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Paleogeography

Genesis and Sedimentation of the Travertines in Georgia

Revaz Khazaradze* and Koba Kharadze*

Vakhushti Bagrationi Institute of Geography, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia

(Presented by Academy Member Revaz Gachechiladze)

On the basis of the studies carried out we determined the areas of the genesis and distribution of travertines on the territory of Georgia. As it became clear the distribution of travertines in the Caucasus Mountains is mainly linked to the distribution line of Mesozoic sediments, where two types of travertines can be distinguished: an active travertine (it has a source and sedimentation is still lasting) and an inactive travertine (the source has dried up and sedimentation does not take place). In the active travertines there are numerous prints of plant leaves and stems that enables to determine the approximate age of their genesis; it became known that it may belong to Holocene or a period close to the modern age. As to the inactive travertines, they are poor in vegetation prints. They have been eroded and therefore, it becomes difficult to determine their age. *© 2020 Bull. Georg. Natl. Acad. Sci.*

Travertines, active travertine, inactive travertine, genesis

Water saturated with the carbonate material deposits it onto layer surfaces in the forms of limestone, tufa and travertine. The outcropped rocks are not always presented as limestone. In many cases the material is formed and deposited in the form of travertine at the bottom of insoluble rocks.

The travertines in Georgia are studied mainly by the fossil vegetation imprints in them. As to fauna, it is not yet observed. Travertines containing flora are discovered in the Gudamakari gorge, in the region of Kazbegi (Truso gorge), Upper Svaneti, Liakhvi gorge, Abkhazia.

The travertines in Georgia, in the opinion of the most researchers [1,2], belong to the period following the glaciation (Holocene). Seemingly, the above researchers share the idea that mineral waters were widely spread in the Quaternary in the Caucasus Mountains and sedimentation took place by participation of cold springs. However, there is a consideration that in the past the old travertines were deposited by hot mineral springs (therms), as a result of activation of volcanic eruptions. Generally, the travertines in the Caucasus have different ages. Some of them are being deposited now; some of them were deposited in different epochs of the Quaternary period. There are many cases, when there are fossil leaf imprints and herbaceous stem voids in travertines. In some regions of Georgia, travertines are widely used in

building and are turned into high quality lime (Pirikita Khevsureti, Tusheti, etc.).

In the Caucasus Mountains the accumulated travertines are mainly spread over the gorges of distribution areas of Mesozoic sediments. In the gorge of the river Zhoekvara (Gagra region), there are pinkish-yellowish travertines at 6-7 km distance from the estuary. In the basin of the river Bzyb, at the bottom of the Adange Pass, S. Chikhelidze [3] discovered cemented iron material. In the Kodori Gorge, above village Azhara there are limestone travertines with leaf imprints in them on the right bank of the river. According to D. Tsereteli [4] there are vegetation imprints in the travertines observed in the basin of the river Enguri, in the gorge of the river Mulkhuri, between the slope of the Ughviri Pass and villages Adishi and Bogre. The travertines accumulated in the gorge of the river Khobi, on the right bank between villages Mukhuri and Lugelas Tskaro, are outcropped. In the upper part of the basin of the river Rioni, travertines are widely spread below Ambrolauri in the gorges of the tributaries (Lukhunuri, Kadjiani, Gaveritula, Gomula, between Gomi and Kvazha) alongside the left bank of the river Rioni, also in the gorge of the river Chanchakhi near village Ghurshevi, in the gorge of the river Chveshura. There is a great quantity of travertines in the basin of the river Didi Liakhvi, in the gorges of the rivers Kadlasan-Doni, Sba, Keshelta, Britati. The travertines accumulated in the gorge of the river Keshelta are rich in vegetation imprints. The lower part (1800-1950 m) of the river Britati is especially interesting as far as here the travertines create terraces, on which dwelling houses have been built. The thickness of the terraces reaches 2-4 m. However, they are different in age and may be older than early Holocene (the period after the Britati Gorge was freed from the glacier).

The source in the basin of the river Tergi is especially rich in travertines. In this regard the most noteworthy is the Truso gorge above village Kobi. The same kind of travertines are spread in the gorge of the river Snostskali and the source of the river Bidari on the northern slope of the Jvari Pass. In the Truso gorge the travertines are accumulated in large quantities in the lower part of the gorge, in the areas of village Okrokana (2100 m above sea level) and also in the upper part of the gorge, at the end of Kasriskhevi, at the ending of the lava flow of volcano Khorisari. Here the travertines create terraces with the imprints of fossil leaves and cylindrical voids.

