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Geography

Geomorphological Zoning of Okriba Karst

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(Presented by Academy Member Revaz Gachechiladze)

ABSTRACT. Karst caves (Sabero, Solkota, Satsurblia, Sakajia and Oghaskura) on the Tskaltubo limestone massif enclosed within the boundaries of Okriba karst were revealed and morphologically described. They were referred to four morpho-hypsometric zones: 1. middle mountainous; 2. low mountainous; 3. hilly karst massifs and 4. Colchis (Imereti) plane lowland. Four main karst massifs were analysed and dated. On the basis of analysis of detailed wide-scale field exploration a map of geomorphological zoning of Okriba karst was compiled. According to our scheme two zones of Karst occurrence were identified on the territory of Okriba: 6 karst regions and 19 subregions. Areas were calculated for all outlined regions and subregions. Karstic processes and karstic forms of the relief are presented by diverse plastics in the above listed karstic geomorphological regions and subregions, identified on the basis of individual geomorphological peculiarities. The present paper presents sketch map showing geomorphological zoning of Okriba karst. © 2018 Bull. Georg. Natl. Acad. Sci.

Key words: Karst, Okriba, zoning, Khvamli massif, Racha range, Tskhaltubo massif, Okriba-Argveti massif, karst relief

Okriba is Georgia's one of the most picturesque historical-geographic provinces of complex nature. There is a dual concept of its name and boundaries. 1. Okriba itself, or "inner (shida) Okriba" embraces hilly Okriba basin, located in the east of Rioni gorge up to Mukhuri pass, northern border of which is circumscribed by the basis of the southern slope of Khvamli-Nakerala range and southern border – by Okriba-Argveti hillock; 2. According to L. Maruashvili [1] western border of the "extended Okriba" coincides with the river Tskhenistkali, and eastern border - with the meridian of the river Chkhara (watershed of the rivers Tkibula and Dzusa), southern - with Imereti lowland along the Ghvankiti-Matkhoji parallel and the northern – with the bases of the southern slopes of north Khvamli-Nakerala range. We made certain adjustments only to the northern border of "extended Okriba", which was drawn along the basis of Khvamli-Nakerala limestone range, as the mentioned range is an outermost northern part of Okriba anticline elevation, which escaped erosion. By geology, geomorphology and landscape it stands closer to Okriba, than to the adjacent Racha-Lechkhumi Tertiary synkline basin, situated north of it. Famous botanists A. Grossheim, N. Kuznetsov, A. Kuthatheladze attributed Khvamli-Nakerala to the Colchis floristic province by floristic viewpoint. One more argument – as the limestone encirclement of the southern wing of

Okriba anticline, which escaped the erosion processes is considered to be the component of Okriba, inclusion of the encirclement of the northern slope, escaped from the erosion also seems quite logical. Total length of boundaries of the "extended Okriba" within the borders makes 200 km; its area equals 2000 km^2. Absoulute altitude ranges from 85 m (river Kvirila confluence) up to 2002 m (mount Khvamli or Shukura).

