

The Pleistocene Glaciation Pseudomoraines in the Caucasus Mountains

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(Presented by Academy Member David Lordkipanidze)

ABSTRACT. The study of the palynological spectrum shows that in the basin of the river Kodori on the territories of the so-called “Tsebelda Moraine” and village Khevi (350-400 m and 550-600 m above sea level, respectively) the sediments are fluvial deposited under the conditions of humid, moderately warm climate. In the basin of the river Enguri the boulders (Porphyry) near village Khaishi are local, while the granite boulders are cast out of the Nenskra Gorge, from the Okrila and Tskhvandira Massifs. The friable suites in the basin of the river Terek, at the mouth of the river Amali and the territory of village Balta are the product of the glacial torrent developed from the Devdoraki Glacier. The vegetation spectrum of the sediments on the territory of village Omalo shows that the sediments have been deposited under the conditions of simple, mild climate and are not at all linked to the glacier. © 2018 Bull. Georg. Natl. Acad. Sci.

Key words: glaciation, Pleistocene, pseudomoraine, glacial torrent

Proper understanding of the geologic past (Pleistocene), together with other phenomena, requires paying special attention to the old glaciation of the Caucasus Mountains as far as it caused radical changes in the geographic environment.

The first data on the modern and old glaciations of the Caucasus Mountains was recorded since the second half of the XIX century. It is the period, when four-fold glaciation was stated in the Alps. The researchers of the old glaciation of the Caucasus Mountains were to some extent under the influence of the above fact and their researches were based on the Alpine Glaciation. This approach became so popular that it has supporters even

nowadays. They assume that some of the old (Pleistocene) glaciers of the Caucasus reached the territories of the foothills.

The critical analysis of the newest materials obtained in the expeditions and from literary sources enabled us to form our opinion about the old glaciation in the Caucasus. Our researches are based on the results of the complex (geomorphological, palynological, petrographic, paleontological, archaeological) investigations in the basins of the rivers Kodori, Enguri, Rioni, Terek, Aragvi and Tushetian Alazani. These results are quite different and include many new approaches about the distribution of the old glaciers in some of the river basins. Below we suggest

materials based on the facts, which make the existence of enormous glaciers in Pleistocene in the Caucasus Mountains doubtful.

In the gorge of the river Amtkeli, which is a tributary of the river Kodori, near village Khevi, in the site of "Satskhunari" at absolute height of 530-550 m there is a hill built of friable sediments including boulders of well processed granite, porphyry and diabase (0.25-0.5 m). The boulders are extremely eroded. They break up at a slight blow and become friable. Some of the researchers consider the hill as the remain of the old glaciation [1-3]. However, other researchers [4-7] are absolutely sure of fluvial genesis of the hill.

As a result of the detailed study of the Satskhunari Hill by petrographic and palynological methods we determined that the hills are built up with reddish-brownish moderately granular clayey sand. It is obvious that accumulation of the material took place under equal conditions. As to the granite, diabase and porphyry composing the friable suite, the well processed boulders and their particles are eroded to that extent that they break up at a slight blow and become friable. It means that the materials are very old. The palynological study of the friable sediments of the Satskhunari Hill revealed that arboreal plants, mainly broad-leaved trees are dominating in the vegetation cover. However, it is noteworthy that unlike the modern vegetation cover, in the fossil spectrum we come across such relicts as: *zest*, *podocarpus* and *tsuga*, which nowadays are not met in the Abkhazian flora and are characteristic of a climate warmer than the current one. Consequently, we may suppose that near village Khevi (Satskhunari) the friable material of the suite was accumulated under moderately warm and humid climate conditions. It excludes their glacial genesis. Moreover, abundance of the vegetation cover by the river bank indicates to their fluvial genesis.

The most interesting is determination of the genesis and sedimentation conditions of the so-called "Tsebelda Moraine", which is located at

absolute height of 350-400 m at the confluence of the river Jampala in the gorge of the river Amtkeli, which is a tributary of the river Kodori. Some of the researchers [2,3] consider it as a moraine, while others [5, 7-9] are sure of the fluvial genesis of the hill.

