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ON THE EVOLUTION OF KARST CAVES IN THE CONDITIONS OF PLATFORM KARST (ZEMO IMERETI PLATEAU CASE STUDY; GEORGIA)

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Abstract

The actual materials obtained as a result of our studies carried out during years in the ZemoImereti Plateau, namely, the morphological analysis of karst caves, hydrological-hydrogeological studies, results of tracing (indicator tests) of underground waters, borehole data and others, allow us to prove that the influence of phreatic, vadose and dry epochs has been reflected in the evolution of caves. An important part of karst caves has undergone the phreatic stage of development, though nowadays the traces of pressured flows in most cases have been erased by impact of vadose waters and other processes (corrosion, destruction, formation of speleothems, etc.). It is being also identified that the process of evolution of caves is not similar within the same karst massif that is related to the violation of the normal course of cave development by the influence of tectonic movements or other conditions.In the modern stage of development, the phreatic regime is well expressed in the Ghrudo underground basin, and the traces of both the vadose and dry epochs are well preserved in the higher located caves that went through the cycle of development. The periodic streams play an active role in the next stage of cave development, which, in turn, has been reflected in cyclical nature of sedimentation.

Key words: Hydrogeological studies, indicator tests, cave development cycle.

Introduction

The occurrence of karst cavities remains a topic of discussion so far. One group of researchers gives preference to the occurrence of caves only in the phreatic zone (Grundi, Devisi, Savitski, etc.), the second group – in the vadose zone (Kattseri, Marteli, Lemani, etc.), but most researchers believe that the cave occurrence begins in the phreatic regime of waters and ends in the vadose (Trombi, Korbeli, Maruashvili, Gvozdetski, Maksimovich, etc.).

Issue of discussion is a reference to the leading process (agent) in the cave-occurrence. One group of researchers thinks the leading agent is a pressured or free erosion, the second group – corrosion (nival, mixed, condensation, etc.), and the third group – a joint impact of corrosion and erosion on the karstified rocks, though it remains to be discussed, which one is leading.

Based on our many years' observation and research, it can be said that the occurrence of the caves takes place simultaneously in the zones of depth circulation, full saturation (phreatic regime) as well as in the zones of seasonal fluctuation and aeration (vadose regime). Therefore, underground karst forms of relief are developed under the corrosion, erosion (pressured erosion or free erosion) and gravitation impacts in various hydrodynamic zones.

Study Area. ZemoImereti Plateau includes the easternmost part of western Georgia's limestone stripe, which is characterized by peculiar natural conditions (relief, tectonics, climate, surface and underground waters), and is the only karst platform region in Georgia [1, 2, 3, 4, 5].From the relief point of view, it is sharply distinguished from other karst massifs of Georgia and includes a central, relatively high part of the intermountain plain of Georgia. Most of the part of the plateau surface is located at the height of 400-800 m above sea level. It is characterized by deep river gorges and the peculiar soft relief of watershed areas. The uniform surface of the plateau is dissected by the canyon gorges of the Kvirila River and its deep (100-250 m) tributaries into relatively small plateaus with steep slopes and plain surface.

Geologically and structurally the study area as part of the Georgia's block is represented by two structural floors: the Pre-Cretaceous base and the Cretaceous-Neogene platform cover. Paleogeographically

the latter is divided into two sub-horizontal sub-floors: Cretaceous carbonate and Neogene terrigenous (Fig. 1).