Of genetic types of relief structural erosion, accumulation, landslide-gravitational and karstic reliefs are presented on the territory of Okriba. Karstic relief is quite widely spread in Okriba, where zone of the occurrence of karstified limestones covers southern peripheral part of the Caucasus (Khvamli-Orkhvi-Tavshava-Tskhrajvari-Nakerala massifs), foothills of the northern Imereti (massifs of Okriba-Argveti-Tskalmechkhera and Chakhati-Tskaltubo). Forms characteristic of Okriba limestone karst are – caves, shafts, wells, chasms, tonnels, dolines of different types (among them "tskvarami caves", certain type of deep sinkholes, first described by Georgian speleologists) also bigger size karstic hollows of more complex genesis – uvalas (canyon-like formations on Kvhamli and Orkhvi-Tavshava-Nakerala) and poljes (karstic caves). Abundance of the latters was found on Tskaltubo-Sataplia massif, Orkhvi-Nakerala ridge and Okriba low mountains (Akhalsopeli polye). The shaft "Boga" of glacial origin, occurring on Khvamli plateau at 1710 m altitude, Sataplia and Navenakhevi caves, arranged for touristic routes, 12-13 tier perforating karst tunnel of Tsutskhvati are popluar touristic places. Of superficial karstic corrosion microphorms for naked limestones karst fields ("Karre"-s or "Schratte"-s), incised surface of the exposed limestones, the so-called limestone pavement, are common here, which are classically characteristic of Khvamli, Orkhvi-Tavshava and Nakerala ranges and also of the Chakhata Motsameta section on the southern declivious slope of the Godora mountain. According to N. Gvozdetskii Okriba karst, as well as Caucasus karst, does not belong either to mediterrannean or middle European types. It occupies an intermediate position between them, but some sections of Okriba may conventionally be attributed to the naked type karst (Khvamli, Orkhvi-Tavshava and Tskhrajvari-Nakerala southern cliffs) or covered type karst (coated with soil and vegetation) – Khvamli, Orkhvi-Tavshava-Nakerala plateaus, Samgurali-Sataplia limestone hillock and others.

Karst types of Okriba, according to hypsometric characteristics occur in four zones: middle mountainous (Khvamli, Orkhvi, Tavshava, Tskhrajvari-Nakerala massifs), low mountainous (Okriba-Argveti and Tskalmechkhera massifs), hilly (Tskaltubo limestone massif, Chakhata-Motsmeta-Nagarevi-Navenakhevi) and Colchis plane-lowland (Khomuli-Gumbra-Banoja, Kvemo Godogani, Eklara-Chognari-Khvakhchiri and others).

Of 23 main limestone massifs identified by L. Maruashvili in 1963 four are more or less enclosed in Okriba: 1. Khvamli massif (southern cliff and ridge), 2. western part of Racha range (Nakerala-Orkhvi section), 3. Tskaltubo massif, 4. Okriba-Argveti massif. Karstic overview of the mentioned massifs according to the main characteristics is presented below.

Khvamli massif is situated between the rivers Rioni and Tskhenistskali; from the west it is bordered with Saretskela rocky gate, from east – by Tvishi rocks. It represents a double cuesta. To Okriba belongs southern tall (2002 m ASL) cuesta built with thick layeres of lower Cretaceous limestones, which southern cliff oversees the whole Colchis. It is separated from the northern low-rise cuesta by the old gorges of Lakhepa-Tikhnara.

According to L. Maruashvili [2] Khvamli belongs to the medium mountain region of rapidly rising mountan karst zone. Tall southern cuesta of Khvamli morphologically consists of two parts: southern cliff and declivous plateau. Both represent a kingdom of different varieties of karstic

formations. Karstified area of Khvamli plateau makes 42 km^2, where in the regions adjacent to the ridge the limestone karst fields ("Karre"-s) and very deep dolines (referred by Georgian speleologists by the term "tskvarami caves") dominate. The latters perforate the whole strip adjacent to the crest. In the far northern part declivous surface of the plateau is dissected with the complex of longitudinally oriented uvalas. Their location follows the certain regularity, namely they are situated along the lines of fissures. All uvalas are distinguished with distinct morphology. One of them, directed towards the entrance of Boga shaft was named by us as "Boga's uvala". From the bottom of the second one the constant debet karst spring Ulevela outflows and, accordingly, it was given the name "Ulevela's uvala". In the forest zone of Khvamli plateau Tekenteri karstic well is situated, which entrance is through the hollow of a large beech tree and it spreads to the 16m depth. Height of the southern cliff of Khvamli (area 5 km^2) fluctuates within the range of 300-600 m, and length along the broken line makes 19-20 km. It is built with Low Cretaceous cracked limestones, which are slightly inclined to the northern direction. Specific peculiarities of the Karst in the cliff are determined by the three-tier cave complex, from which Japaridze's shelter (nabinavari), Pirghia, Verdzistava [1,3] and several others are well known [4]. Karstic fields ("Karre"-s) and systems of karstic-exotectonic fissures are also characteristic to the cliff. A giant stone block has detached from the southern cliff in December of 2012; dimensions of the separated limestone block by our visual determination exceeded10x15 meters.