Seemingly, the assumptions of the above researchers are based on the hill with a well expressed relief and the boulders scattered over the surface, the lithological structure of which are quite different from the local rocks. The hill based on paleogene limestone is attracting attention at a glance. In case the hill were a moraine it would be built of friable materials and boulders. In fact, it is a body composed of comparatively less solid limestones developed in the massive limestone layers. Some of the researchers consider it as a product of glacioidislocation. As to the processed granite, diabase and porphyry boulders scattered on the hill surface, they are not at all linked to the rocks composing the Caucasus Mountains. They are identical to (in composition) the Gorabi and Kelasuri intrusive rocks, which are outcropped at the middle reaches of the river Jampala. This assumption is also proved by the fact that no boulders similar to the rocks composing the central Caucasus Mountains were observed in the gorge, from the Amtkeli Pass to the Kelasuri Intrusive. Similar situation is in the Jampala Gorge. As to the suite of the friable layers, which are precipitated across the eastern slope of the hill, the palynological analysis of the samples obtained from the sections of three segments enabled us to make our assumption on the sedimentation and the environmental conditions for the friable layers. In each of the sections the fossil spectra are similar to the spectra obtained from the soil layer characteristic of the vegetation cover of the foothill line in West Georgia. As to the existence of aliens (*Sequoia* and *Cedrus*) in the fossil spectrum, it makes us suppose the oldness of the layers and the conditions of sedimentation that indicates to a warmer period compared to the current conditions.

Consequently, according to the data of the above mentioned factual materials we may conclude that in the Amtkeli Gorge the old glacier reached the absolute height of 1450-1500 m but not the "Tsebelda Moraine" at 350-400 m.

The same situation is observed in the basin of the river Enguri, where, according to the opinions of the most researchers, the old glaciers of the Enguri were spread to 500 m, the absolute height (village Khaishi). Their assumption is mainly based on G. Allin's [10] point of view. In his opinion the porphyritic boulders scattered on the village territory rolled down from the slopes and were cast out by the river Tkheishi. As to the boulders composed of microcline porphyritic blastic granite, quartz diorites and gneissic granite scattered over the territories of villages Tobari and Khaishi, they were cast out of the rocks composing the Okrila, Kharikhra and Tskhvandori Massifs. The petrographic studies of these rocks showed that they have no links to the plagiogranites building the sources of the river Enguri, the massif of the peak Shkhara. Thus, they cannot be considered as moraine material brought down by the old Enguri glacier. In fact, the above mentioned boulders were cast out by the old Nenskra glacier, which was spread nearly to the gorge of the river Enguri (villages Tobari, Khaishi). It is the remains of the moraine.

Abundance of moraine materials is observed in the villages of Ipari Community: on the territory (1550 m above sea level) of villages Bogreshi, Zegani and Nakipari. Here we meet the boulders of plagiogranites and crystalline slates of the river Enguri and the sources of its right-bank tributaries Adishi and Khalde. Morphologically, there is no moraine seen in the relief here. However, separate erratic boulders are scattered in great numbers and they even reach the summit of the Ughviri Ridge. Consequently, we may suppose that the boundary of the maximum spread of the old Enguri glacier must have reached the territory of Ipari Community. As to the moraine material in villages

Latali, Pari, Etseri and Khaishi, they are not linked to the old Enguri glacier. They were cast out of the sources of the tributary rivers.

Very often, some researchers consider the suites formed as a result of glacial mud torrent phenomena in glaciation areas are moraines left after the glaciation. At a glance it should not sound strange as far as, like in moraines, the friable material and the boulders in it are not processed and this fact misleads the researchers. A good example of this is a section of 100-120 m thick friable layers segmented with unprocessed boulders in the gorge of the river Terek at the mouth of the right-bank tributary, the Amali. Some of the researchers [11-13] consider the suite is a moraine left at the place of the old Terek glacier, while others [14,15] assume it is a product of the torrents.

Complex studies of the above sediments enabled us to make our assumption about this formation. As a result of the palynological studies [16] of the samples obtained from the section of the friable layers we determined that the fossil spectrum wholly manifests the taxons composing broad-leaved forest that obviously excludes existence of glacial phase in this area of the Terek Gorge, as far as the fossil vegetation spectrum is mainly characteristic of warm mild climate conditions. According to the petrographic studies of the boulder material of the Terek Gorge the old (Wurm) glacier of the Terek Gorge would not spread out below village Kobi (1800 m above sea level). The lower part of the gorge was free of glacier and only several sections were invaded by the glacial masses, which blocked the Terek Gorge for long periods of time. The best example of this is the section of the survived lacustrine sediments near the highway at 150-180 m (near the house of prayer) on the left slope of the Terek Gorge, above village Gveleti. The palynological studies of the samples obtained from the section revealed that here, together with herbaceous plants, nearly all taxons characteristic of broad-leaved forests are presented. The unique grains of the relicts (Tsuga,

Cedrus) indicate the existence of mild warm climate conditions.