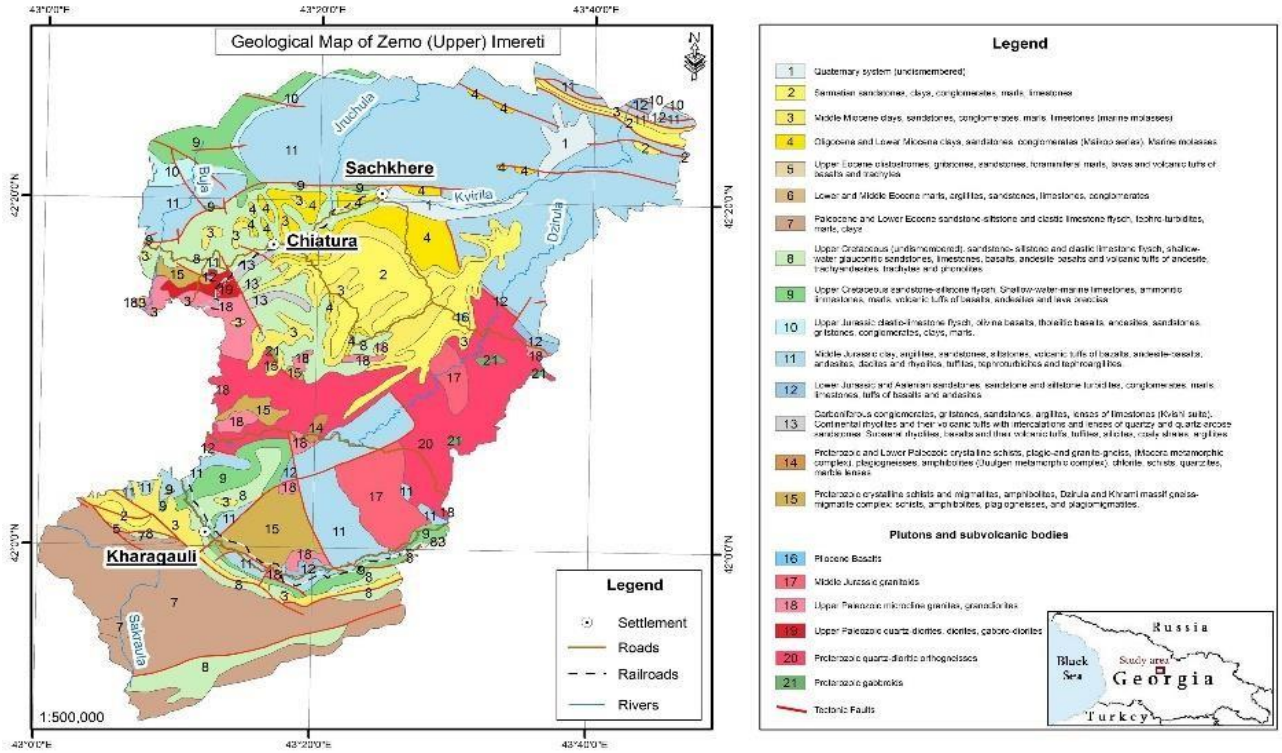

Fig. 1. Geological map of the ZemoImereti Plateau [6].

Research and Methods

In the framework of the research we have used a variety of research methods that are used to study classical karst territories, including: field-surveying, geomorphological, indicator (water tracing method), and many others. We also analyzed the boreholes' data, through which the depth circulation zones were identified.

The correlation of the heights above sea level of karst waters and cave entrances, as well as relative heights of the cave tiers and terraces developed in the individual river gorges were used to identify the epochs of delay of ascending tectonic movements.

Results

The study of factual material accumulated over the years by us in the ZemoImereti plateau, in particular, the morphological analysis of underground cavities, the study of their hydrogeological peculiarities and research of relations of surface karst forms, indicator tests, borehole data, etc., allow us to conclude that the genesis of underground karst forms is closely related to tectonic fragmentation and is carried out simultaneously in the surface and depth of the karst massif. In addition, the more favorable conditions for the cave occurrence are created while the occurrence of concentrated streams that is largely characteristic for the phreatic regime. Such a regime can be established under the main drainage levels and above these levels too.

On the modern stage of development, as mentioned above, the cave occurrence takes place simultaneously in the depth circulation zone, full saturation levels' seasonal fluctuation and aeration zones. Therefore, the underground karst forms of relief are developed under the impact of corrosion, erosion (pressured or free erosion) and gravitation in various hydrodynamic zones. Based on the materials obtained by us, it can be noted that some caves in the study area are on the stages of fissure, hole or channel that is proved by the borehole data [7, 8] and the existence of karst underground streams beneath the river beds [1, 2]. It is known that in the vadose epoch of cave-occurrence, the fissures and karst cavities are discharged from permanent pressured waters and are under the impact of infiltration-influation-condensation streams.Hidrologically it corresponds to the active water exchange or aeration zone.

