GEOLOGY OF THE BAZOUM HORST-ANTICLINORIUM (NORTHERN ARMENIA): EXISTING KNOWLEDGE GAPS AND THE NATURE OF THE SOUTHERN BOUNDARY OF THE OPHIOLITES

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Abstract

The Bazoum horst-anticlinorium in Northern Armenia is a unique block-folded structure with complex stratigraphy and a history of multistage magmatism, metamorphism, and tectonics. Despite the various types of research conducted in the different formations of the area, many issues remain controversial or unexplained. The purpose of this article is (1) to highlight the main problems and gaps as a result of more than two years of work, (2) to introduce clarity between rocks of different composition and origin based on complex stratigraphic and tectonic relationships, (3) to present the position and condition of the southern boundary of the horst-anticlinorium through several basic geological cross-sections that will contribute to the creation of a relatively realistic map of this structure. In igneous rocks, detailed petrological (with precise geochemical support), and in associated sediments age (yet only paleontological) research will contribute to the differentiation of syn-ophiolitic and post-ophiolitic formations. In particular, the question of the existence of the "Deghnaget suite", and the review of its distribution scale have gained importance, not only in the southeast, in the parts associated with ultrabasic rocks, but also in the western parts of this horst, which was almost neglected until now.

Keywords and phrases: Lesser Caucasus, Northern Armenia, Bazoum horst-anticlinorium, ophiolite complex, geotectonics.

ԲԱԶՈՒՄԻ ՀՈՐՍՏ-ԱՆՏԻԿԼԻՆՈՐԻՈՒՄԻ (ՀՅՈՒՍԻՍԱՅԻՆ ՀԱՅԱՍՏԱՆ) ԵՐԿՐԱԲԱՆՈՒԹՅՈՒՆԸ. ԱՌԿԱ ԲԱՑԵՐԸ ԵՎ ՕՖԻՈԼԻՏՆԵՐԻ ՀԱՐԱՎԱՅԻՆ ՍԱՀՄԱՆԻ ԲՆՈՒՅԹԸ

ՂԱԶԱՐ ԳԱԼՈՅԱՆ

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Համառոտագիր

Հյուսիսային Հայաստանում Բազումի հորստ–անտիկլինորիումը եզակի բլոկածալքավոր կառույց է՝ բարդ շերտագրությամբ, բազմափուլ մագմատիզմի, մետամորֆիզմի և տեկտոնիկայի պատմությամբ: Չնայած այստեղ առկա տա–րատեսակ առաջացումներում նախկինում տարված տարաբնույթ հետազո–տություններին՝ բազմաթիվ հարցեր շարունակում են մնալ վիճահարույց կամ չլուսաբանված: Սույն հոդվածի նպատակն է վերհանել հիմնական խնդիրներն ու բացերը, հստակություն մտցնել տարբեր կազմի ու ծագման ապարների միջև՝ ելնելով ստրատիգրաