones, knives, etc. In the front part of the Dzudzuana Cave, a dwelling of the Paleolithic human has been found. Later, in the cultural layers of the cave, the existence of 35–32,000 years old wild linen fibers was proven.

The remains of the Acheulean age found in the Kudaro and Tsona Caves were previously found only in the conditions of open-air,

Table 6.1 Georgia's longest (> 1000 m) first ten karst caves

Name of the cave	Limestone massif	The height of the entrance, m a.s.l	Total length (m)	Total depth (m)	Bottom area (m ²)	Volume, (m ³)
Mchishta vaocluse cavity	Bzipi-Khipsta watershed	30	> 20,000	83	–	–
Tskaltubo (“Prometheus”) cave system	Sataplia-Tskaltubo massif	147	> 15,500	–	91,520	684,850
Sakishore	Racha massif	1200	4500	20		
Akhali Athoni Cave System	Khipsta-eastern Gumista watershed	60	3285	189	50,000	> 1.5 million
Abrskili	Kelasuri-Kodori watershed	265	2500	10	19,100	95,500
Gega	Arabika	250	2250	155	9600	86,000
Usholta	Racha	1700	2150	–	10,700	43,000
Potoltsvena	Migaria	1100	1800	280		
Tkibula-Dzevrula	Rioni-Dzusa watershed	490–510	1635	220	5500	35,000
Kelasuri	Tsebelda	190	1400	25	2300	14,000
The Okrojanashvili Cave	Askhi	750	1300	15	6000	50,000
Koko Cave	Migaria	280	1000	5	2500	6500



Dzudzuana Cave entrance



Archaeological section in the Dzudzuana Cave

Fig. 6.1 Underground archaeological monuments of world importance (Photos by K. Tsikarishvili)

displaced by the wind and petrified. Such kind of a discovery and cave dwellings, in addition, at such a hypsometric altitude (1500–1700 m), are very few in the world. Tsona Cave (Fig. 6.2) is one of the caves located at highest altitudes above sea level (2100 m) in Europe that was the shelter for primitive hunters. As it turns out, the territory of Georgia was one of the most favorable regions of settlement for primitive humans.

During many enemy invasions, the Georgian people used caves on high rocks and inaccessible cliffs to save the important state documents, precious manuscripts, or nation's treasury. Vakhushti Bagrationi notes: "To the west of Rioni, at the foot of the mountain, is a Khomli's rock, very high. there is a cave carved in this rock, the inaccessible for enemy, the storage for the treasures of the kings" (Bagrationi 1997).

The Khvamli limestone massif, which is erected between the rivers of Tskhenistskali and Rioni (up to 2000 m), is distinguished by slightly inclined slopes toward the north and very high and effective cliff looking toward the south. This is the cliff, where the hanging streams have generated there several small karst cavities, including the legendary Khvamli Cave, which historically has been visited by a number of groups of robberies interested in grabbing the treasure (Janashvili 1904).

Scientists of the Vakhushti Bagrationi Institute of Geography (Zurab Tatashidze, Levan

Maruashvili, Shalva Kipiani, Tamaz Kiknadze, Jumber Jishkariani, Boris Gergedava, Kiazio Rakviashvili, Kukuri Tsikarishvili, Zaza Lezhava, and others) have contributed greatly to the study of the underground world of the Caucasus. They conducted important works to study the Akhali Athoni, Sataplia, Tskaltubo (Prometheus), and other cave systems that later became the basis for equipping these wonderful speleo-objects of nature for tourist purposes.

The discovery of the Akhali Athoni Cave (1961), its complex studies (1961–1988), and the ending of well-equipment works at the level of international standards (1975) resulted in a wide range of scientific and public resonance.

The Akhali Athoni Cave was opened for tourists in 1975 and became a popular monument in a short time (Fig. 6.3). With the number of visitors for 4 years, it has left behind the well-known caves of Europe and Asia (1976—804,447 visitors, 1977—821,041 visitors, 1978—786,500 visitors, and 1979—707,600 visitors) (Tintilozov (Tatashidze) 1983).