From the vadose epoch, vaucluse, fissured-corridor, stream-corridor and periodical stream-corridor stages are well expressed in the study area. The vaucluse stage that starts the vadose epoch of development of the cave is a time of substantial changes in the life of the cave. It starts with the opening of the cave, or with the opening of the free exit in its lower ending, which takes the cave flow on the earth's surface, in the normal atmospheric pressure environment. The flow of cave stream increases sharply, which leads to erosion enhancement, destruction and the desire of the cave alongside profile to the balance curve. On the mentioned stage, individual sections of karst cavities are characterized by the phenomena of hard water discharge, especially during the abundant atmospheric rainfalls, when the water levels in the karst cavities are significantly higher. The vadose stage is well expressed before flowing out on the surface in the basins of the Ghrudo, Monasteri, Lezhubani, Tiri, Kldekari, Bondi and other vaucluse streams.

The beginning of a stream-corridor stage is associated with the reduction of intensive mechanical erosion in the cave, which may lead as a result of the development of balance profile or the sharp decrease in flow in the cave. In this stage, the cave corridors and halls are already mainly developed. The most part of the cavity is filled up with air; speleothems are developed intensively; the destruction is underway. The latter may cause the occurrence of pooled lake and the accumulation of clay (e.g., Karianiklde and Ormoebi caves). In the second half of the stage, alluvial and other materials are accumulated. The following caves are in the stream-corridor phase of development: Bochoklde, Shvilobisa, PataraSadatviaklde, Khvedelidzeebisklde, Shekiladzeebisklde, Varsima, Kudurebisklde, Ekvtimesklde, Dzudzuana, Nikrisa and others.

Periodically, the stream-corridor stage begins with the disappearance of permanentstream in the cave. During this stage, periodic action of temporary (related with rain and snow melting) floods takes place. On this stage of development are the important part of the caves in the study area – Samertskhleklde, Bnelaklde, Jikhura, Sachinkia, Piraghiaklde, the part of Rganisklde and other caves.

The vadose epoch is replaced with a dry epoch, which is represented only by a dry-corridor stage. It begins after the disappearance of water flows in the cave.Erosion is stopped in the cave and among the corrosion types the water chemical reactions are preserved that are leaked out on the walls as a result of steam condensation of the warm air flown from the outside. Development of speleothems is stopped. Accumulation of gravitational, remnant, anthropogenic and zoogenic materials take place that ultimately leads to the filling and modifying of the cave.

Fig. 2. a) Jruchula cave; b) Sameleklde cave

The examples of the cave on the dry-corridor stage are Tsona, Jruchula, Sameleklde, Samgleklde, Gvarjilasklde, the front part of Rganisklde, Tsilto III, Ortvlaklde, Ghvitori, Kozmani, Deviskhvreli, Mghvimevi, Bogirisklde and others (Fig. 2).

It should be noted that the above mentioned individual stages of the development of cave continue tens and hundreds of thousands of years.For example, the dry-corridor stage in the Tsona cave had begun 100-

300 thousand years ago (Lower Paleolithic, Acheulian -Moustian), and in the Ortvala cave – 40 thousand years ago according to archeological documents [9, 10, 11].

The sequence of these stages, or the violation of normal process of the cave development, may be caused by tectonic movements, destruction in individual parts of the cave, human intervention and other reasons.

Intensive ascending tectonic movements and short-term delay epochs that have been emphasized by a number of researchers [12, 13, 14], mainly stipulated the step-wise layout of the caves on different stages of development in the ZemoImeteri Plateau as well as the wide distribution of tunnel-type underdeveloped caves. Thus, the caves of Sameleklde and Jupchula developed in high steps in the Jruchula gorge are on the dry-corridor stage, and the Taroklde and Samertskhleklde caves – on the periodical stream-corridor stage.

Khvedelidzeebisklde, located on the lower level, and yet invisible floor below it (the latter is flowing out in the form of pressured water in the bed of the Jruchula River) are on the stream-corridor or vaucluse stage (Fig. 3).