After special studies of the travertines in the lower part of the Truso gorge (the areas of village Okrokana) by V.Vilenkin and P.Kovalyov [2] it was determined that birch, beech, oak and willow trees were presented here. It is also noteworthy that birch and willow trees are observed even nowadays at 2800-2900 m above sea level in the Truso gorge. As to beech and oak, they are not met today in this part of the Truso gorge. Above mentioned V.Vilenkin and P.Kovalyov [2] ascribe the travertines of village Okrokana to the middle Holocene.

As it is known, in the Truso Gorge a bore-hole was made (2007) near village Abano. From this place a heavy flow of water and gas is spilled out. In this regard, it is necessary to determine whether the bore-hole has any influence on the gas flow and whether it decreases the debit of the sources feeding the travertines. According to geological assumptions the basin feeding the mineral water and gas in the Truso gorge must be a single whole. In this case the quantity of the water and gas spilled out is undoubtedly decreased. Consequently, it is possible that closing of the bore-hole will become an issue under consideration. It is also to be taken into account that the sedimentation of the travertines in the Truso gorge has been assigned to the Red Book (1982) and to the List of Natural Monuments (2012) and is being conserved by the state.

As we have noted above, there are thick rows of travertines on the northern slope of the Jvari Pass, along the highway and a mineral spring is flowing on their reddish surfaces. This means that

sedimentation of travertines is taking place even nowadays. However, there is a circumstance to be marked: alongside the whole highway, despite the travertines are under state conservation (2013), the lower part of the travertines have been demolished in order to widen the road. We consider it unacceptable (Fig.).

Travertines are observed in the Snostskali Gorge, above village Juta, on the left bank of the river Jutistskali, at 2350-2400 m above sea level. These travertines are located in the distribution line of the Jurassic argillaceous slates, under the old glaciation cirque. The vegetation imprints conserved in the travertines were determined by K. Chochieva and N. Mamatsashvili [5]. However, precise determination requires obtaining additional material as far as the old glacial cirque is built of slates and is in no way linked to the bare-rock summits composed of diabase. Consequently, we may suppose that diabase rocks in the basin of the river Kerknistskali were brought by a glacier, which flowed over the watershed branch of the bare-rock summit. Quite large travertines are scattered on the surface of the jut cone. Two among them have been passed to the right bank of the river Jutistskali, where birch shrubbery is observed. Existence of the samples of the forest species determined by K. Chochieva and N. Mamatsashvili [5] prove that the upper boundary of the forest passed high above in the past.

Fig. Jvari Pas travertines.

The travertines in the basin of the river Aragvi were studied in the gorges of the rivers Tetri Aragvi, Gudamakari Aragvi and Pshavi Aragvi. There are especially thick travertine rows in the Gudamakari gorge. This gorge was studied by I.Palibin [6], who revealed the fossil flora dating back to the glaciation: pine, willow, alder, lime and birch. According to V.Rengarten [7] the fossil vegetation imprints in the travertines in village Makarta are characteristic of the severer climate than the one nowadays, which must be caused by

recession of the Wurm glaciers. The Tetri Aragvi travertines in the gorge of the river Khevsha are described by I. Palibin [1], who revealed the imprints of the vegetation (willow, birch, beech, walnut, oak, etc.).

There are many piles of travertines in the basin of the river Arkhotistskali (sources of the Assa), on the northern slope of the Main Caucasus Ridge, at 2170 m above sea level, on the right bank of the river. Generally, travertines are used as building material in Pirikita Khevsureti.

Travertines are also widely spread in Tusheti, in the gorge of the river Andi Koisu. Thick rows of travertines have been described in the gorge of Pirikita Khevsureti, in the areas of village Dartlo. There are numerous vegetation imprints (leaves) and voids left by plant stems in the travertines. The travertine distribution areas are located on the left slope of Pirikita Khevsureti, at approximately 1900-2000 m above sea level. According to D. Tsereteli [8], the travertines in the areas of the old Dartlo Castle date back to the Wurm glaciation epoch, and the lower part of the travertines belong to the period following the Wurm glaciation.

In the mountain line of the basin of the river Alazani there are travertine piles in the gorge of the river Ilto, above village Bukhrebi (Akhmeta Municipality), at 1060 m above sea level. On the right bank of the river there is a huge travertine rock with the height of 5-6 m, which might have rolled down from above. Some leaf imprints are observed in the rock fragments.