Speleotourism is originated in Georgia from the Famous Sataplia Cave, which was detected in the territory of the Sataplia Strict Nature Reserve, in the vicinity of Kutaisi in 1925 by Petre Tchabukiani, a tireless researcher of history and nature monuments. After discovering more than 200 footprints of dinosaurs in the vicinity of the cave, interest toward the Sataplia Cave has

Fig. 6.2 Paleolithic dwelling in the Tsona Cave (Photo by D. Tushabramishvili)



increased. By doing so he has made a great contribution to the promotion and development of speleology in Georgia. Today “Sataplia” is one of the most interesting and popular speleo-tourist monuments in Georgia (Tsikarishvili et al. 2015) (Fig. 6.4).

In summer of 1984, the speleo-team of Vakhushti Bagrationi Institute of Geography detected a previously unknown underground monument in the Kumistavi Village densely populated district of the Tskaltubo limestone massif, which turned out to be an interesting speleological object. The main entrance of the cave (known as “Tskvarami”) has been known from the earliest times, which has long attracted the attention of the specialists, but everything was ended by looking around a 60-m tunnel,

beyond which only the bats were able to reach the exit. In the next summer of 1984 (July 15), at the end of the hall, at the height of 2.7 m from the bottom of the hall, after widening and overcoming the 40 cm diameter oval hole in the clay stopper, the researchers got in the underground halls decorated with beautiful speleothems. Researchers were step-by-step patiently expanding the narrow passages filled out of clay and water stopper. Overcoming each barrier was ended up with the discovery of new and different size halls distinguished from each other by abundance of different shape speleothems.

What has been mysterious for millennia, has become available for visitors due to the great enthusiasm and devotion to Georgian researchers. The modern standards well-equipment works

Fig. 6.3 Line of tourists at the Akhali Athoni Cave entrance (1975) (photo by K. Tsikarishvili)



of Tskaltubo Cave has been completed in 2012. The speleo-objects located adjacent to the cave system (Solcotta, Satsurbliia, Orpiri, etc.) are of speleo-tourist and speleo-therapeutic importance, (Tatashidze et al. 2009a, b).

In the Akhali Athoni Cave, the most beautiful columns of long stalagmites, cypress-like stalagmites, calcite peculiar surfaces—“stony waterfalls”, stalactites of eccentric form, helictites of strange form (like a spring, question mark, circle, screw, etc.), luxurious „chandeliers” decorated with the carvings of speleothems, “Dry Spas”, decorated with the calcite crystals, the “underground workshops” of cave pearls and many others.

There are large stalagmites in the main and lateral corridors of Tskaltubo (“Prometheus”) Cave with the rows of finely sculptured stalactites

grown from the ceiling. Along with the snow-white and dark honey stalactites the black speleothems also attract attention. The calcite “castle-towers” are fantastic. The powerful columns of stalagmites made up of figures of various forms add really triumphal look to the halls. There is one more wonder of nature in the last part of the cave—the stalagmite of “Bermukha” (Fig. 6.5).

An interesting speleological discovery was made on the northern slope of the Nakerela Range, in the areas of so-called “Bangvalamdelo”. The entrance of the Muradi Cave opens on the slopes of the south-eastern exposition of one of the hills of the northern slope of the Nakerela Range, at an altitude of 1495 m above sea level, and has an arc shape. The width of the entrance is 4 m, and the height is 1 m. The 2nd floor of the

Fig. 6.4 “Giant stalagmite” in the Sataplia Cave (Photo by K. Tsikarishvili)



cave is rich in speleothems. The existing microclimate conditions (dry and humid sections, districts with cozy and air-sensitive mobility) and high-chemical soluble water jets and drops, which are mainly formed by infiltration and condensation, create favorable conditions for the intensive development of speleothems. This section contains almost all types and sub-types of water-chemogenic deposits, which are presented in the caves of Georgia (Fig. 6.6).