Western part of **Racha range**, which is enclosed in Okriba (Nakerala-Orkhvi section), is situated between the gorge of the river Rioni and Mukhuri pass (karstified area makes 97 km^2). It spreads from the north-west to south-east to approximaltely 35 km and coincides with the western part of the range. Crest of Racha range is comparatively low and narrow here, where absolute altitude of the lowest site at Tvishi rocky gate makes 310 m, while its maximum altitude at Tskhrajvari attains 1569 m. It is built of lower Cretaceous thick layered limestones. Characteristic feature of the karst along the whole crest is domination of poljes-hollows ("Dzvelakho", "Sajinibo", "Gobsatibi", "Berebis satibi", etc.), which in their turn are riddled with secondary funnels and sinkholes (dolines, "tskvarami caves"). Height of the southern cliff on the mentioned section fluctuates from 150-200 m to 600-700 m (at Tskhtajvari, on the top of town Tkibuli). Of karst forms caves, niches, karstic field formations, karst-tectonic clefts, karstic-denudative heights (tower-like, cistern-like, column-like, and other strange shapes) are presented on the cliff. Of caves Orkhvi [1,5] and Tskhrajvari [1, 6] caves are known here.

Tskaltubo massif (with total area 272 km^2, karstified area arrpoximately 120 km^2), is situated between Rioni-Tskhenistkali, Kvamli and Colchis (Imereti) lowland and belongs to the karstic zone of the Caucasus foothills (altitude ASL 70-1000m). Presence of strong carbonaceous, karstable chemically pure limestones, abundance of clefts, small inclination of layers (inclination of karstified territory on the watershed of Semi and Kumistavi makes mainly 4-5^o), process of slow ascention, abundance of atmospheric precipitation (mean precipitation 1575 mm) and other factors create here optimum conditions for formation of the karst.

Direction of caves is determined by tectonic fractures of different character. Mostly tectonic clefts of south-west direction occur here (260-270^o), along which the main corridors of caves are directed. With sites of crossing of clefts big halls are connected (the length of one of the halls of Melouri cave makes 100m, width - 50m. Length of the hall in Bgheri cave exceeds 200 m, width 40 m, height fo ceiling is more than 25 m [7, 8].

Tskaltubo massif is a well defined morphological unit, which hilly relief is almost totally karstified. Its topographic surface is riddled

with more than thousand funnels and sinkholes ("tskvarami" caves), karstic wells, depressions-polyes, limestones karst fields ("Karre"-s), caves. According to data [2] Tskaltubo cave belongs to the Kvemo Imereti (Okriba) region of slowly rising hilly karst. In the karst type developed in slowly rising limestones of low mountain foothills he isolates Kvemo Imereti region and Tskaltubo-Sataplia subregion. Morphologically Tskaltubo massif represents a plateau, obliquely inclined towards Colchis lowland and dissected by karstic-erosive processis, to which are characteristic monocline hillocks and hills, naked cliffs (Samgurali, Sataplia, Banaketi, Matkhoji, Etseri, Ukimerioni), polje-like depressions (Banoja – 150 m ASL; Gumbra – 130m ASL; Tskaltubo II -140m ASL; Tskaltubo I – 130m; Kariobi II – 460 m ASL; Kariobi I – 440 m ASL; Msrali – 490 mASl; Lekouri -430m ASL; Sipighele -435m ASL; Gureshebi -340m ASL; Tskhunkuri – 256m ASL; Sataplia -216m ASL and others). Up to 55 caves have been discovered and more or less investigated on Tskaltubo massif so far. Among them the most important are: Tskaltubo cave (discovered by J. Jishkariani) [9], Solkota, Satsurblia, Sabero, Basila, Sarkumali, Sakajaia caves (discovered and morphologically analyzed by O. Chkheidze, A. Tvaltvadze and V. Gabelashvili) [10] and famous Sataplia caves, which is arranged for tourists' excursions. South-west of it, in 700-800 m distance the second Sataplia (Institute of Geography), the third Satapla and the forth (roadside) Sataplia caves are situated, which were discovered and investigated by the speleological expedition of the Institute of Geography in 1959.