During the expedition carried out in Zemo (Upper) Svaneti we paid attention to the distribution of the travertines and the vegetation imprints in them. Despite the fact that travertines are not widely spread in Zemo Svaneti we had possibility to distinguish two types of travertines: 1) an active travertine (it has a source and sedimentation is still lasting) and 2) an inactive travertine (the source has dried up and sedimentation does not take place). We will try to briefly describe the active and inactive travertine beds below.

Some time ago there was a spring in 2 km distance below village Lakhamula, in the gorge of the river Manshura, near the highway, on the lias slates. Nowadays the slate surfaces are covered with travertine deposits with no imprints of fossil vegetation.

There is a similar situation in the upper part of the gorge of the river Parichala (a tributary of the river Enguri). On its right slope a mineral spring is flowing and it is depositing travertines mainly on the bed rocks. Here fossil vegetation imprints are not observed either.

In the gorge of the river Dolra, on its right bank, on the territory of village Ushkhvanari the lias slates are outcropped and a mineral spring is flowing over them. Travertine deposits are observed on the slate surfaces.

The debits of the above mentioned springs are so minimal that the visible travertines are very thin and are poor in vegetation imprints. Therefore, they cannot be used for paleo-geographical studies.

There are thick rows of travertines in the gorge of the river Hadishchala, 1.5-2 km above village Bogreshi. On the left bank of the river there are several branches of a spring flowing from 4-6 m height above. Here, travertine deposits with fossil vegetation leaves and stems are observed at some places.

There are huge piles of travertines in the areas, where mineral springs existed in the past and have dried up. In this regard the travertines in the Dolra gorge are especially noteworthy, the outcrops of which have survived in the areas of villages Ushkhvanari and Bagvdanari, on the slopes of the Bali Ridge, at 200-250 m height from the bottom of the gorge. On this section the visible thickness of the travertines is 12-15 m. The travertines are characterized with yellowish colour, remarkable firmness and high porosity. They are very rich in imprints of vegetation leaves and stems, which are poorly conserved in most cases. The local

population uses the travertines for the production of lime, which is known as so called "spendiki".

Travertines are widely distributed in the Mulkhuri Gorge, on the northern slope of the Ughviri Ridge, on the height of 100-150 m from the highway (200-250 m from the bottom of the gorge). Here the travertines are outcropped with numerous fossil vegetation leaves and stem voids like the Becho travertines. Unfortunately, the leaf imprints are poorly conserved that makes it difficult to study them. The Mulkhuri travertines are widely used as building material. The local population has been exploiting them for years. The thickness of the travertine piles indicates the fact that there were quite favourable conditions for travertine sedimentation here in the past.

There is a rather thick row of travertines in the source of the Khalde gorge, in the 2-2.5 km distance from the glacier tongue, on the right slope of the gorge, at 250-300 m relative height. The travertines in the Khalde gorge, unlike the Becho and Mulkhuri travertines, are poor in fossil vegetation imprints. There are only a few leaves met, the reason of which is that the row of the travertines is located at 2400 m above sea level in the Alpine zone. We may suppose that in the past the forest belt did not reach this height and the small quantity of leaves mentioned above were brought by wind to that height. The Khalde travertines, due to oldness, are severely eroded. It makes us suppose that they must be a formation of an early period (Pleistocene), Holocene [9].

Less quantity of travertines is observed on the southern slope of the Ughviri Ridge, at 250-300 m height from the gorge bottom, near village Ieli, at the right side of the sleigh track. Like the Becho and Mulakhi travertines, there is a great quantity of fossil vegetation leaves and stems which are used as building material by the local population.

In the travertines of Zemo Svaneti the vegetation trace is mainly presented as leaf imprints. Here fossil fruits and cones are rarely met. Even the leaves are poorly conserved and are presented as fragments, in which, due to high porosity, integrity of the ribs is disturbed. Despite that, N. Ratiani [10] studied and determined the fossil vegetation in the travertines of the Dolra gorge. The author distinguished the following vegetation families and species: gymnosperms – fir-tree (it is mentioned for the first time in regard to Georgian travertines) and pine; angiosperms – maple (mentioned as fossil for the first time), birch, hop hornbeam, oriental oak, mountain ash, rowan, goat willow and elm.

It is obvious that in the travertines of the Dolra gorge the mountain species of vegetation are mainly presented and the deciduous species are dominant here. There is a similar situation in the travertines of Mulakhi and Ieli. Elm and hop hornbeam species are not met nowadays in the travertine distribution areas. According to the fossil forms we may conclude that during that period on the territory of Zemo Svaneti, unlike nowadays, there was warmer and damper climate that made favourable conditions for existence of elm and hop hornbeam (even on rather high territories up to 2200 m). These species must have died out due to climate change, namely, the cold weather. The fact that in the travertines of Zemo Svaneti heat-loving deciduous plants are dominating makes us suppose that they were deposited in warm climate conditions (periods between glaciations). If taking into consideration that travertine sedimentation requires a long time and the above mentioned areas are occupied by quite thick rows of travertines, we may suppose that the travertines in Dolra and Mulakhi must have deposited in the Riss-Wurm interglacial period. It is also indicated by their location on high slopes that coincides with the fragments of Riss trog bottom survived on the slopes [11].

We cannot ascribe the Khalde travertines to the same period as far as there are no fossil vegetation imprints in them and we do not know in which conditions they were deposited (glacial or interglacial period). However, it is obvious that

during travertine sedimentation the upper boundary of the forest was located below them and the rarely met fossil leaves revealed by us must have been brought by wind to that place.

Forms deposited by springs in the forms of travertines and limestone tufa are less distributed in the intermountain line of Georgia. It is caused by geological and hydrogeological composition, namely, the lack of hydro-carbonate waters. Despite that, few piles of travertines and limestone tufa are observed in the intermountain line: on the Zemo Imereti Plateau (the Dzirula crystal massif), in the gorge of the river Kvirila, between Sachkhere and Shorapani, with the imprints of vegetation leaves, on the Gombori Ridge (Kakheti), the Tabatsveri Peak (Gurjaani Municipality), on the valley of the river Iori some limestone tufa with plant imprints are observed [12].

Deposited forms are widely spread on the mountainous part of the South Caucasus constituent of Georgia, compared to the intermountain lowland. S. Chikheladze [3] described travertine piles with vegetation leaf imprints in the Gujareti Gorge (on the Trialeti Ridge), to the south of village Zemo Gujareti, near the Ramniskhevi Spring.

Most of the researchers, as they share the idea of the great glaciation in the Quaternary period, ascribe the travertines on the territory of Georgia to the period following the glaciation (Holocene) as far as survival of the travertine piles in the relief is excluded. However, this assumption is not proved by facts. It is necessary to carry out detailed studies of the vegetation and animal bones, which were fossilized in different epochs of Holocene, Pleistocene and Eopleistocene in the travertines on the territory of Georgia. In this regard, the flora and fauna (vegetation leaf imprints and animal bones) are especially interesting in the travertines outside the glaciation boundary.

პალეოგეოგრაფია

საქართველოს ტრავერტინების გენეზისი და სედიმენტაციის პირობები

რ. ხაზარაძე* და კ. ხარაძე*

* *ივანე ჯავახიშვილის თბილისის სახელმწიფო უნივერსიტეტი, ვახუშტი ბაგრატიონის სახელობის გეოგრაფიის ინსტიტუტი, თბილისი, საქართველო*

(წარმოდგენილია აკადემიის წევრის რ. გაჩეჩილაძის მიერ)

ჩატარებული კვლევების შედეგად შესწავლილ იქნა ტრავერტინების წარმოქმნისა და გავრცელების უბნები საქართველოს ტერიტორიაზე. ირკვევა, რომ კავკასიონზე ტრავერტინების გავრცელება ძირითადად დაკავშირებულია მეზოზოური ნალექების გავრცელების ზოლთან, სადაც შესაძლებელია გამოიყოს ტრავერტინების ორი ტიპი: მოქმედი ტრავერტინები (წყარო არის

და დალექვა ამჟამადაც მიმდინარეობს) და უმოქმედო ტრავერტინები (წყარო დამშრალია, დალექვა არ ხდება). მოქმედ ტრავერტინებში მრავლად არის წარმოდგენილი მცენარეული ფოთლებისა და ღეროების ანაბეჭდები, რომლებიც საშუალებას იძლევა მიახლოებით დავადგინოთ მათი წარმოქმნის ასაკი; ირკვევა, რომ იგი შეიძლება განისაზღვროს ჰოლოცენით ან თანამედროვესთან ახლო დროით. რაც შეეხება უმოქმედო ტრავერტინებს, რომლებიც ძალზე ღარიბია მცენარეული ანაბეჭდებით, გამოფიტულია და ასაკიც ძნელი დასადგენი ხდება.

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