Here are presented stalactites, stalagmites, stalagnates, helictites, travertins of different sizes, forms, and colors, as well as calcite stony curtains and waterfalls, stony calcite “forests” and

“flowers”, underground lagoons and gours—with the water pools of miniature or important areas; also crystallized from water solutions—oolites, pizolites and cave pearls (Fig. 6.7).

Specific mineral aggregates are—limestone dough, lunar milk or stone milk, calcite stony plates, calcite layered sediments, calcite bark, and others. The calcite formations are found in the dry sections in dried or weathered form (Lezhava et al. 2016).

In some places, the scattered old fragmented boulders are covered by a thick layer of calcite and stalagmites, calcite miniature forests, flowers, and other forms are developed. One of the



One section of the "Tskaltubo" hall
("Prometheus" Cave)



Stalagmite "Bermukha" ("Prometheus" Cave)



The fragment of the "Solkotta" Cave



Eccentric stalactite in the "Bear" Cave

Fig. 6.5 Some cave formations (Photos by K. Tsikarishvili)

most interesting formations in the Muradi Cave is the peculiar mineral aggregates, so-called "limestone dough" and "lunar milk" or "stone milk". These forms are not often found in the caves of Georgia. In the Muradi Cave, as well as in the other caves, the noted mineral aggregates are mainly represented in humid corridors and tunnels and occupy miniature water pools and deep pits. Their origin is actively underway under the aggressive influence of condensation waters. Muradi Cave is unique and beautiful due to the eccentric round formations ("Rafaelo balls") formed from calcite aggregates—pizolites and oolites that do not have analogy in the Caucasus (Asanidze et al. 2017a,b,c) (Fig. 6.8).

In the future, it is important to consider their advanced laboratory study with the help of the relevant field specialists to determine the complete and convincing picture of the origin and growth of these unique, eccentric calcite round formations.

In Georgia, other similar and possibly even better monuments are expected to be revealed. One of the most promising underground phenomena of the planet is to be noted on the 3rd km from Sokhumi-Sochi central highway. The Mchishta powerful underground stream (Fig. 6.9), which erupts from the crack of the southern slope of the Bzipi Range, reliably protects its mysterious underworld so far.



Fig. 6.6 Underground Laguna in the “Muradi” Cave (Photo by L. Asanidze)

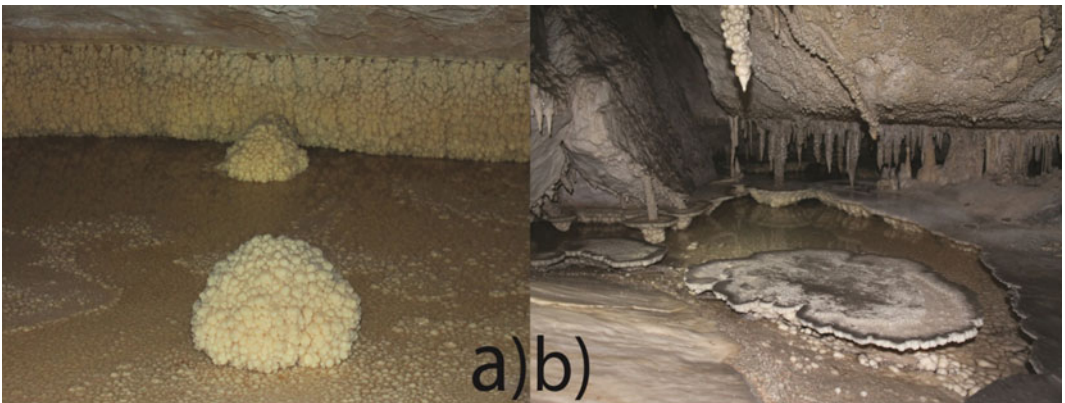


Fig. 6.7 **a** Pool calcite speleothems related to water table fluctuations; **b** Shelfstone type of speleothems formed around the edges of the small pool surface (photos by L. Asanidze)