Okriba-Argveti massif spreads latitudinally for 27 km between Rioni-Tskaltsitela and Dzusa gorges. Its western part is known as Dokhora-Sakolavi, while eastern part as eastern water outfall. Maximum absolute height marks are within the range of 700-1300 m. Within the borders of the massif are enclosed Tsutskvati cave system, Iazon's cave, Chakhati, Sakazhia, Nagarevi, Navenakhevi, Zedashidze, Sagvarjie and other caves, underground beds of rivers Tkibula and Maghara (karstic tonnels). Of surface karstic relief forms karst fields ("Karre"-s), karstic funnels, sinkholes of different size and age, sinkholes (the so calles "tskvarami" caves), poljes (Akhalsopeli) and polye-like depressions (Nagarevi, Navenakhevi, Eklari) are most characteristic here. Also limestone precipices and cornices, karstic niches, karstic-denudative heights are found in this massif. Despite the interrupted territorial spreading, karstic processes and forms significantly affect morphological appearance of the southern Okriba and adjacent areast. Karstic relief is characteristic to the southern and south-western peripheral areas of Okriba-Argveti massif, in particular, polye-like plane-hollow and Kvakhchiri height include karstic forms (sinkholes, karstic fields). Furthermore, morphometrically and morphologically this section essentially differs from the higher northern limestone parts. In this strip Karstic relief spreads from the canyon of river Tskaltsitela (between the Motsameta-Abuna bridge), where north-western part of Godogani, in particular, monocline limestone range of Sakolavi (Dokhora) belongs to it, which south-eastern continuation (branch) reaches the source of river Chishura.

In this strip the well known Iazoni, Chakhati, Sakazhia (river Tskaltsitela canyon), Godogani, Nagarevi, Navenakhevi caves are situated, which are rich with speleothems. Zemo Godogani (Veleba) and Nagarevi karst plateaus-poljes are rich with karstic funnels, deep sinkholes ("tskvarami" caves), wells, where diameter of sinkholes ("tskvarami" caves), fluctuates withing the range of 150-250m (depth varies from 10-15m to 30-40 m).

Age of Okriba karst and also opinion of researcher on this subject are different. On the map compiled by N. Astakhov and L. Maruashvili [11] showing geological age of Georgia's relief, middle moutainous and upper mountainous relief, in which Khvamli and Orkhvi-Nakerala massifs are

enclosed, are dated by Oligocene, age of Okriba is determined as upper Miocene, age of Bari - as mid Pliocene. Age of Sakazhia cave is determined by G. Devdariani and I. Saghinadze [5] as old Euxinian, of Sapichkhia cave – as Karangatian and Chakhati cave is dated by old Euxinian. The main cave of Tskhrajvari is dated by D. Tsereteli (1956) by the end of the upper Tertiary period.

In our opinion in the mid Miocene as a result of Styrian tectonic movements significant parts of Khvamli and Racha massifs were fred from the sea, deep erosion of rivers and karstification processes started (the first stage). On the second stage (which started before the beginning of the upper Miocene and continued up to the end of the lower Pliocene) Attic tectonic movements caused ascension, lowering of subterranean waters, activation of karstification processes and nucleation of the Boga cave on Khvamli plateau and upper caves on the cliff. On the third stage (which started in the middle Miocene and continued up to the end of the upper Pliocene) hydrological net has deepened as a result of Rodanic orogenetic movements, and karstification processes in the low mountainpus and hilly strip of Okriba have intensified. In our opinion II and III Tskhrajvari caves, lower tier caves on Khvamli cliff, caves of Sataplia height and Tskunkuri-Zeda Kumistavi caves are formations of the same period (epoch). On the forth stage (from the beginning of Quaternary up to the present day) has terminated the development of karst formations of Okriba (Tsutskvati cave complex, Tkibula-Dzevrula, Godogani-Nagarevi, Banoja-Khomuli) started earlier in the Upper Pliocene and nucleation of new karst formations has started.

Geomorphological zoning of karst is one of the most significant problems in investigation of karstic relief. Information contained in studies of L. Maruashvili [2], Z. Tatashidze [12] and Sh. Kipiani [13, 14] is very valuable for the geomorphological zoning of Georgian karst in general and for the issues of geographical-speleological and karstic zoning of Okriba in particular. Karst strip of west Georgia is divided by L. Maruashvili into zones and regions, where zones correspond to the types and regions - to the subtypes. To the second region singled out by him belongs the middle mountainous Okhachkue-Nakerala karst region, which in Okriba includes Khvamli and Nakerala limestone massifs. In the hilly slowly rising karst zone or type (which spreads from Akhali Atoni (Novyi Afon) up to Zemo Imereti plateau) he unites Okriba region with Tskaltubo, Kutaisi, Sakolavi-Chognari and Okriba-Argveti limestone massifs. Karst region, developed in geosynclinal conditions of the west Georgian karts strip, is divided by Z. Tatashidze in two speleological subregions: a) middle- and and high-mountainous limestone massifs, where two of nine big limestone massifs identified by him, in particular, Khvamli and Racha massifs are more or less extended in Okriba; b) in the subregion of foothills of limestone subregion he isolates eight massifs, of which only one – Tskaltubo massif is presented in Okriba. In the paper, published in 1965, Sh. Kipiani outlines the types and zones, regions and subregions [13]. Total of 23 karst geomorphological regions and 52 subregions were identified by him in Georgia. Only two regions (Lechkhumi middle mountainous and Kvemo Imereti regions) and three subregions (Kvamli monocline karstic elevation, built mainly of dolomite limestones; Tskaltubo-Sataplia karst subregion and Okriba subregion – with Kutaisi-Navenakhevi-Akhalsopeli-Dzevri-Chkhari,
Akhalsopeli and Tsutskhvati tectonic-karst poljes spread on the territory of Okriba to more or less scale. The first of above listed subregions is singled out in the middle mountainous region of Lechkhumi and the last two - in the middle mountainous zone of Kvemo Imereti. According to the second, more recent scheme [14] of the 60 main karst regions, identified in Georgia, five regions: 1. Khvamli, 2. Racha-Nakerala, 3. Tskaltubo-Sataplia, 4. Chakhati, 5. Territoty between the rivers Tskaltsitela and Dzusa in the form of Okriba Karst region fall into Okriba.

Table 1. Geomorphological zoning of Okriba karst

Zones of karst occurrence	Karst regions	Location	Minimum and maximum altitude, m ASL minim.	Area, km^2	Karst subregions	Location	Area, km^2
1	2	3	4	5	6	7	8
A. Southern slope of the Caucasus range	I. Khvamli massif	Between rivers Rioni and Tskhenistskali	320-2000	48	1. Khvamli plateau	Between rivers Lakhepa and Tskhenistskali	42
					2. Southern cliff of Khvamli	Between rivers Rioni and Tskhenistskali	5
	II. Western part of Racha range	Between rivers Rioni and Kvirila	320	97	3. Orkhvi-Tavshava-Tskhrajvari	Between the river Rioni and Mukhura pass	35
					4. Nakerala range	Between rivers Tkibula and Dzusa	16
B. Intermontane plane	III.Tskaltubo-Didvake	Between rivers Tskhenistskali and Tskaltubo	149-941	91	5. Gelaveri-Etseri mountain	Between rivers Tskhenistskali and Semistskali	13.5
					6.Tkhunkuri-Kumistavi	Basin of rivers Tskhunkureli and Kumistskali B	13
					7. Kvilishori-Khomuli	Between rivers Kumistavi and Tskaltubo	36
					8. Gvimbra-Banoja	Between rivers Tskaltubo and Oghaskura	29
	IV-Kutaisi-Sataplia	Between rivers Rioni and Opurchkhetistskali	125-476	15	9. Sataplia-Sabero elevation	Between rivers Rioni and Tskaltubo	11
	V-Mtsvanekvavila-Sapichkhia-Godora	Between rivers Rioni and Tskaltsitela	130-429		10. Ukimerioni-Gochoura plateau;	Between rivers Rioni and Oghaskura	4
					11. Nabambrevi-Motsameta plateau	Between rivers Rioni, Tskaltsitela and Jvrisghele	16.5
	VI - south-east Okriba	Between rivers Dzusa and Tskaltsitela	120-1310	130	12. Tskaltsitela limestone canyon	Between Motsameta and Abuna bridge	8
					13. Dokhora-Sakolavi hillock	Between rivers Tskaltsitela and Sabanela B	9
					14. Veleba-Sabanela Plateau	Between rivers Tskaltsitela and Kajiskhevi	3
					15. Chakhati limestone hillock	Between rivers Chakhatisghele and Kajiskhevi	3
					16. Tsutskhvati-Akhalsopeli	Between the river Shabataghele and mount Udabno	35
					17. Tsiteliklde-Tskalmechkhera hillock	Between rivers Tkibula and Dzusa	10
					18. Nagarevi-Chognari plateau	Between rivers Chishura and Tskaltsitela	37
					19. Navenakhevi-Simoneti plane	Between rivers Chishura and Rokiana	10