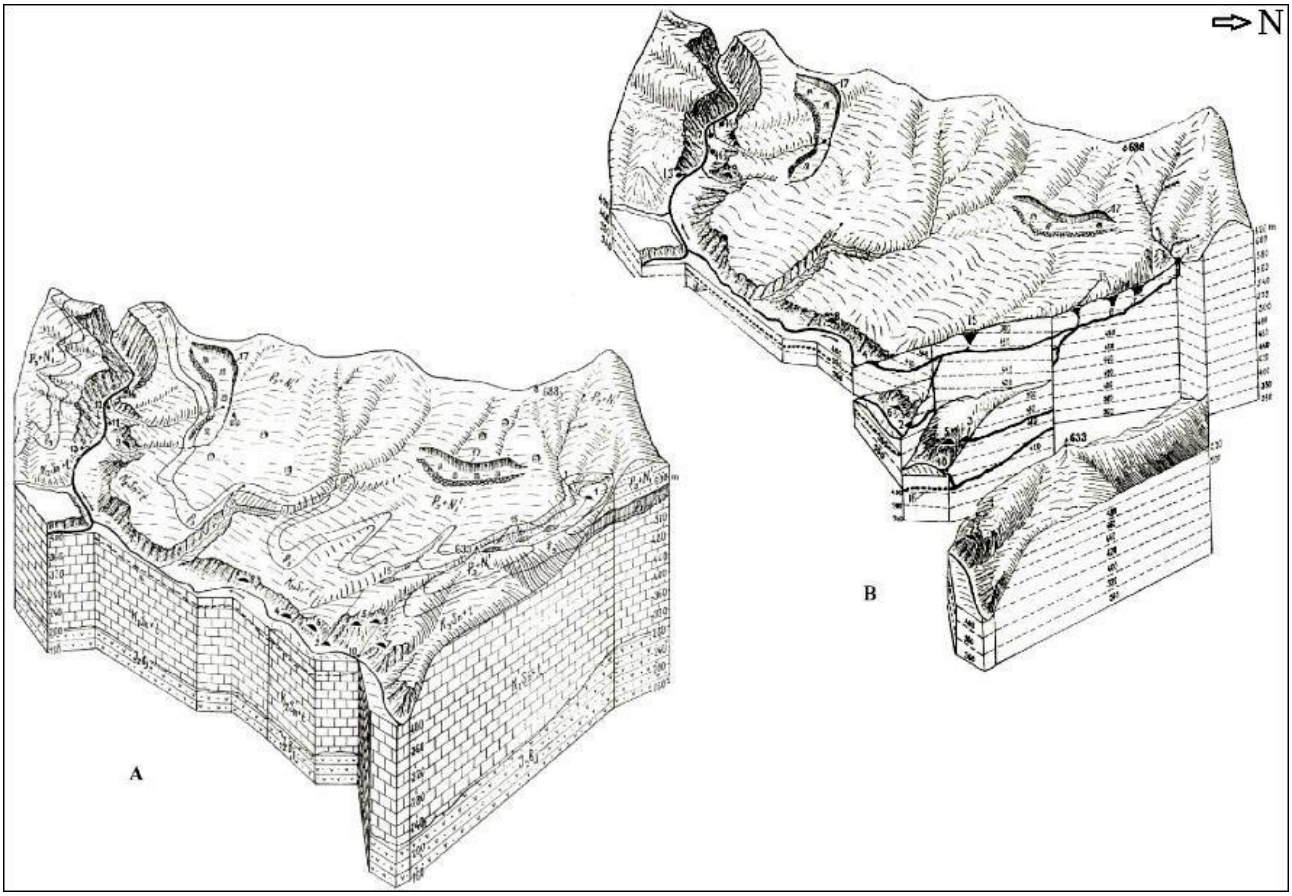

Fig. 3. A) Geological conditions of development of karst events; B) Hydrogeological situation in the Darkveti-Zodi Plateau (block-diagrams).

Intercomparison of absolute altitudes (Fig. 4) of the cave entrances and karst sources, as well as the relative heights (Tab. 1) of the cave tiers and terraced stages developed in the individual river gorges allow us to presume that the epochs of delayed tectonic movements should be at least 4-5.

Different sections in the same cave can be in the different stages of development simultaneously. An example of this is the Shvilobisa cave, where there are sections in the stream-corridor and periodically streamy stages of development. Also, the front section of the Ranganiklde cave is in a dry-corridor stage of development while the further section is in the periodically stream-corridor stage.

The normal process of development of the cave can be violated by human activity. For example, during the field work, we had to witness the filling of the Baratashvilis' shaft and Pirana abyss with the bad rocks of

manganese ore. We couldn't find some of the caves (e.g., Kvatia), which were previously recorded and described by us; as we assume, they were filled up with manganese bad rocks.