The Mchishta powerful underground river (average annual discharge is $9.5 \text{ m}^3/\text{sec}$, maximum discharge— $197 \text{ m}^3/\text{sec}$) collects water from the vast high mountainous area of Bzipi limestone massif. Almost all of the underground waters of entire Bzipi massif are gathered in the Mchishta basin. Therefore, Mchishta and “Snezhnaya-Mezhennogo” abyss are the constituents of the same hydrogeological system. This system starts with the entrance shaft of

“Snezhnaya” (at 1960 m above sea level) and ends with the Mchishta powerful vaucuse exits (at 70 m above sea level). So, the relative difference between the surface water absorption and exit centers reaches 1890 m (Tatashidze et al. 1987, 1988).

According to the estimations of the Georgian researchers (Zurab Tatashidze, Levan Maruashvili, Givi Gigineishvili, Davit Tsitsishvili, etc.), the Mchishta underworld contains several



Fig. 6.8 Spherical stalactites in the Muradi cave (Photo by L. Asanidze)



Fig. 6.9 The Mchishta River powerful vaucluse stream

tens of kilometers long underground cavities filled by water and air (Tatashidze et al. 1989).

We have full bases to look at the future of speleological surveys very optimistically and realistically, moreover, out of the world's top ten

of the deepest karsts abysses five are in Georgia—the 1st and the 2nd places are shared by the “Veryovkina” (2212 m) and “Krubera” (2197 m) abysses, detected in the high mountain limestone massifs of Georgia.

Even more impressive is the fact that out of ten karst abysses with the depth over 1000 m, registered in the area of the former USSR, nine are located in Georgia (Abkhazeti) (Table 6.2).

The “Napra-Mchishta” (Bzipi massif) water content system studied in the Mchishta basin turned to be the deepest on the earth (2345 m). Similar karst hydro-systems are detected only in Mexico (2553 m) and China (> 2500 m) (Kiselev 1995).

At present there are single cave abysses in Georgia that are distinguished by grandiosity and magnitude. The following comparison gives us the vivid illustration of this fact: the total volume of more than 800 karst caves found in the well-studied speleo-region of mountainous Krimea is 1.5 million m³. The same volume has only the Akhali Athoni Cave in Abkhazeti. One more, the volume of 1500 caves (more than 5 million m³) revealed in the Middle Asia region at present, is almost as much as the volumes of Akhali Athoni and Snezhnaya Caves together (Tatashidze et al. 2002).

There are indeed excellent prospects of speleological research in Georgia. We have full bases to look at the future of speleology very optimistically and realistically, moreover, this fact in itself shows us the increased authority of Georgian speleology internationally.

The medium and high mountainous limestone massifs of Georgia's karst strip are also rich in

snow-icy caves. Especially should be noted the upper part of the “Illusion-Snezhnaya-Mezhennogo” Cave System, namely the “Snezhnaya”, the bottom of which (so-called “Large hall”) at 200 m deep is entirely occupied by the many centuries firm-ice cone of 60 thousand m³ volume. It is the only abyss on the earth, where the snow, firm, and underground glacier extend to such a great depth.

The following freezers are also notable in the “Vakhushti Bagrationi” (firm and ice—1300m³), “Giants” (800 m³), and “Marteli” (600 m³) abysses in the Arabika massif; “Boga” (Khvamli massive), “Skhvava”, “Khreiti” and “Nikorts-minda” freezers in the Racha massif, and the hanging meadow and freezer ‘s snowy wells in the Askhi plateau. A wide distribution of icy wells in the high limestone massifs of Gagra and Bzipi is also notable.

The icy caves are also found in the highland of southern Georgia, in the volcanic, lava, and dolerite rocks (Khorkhebi and Khizabavra Freezers), as well as on the southern slopes of the Caucasus, in the volcanic boulders (Sabatsminda and near Tskhinvali), and in Achara—in the so-called “Samkinvaroebi” (freezers) generated in limestones, etc. It is notable that ice and ice crystals in the natural freezers appear only on hot summer days.