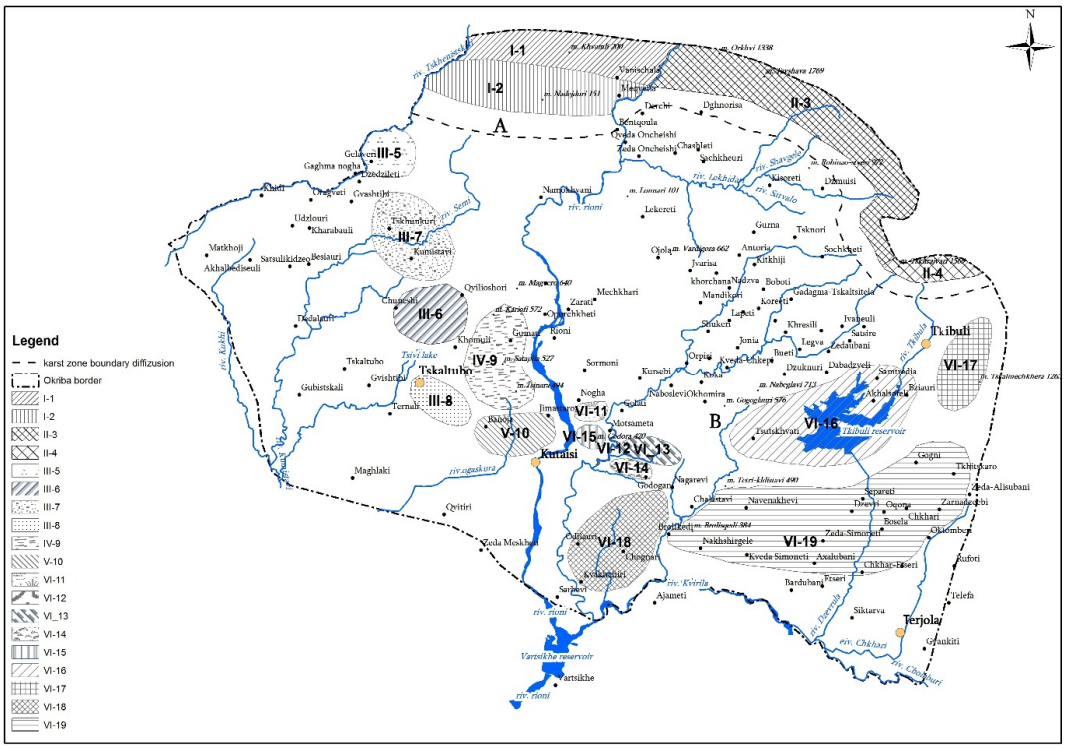

Fig. 1. Scheme of Geomorphological zoning of Okriba karst.
Geomorphological regions of Okriba karst.
I- Khvamli massif, II –western part of Racha range, III-Tskaltubo-Didvake, IV-Kutaisi-Sataplia V – Mtsvanekvavila-Sapichkhia-Godora, VI - south-east Okriba
Subregions: I-1. Khvamli plateau; I-2. south cliff of Khvamli; II-3. Orkhvi-Tavshava-Tskhrajvari; II-4. Nakerala range; III-5. Gelaveri-Etseri mountain; III-6. Tskhunkuri-Kumistavi; III-7. Kvilishori-Khomuli; III-8; Gvimbra-Banoja; IV-9. Sataplia-Sabero elevation; V-10. Ukimerioni-Gochoura plateau; VI-11. Nabambrevi-Motsameta plateau; Vi-12. Tskaltsitela limestone canyon; VI-13; Dokhora-Sakolavi hillock; VI-14. Veleba-Sabanela plateau; VI-15. Chakhati limestone hillock; VI-16. Tsutskhvati-Akhalsopeli; VI-17. Tsiteliklde-Tskalmechkhera hillock; VI-18. Nagarevi-Chognrai plateau; VI-19. Navenakhevi-Simoneti plain.

karst was compiled by us considering the above described schemes built on the basis of the results of more detailed wide-scale field surveys.

According to our sc heme two zones of karst spreading were identified in Okriba (I – southern slope of the Caucasus range; II intermontane plane); 6 karst regions and 19 subregions were isolated Table 1. In geomorphological regions and subregions identified on the basis of individual geomorphological peculiarities, different varieties of karstic processes and karstic formations were detected.

გეოგრაფია

ოკრიბის კარსტის გეომორფოლოგიური დარაიონების ცდა

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(წარმოდგენილია აკადემიის წევრის რ. გაჩეჩილაძის მიერ)

კონკრეტულად გაფართოებული ოკრიბის კარსტზე პირველად იწერება წინამდებარე სტატია. ოკრიბის საზღვრებში მოქცეულ წყალტუბოს კირქვულ მასივზე, ჩვენ მიერ პირველად არის მიკვლეული (გამოვლენილი) და მორფოლოგიურად აღწერილ-გაანალიზებული საბეროს, სოლკოტას, საწურბლიას, საქაჯიასა და ოღასყურას კარსტული მღვიმეები. ოკრიბის კარსტის ტიპები ჩვენ ოთხ მორფო-ჰიფსომეტრიულ ზონად დავყავით: 1. საშუალომთიან, 2. დაბალმთიან, 3. გორაკბორცვიან და 4. კოლხეთის (იმერეთის) ვაკე-დაბლობის კირქვულ მასივებად. გავაანალიზეთ — ეს ოთხი მთავარი კარსტული მასივი და შევეცადეთ მათ დათარიღებას.

ჩვენ მიერ პირველად არის შედგენილი ოკრიბის კარსტის გეომორფოლოგიური დარაიონება, რომელიც გამომდინარეობს დაკონკრეტებული მსხვილმასშტაბიანი საველე კვლევით შეკრებილი მასალების ანალიზიდან. ჩვენი სქემით ოკრიბის ტერიტორიაზე გამოვყავით კარსტის გავრცელების 2 ზონა, 6 კარსტული რაიონი და 19 ქვერაიონი. გამოთვლილია ყველა რაიონისა და ქვერაიონის ფართობები. Dდასახელებულ კარსტულ გეომორფოლოგიურ რაიონებსა და ქვერაიონებში კარსტული პროცესები და რელიეფის კარსტული ფორმები სხვადასხვა პლასტიკითაა წარმოდგენილი, რომელთა გამოყოფას საფუძვლად უდევს კარსტის ინდივიდუალური გეომორფოლოგიური თავისებურებანი. სტატიას თან ახლავს ოკრიბის კარსტის გეომორფოლოგიური დარაიონების სქემატური რუკა.

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