Table 1.

Altitudinal distribution of terraced stages and horizontal caves in the Zemo Imereti Plateau

Relative heights of terraced stages, m				The relative height of the caves, m						
				River gorges						
In the west of Chiatura (Kuchukhidze, 1986)	Sachkhere vicinities (Devdariani, 1964)	Sachkhere - Chiatura section by field surveys)	Stages	Kvirila	Jruchula	Nekrisa	Rganisghele	Tabagrebisghele	Bogiristskali	Sadzalekhevi
5-10	2-4	4-7	I	Ghrudo-6 Parduli -5	Khvedelidzeebis-klde-4	Bregvadzeebis-klde-7	Lezhubani- 4 (vaucluse)	-	Bogirisklde-5	-
20-25	8-12	15-20	II	Pasieti-12	Samertskhleklde-14 Sareki- 15	Dzudzuana-14 Nekrisa-18	Gvarjilasklde- 15	Sakajekari -18 Namdzleviklde-20	Bogirisklde - 14	-
40-45	20-22	30-40	III	Mghvimevi-35	Jruchula -35, Samgleklde-38, Samertskhleklde (II) -32	A grotto across from Dzudzuana cave-33	Bnelaklde-30, grottos across from Bnelaklde cave-30-40 Ortvalaklde -35-40	Judisa-30-35 Gela -33	Zekha 30-35	Jikhura-33 Sadatviaklde -37
50-60	40-50	50-60	IV	Chipianiklde -50	Tarokde -63	-	Grottos -50-60	-	Bochoklde -50	-
80-85	-	-	V	Ormoebi-75	Samelekde -75-80	-	Rganiskde -80-85	-	-	Sachinkia-85 Nakhiznebi-82 Sadzrokhia-75

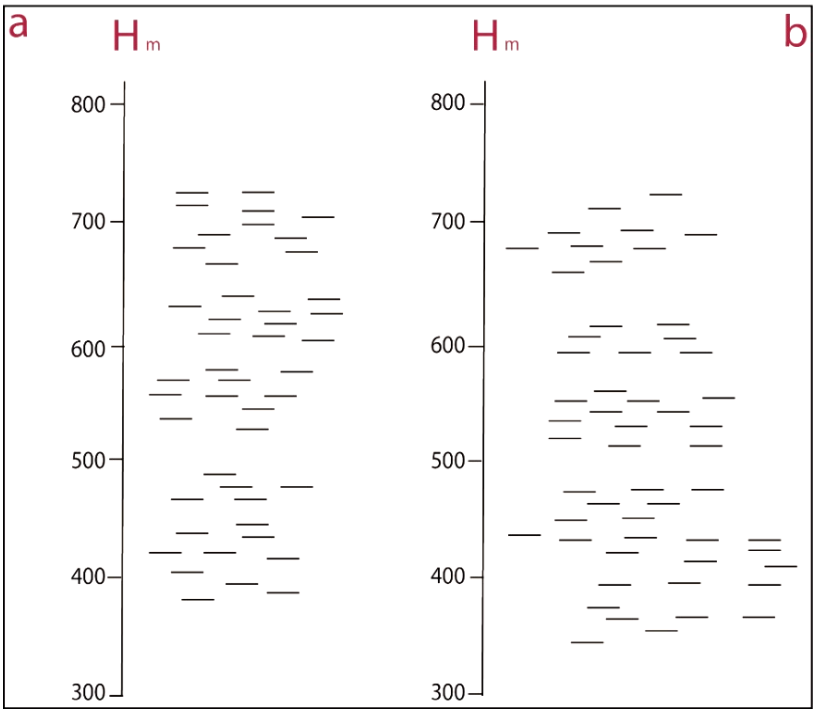

Fig. 4. The scale of distribution of hypsometric levels of horizontal caves entrances (a) and karst sources outlets (b) in the Chiatura structural plateau.

Conclusions

Therefore, considering study of karst caverns and hydrogeological situation, it can be noted that along with the ascending tectonic movements and relief fragmentation of the study area (with short delays) a rapid shifting of karst waters at lower levels (Fig. 2) occurred.All this led to the suspension of the caves development at various stages, and the waters moved in the depths are flowing out in the form of large vaucluse sources, or leaking below the base level and filling up the individual fissures. As it is clear by indicator tests and existing boreholes, there is not only the absorption of waters through the mentioned fissures, but also the movement of their substantial mass, and sometimes they can be discharged in the form of ascending pressured waters in the riverbeds.