In this regard, worth of interest is the “Khorkhebi Freezer” (Fig. 6.10) occurred in the large

Table 6.2 1000-m karsts abysses of Georgia (Abkhazeti)

No.	Name of the cave	Limestone massif	Height of the entrance a.s.l. (m)	Total depth (m)	Total length (m)
1	Veryovkina	Arabika	2309	2212	12,700
2	Krubera (Voronja)	Arabika	2320	2197	16,058
3	Sarma	Arabika	2200	1830	6370
4	Illusion-Snezhnaya-Mezhennogo	Bzipi	1960–2000–2390	1753	24080
5	Pantukhinskaya	Bzipi	1786	1508	7560
6	Ilyukhin	Arabika	2369	1275	5890
7	Moskovskaya	Arabika	2300	1250	1800
8	Arabika (Kuybyshevskaya)	Arabika	2240	1110	3250
9	Dzou	Arabika	2240	1090	6000

lava rocks (30–40 m³ volume) in Tetrtskaro region, in the areas of the village of Kldeisi, on the Bedena Plateau, as a result of the Upper Pliocene dolerite lavas, tectonic or gravitational processes.

The information about it comes from the first half of the eighteenth century.

According to Vakhushti: "... Khorkhebi is a cavity of the rock, which is warm in winter, as in the bath, and in the summer the springs flow from the rock; ... And the ice is pure and abundant, in summer they carry it for the King". Apparently, ice has occurred in great amounts in the past and has been widely used for medicinal and economic purposes (Tsikarishvili et al. 2010).

According to Vakhushti that local people also confirm, the ice is only occurs here on hot summer days.

Of the same origin is the Sabatsminda Freezer (Tskhinvali region), where the small ice crystals and thin ice plates emerge in the 2–3 m deep stone embankments on the background of accumulated snow-ice and low air temperatures in winter.

In Trialeti, in particular, in Tsalka region, in the Kizilkilisa River gorge (the right tributary of the Ktsia River), there are the freezers of similar origin, which are mentioned in Vakhushti's work too: "The Avladis-khevi (now known as Kizilkilisa River) conflows Ktsia from below from the

south, flows out from the gorge-deep ravine, it is cold or icy". And in the Ateni gorge, "there is a fortress on the high rock, built a bigger one, and in the south of the fortress, there is a freezer like a glacier, where the wine is seasoned". The cold air stream generates ice in the depth of the rocky material near the Ateni fortress during the summer. Historically, the Ateni Freezer was used as a wine storage.

The pit-freezers can be also found in Aspindza region (1.5 km away from the former village of Khiza), on the right bank of the Mtkvari River, in the 1.5–3.0 m deep debris of volcanic rocks, where the ice crystals are formed in summer like in other freezers.

The real wonders of nature are the Kurtskhana Freezers in the Adigeni region (16 km away from the place where the Kurtskhana River conflows the Abastumnistskali). In summer, in the boulders and small-sized cavities, the thick layers of ice appear on the bottom and along the walls and the icicles and various forms of formations appear in the fissures. The ice also melts there in winter.

In Achara, the natural freezers are known as the "samkinvaroebi" and are mostly represented in sandstones. Even here, the ice is formed in the summer and is melted in winter. Chanchkhalo Freezer is worth of interest in the Shuakhevi region, which has been used as storage for food products for a long time by the local population.



Fig. 6.10 "Khorkhebi Freezer" formed in the dolerite rocks (Photos by K. Tsikarishvili)

As it is assumed, the conditions of the origin of ice in the natural freezers depend on the peculiarities of the relief of the site and the climate of the surrounding area. In case of violation of one of the components, the favorable factors for the emergence of ice are also violated, due to which this remarkable creature of nature loses its importance, its natural rhythm is violated and the monument faces destruction.

These are the unique underground karst monuments—caves and cavities of Racha, Imereti, Samegrelo, and Abkhazeti. It is easy to imagine what an indelible impression it will be on the visitor. The beautiful underground “palaces” of Georgia should not be left without control. All this requires nationwide protection and care.

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