Generally, we suppose that existence of a glacier in the section of Gveleti-Zemo-Larsi in the Terek Gorge is quite possible. However, the glacier must have been generated not from the Terek but the Devdoraki Gorge. The glacier must have dammed up the river Terek for a long time and created a lacustrine regime there. As to the glacial torrent of the Devdoraki Gorge, it must undoubtedly have developed after the glacier had left the gorge of the river Amali. The torrents brought the moraine material from the gorge to the Terek Gorge. Here they survived as separate boulders (granite-gneiss, crystalline slates). One of such erratic boulders known by the name of "Yermolov Boulder" is met on the territory of village Zemo Larsi.

Nowadays, in the East Caucasus Mountains the modern glaciation has insignificant measures and survived in the forms of kar and circus glaciers [17]. Their common area does not even reach the areas of some of the separate glaciers of the Central Caucasus due to the environmental conditions (continental dry climate, lack of atmospheric precipitations, especially in winter, high solar radiation, intensive segmentation of the relief, etc). Obviously, the same situation must have been in the past as well. Despite that, some researchers

[11,12,18] support the idea of the existence of strong glaciation in the East Caucasus Mountains. However, this assumption is not proved by the analyses of the material obtained by us. We do not suppose that the old glaciers in the gorges of Pirikita Alazani and Tushetian Alazani covered the intermountain trough of village Omalo [18] as far as the structure of the section of friable layers to the south of the airdrome, near the summer farm, does not prove that. The palynological studies of the obtained samples made it clear that the listed vegetation (Fig. 4) is mainly characteristic of the modern flora of the areas of village Omalo and indicates comparatively open environment caused by the glacier developed from the slopes of the Peak Dano (4170 m above sea level). The glacier reached only the peripheral part of the Omalo intermountain trough in the maximum stage of glaciation. Consequently, the friable layers composing the trough may not be considered as the moraine material left at the place of the old Dano glacier.

There are similar situations in other river basins of the southern slope of the Caucasus. Similar materials are mostly met at the mouths of the tributaries, the sources of which are covered with modern glaciers even nowadays. Consequently, in most cases they are "pseudomoraines" enabling some researchers present the old glaciers in exaggerated measures.

პალეოგეოგრაფია

კავკასიონის პლეისტოცენური გამყინვარების „ფსევდომორენები“

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კოდორის აუზში, ე.წ. „წებელდის მორენისა“ და სოფ. ხევის ტერიტორიაზე (350-400 მ. ზ.დ., 550-600 მ. ზ.დ.) არსებული მასალის კომპლექსური კვლევის შედეგად დადგენილი პალინოლოგიური სპექტრები გვიჩვენებს, რომ აღნიშნული ნალექები მდინარეულია და მათი სედიმენტაცია მიმდინარეობდა ნოტიო, ზომიერად თბილი კლიმატის პირობებში.

მდ. ენგურის აუზში, სოფ. ხაიშთან წარმოდგენილი ლოდნარი (პორფირიტები) ადგილობრივია, გრანიტული ლოდნარი კი გამოტანილია ნენსკრის ხეობიდან, ოკრილასა და ცხვანდირის მასივებიდან. მდ. თერგის აუზში, ამაღლის შეერთებასთან და სოფ. ბალთას ტერიტორიაზე არსებული ფხვიერი მასალის წყებები წარმოადგენს დევდორაკის მყინვარიდან განვითარებულ გლაციოლვარცოფის პროდუქტს. სოფ. ომალოს ტერიტორიაზე არსებული ნაფენების მცენარეული სპექტრი მიუთითებს, რომ ნალექების სედიმენტაცია მიმდინარეობდა ნორმალური, ზომიერი კლიმატის პირობებში და კავშირი არა აქვს მყინვართან.

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Received June, 2017