At the modern stage, the individual karst caves, shafts, swells and vaucluse sources were the unified in one karst water-containing system. The lower phreatic horizons of the system are inaccessible for human beings.

Thus, it can be said that part of the karst cavities in the study area was originated in the phreatic epoch, though the influence of the pressured waters of this epoch is almost entirely erased by the influence of the vadose waters and other processes (erosion, rockslides, speleothem formation, etc.).The exception is some caves that went through the cycle (Tsilto III, Rganisklde, Samgleklde, Sakajekari and others), where the signs of phreatism (sloping of corridor bottoms in the depth, the corries developed in the ceiling, the smoothed arch, the considerable thickness of the plastic clays, etc.) are more or less well preserved. The effect of free flows is not less important in the origination-development and transformation of caves in the study area, which is indicated by the existence of the materials of alochtonic origin in terrigene sediments of karst caverns [1, 3], the well-expressed dissected micro-meanders (Shvilobisa, Chiatura 100, etc.), etc.

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References

[1] Lezhava Z. The Karst of ZemoImereti Plateau and Its Surrounding Areas. Publishing House “Universali”. (In Georgian), Tbilisi, Georgia. 2015.

[2] 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. pp. 93-100. Rochester, USA. 2015.

[3] Asanidze, L., Chikhradze, N., Lezhava, Z., Tsikarishvili, K., Polk, J. and Chartolani, G. Sedimentological Study of Caves in the ZemoImereti Plateau, Georgia, Caucasus Region. Open Journal of Geology, 7, 465477. https://doi.org/10.4236/ojg.2017.74032. 2017.

[4] 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.

[5] Lezhava, Z., Tsikarishvili, K., Asanidze, L., Chikhradze, N., Chartolani, G. and Sherozia, A. Karst Relief Development History of ZemoImereti Plateau. Georgia, Caucasus. Open Journal of Geology, 9, 201-212. https://doi.org/10.4236/ojg.2019.93014. 2019.

[6] Gudjabidze GE (2003). Geological map of Georgia, Scale 1:500 000. (Editor: Gamkrelidze et al.). GeorgianState Department of Geology and National Oil Company Saqnavtobi. Tbilisi, Georgia. (in Georgian).

[7] Kuchukhidze G.T. et al. Report on hydrogeological filming of the scale 1:50 000 of ZemoImereti Plateau by the works of 1983-1986. Funds of „Gruzgeolupravleniya“ (in Russian). 1986.

[8] Mamulia G.G., Gambashidze T.G. Annual report on hydrogeological surveys of Chiatura region for 1963. - Funds of “Gruzgeolupravleniya, Tb. (In Russian). 1964.

[9] Lyubin V. P. Study of the Lower Paleolithic of the Caucasus. In the book: Short bulletin of reports and field researches of the Institute of Archeology, vol. 118, M. (In Russian). 1969.

[10] Lyubin V. P. Paleolithic of the Caucasus. In the book: Paleolithic of the Caucasus and North Asia. USSR Academy of Sciences, L. (In Russian). 1989.

[11] Tushabramishvili D. M., Tushabramishvili N. D., BuachidzeTs.I., Lordkipanidze D. O., Tvalchrelidze M. G. Ortvals-klde Paleolithic dwelling. Chronostratigraphy of the Paleolithic of northern, central and eastern Asia and America. Reports of the International Symposium, Novosibirsk (in Russian). 1990.

[12] Maruashvili L. I. Modern relief and geomorphological history of the ZemoImereti Plateau. Proceedings of the VakhushtiBagrationi Institute of Geography. AN Georgian SSR, Vol. 10 (in Russian). 1958.

[13] Tintilozov Z. Karst caves of the north-eastern part of ZemoImereti (geomorphological history). TbilisiState University Works, vol. 72, Tbilisi (in Georgian). 1959.

[14] Tintilozov Z. The karst caves of the Jruchula gorge (attempt of the geomorphological characterization). The caves and cavities of Georgia, speleological collection, vol. 1, Tbilisi (in Georgian). 1963.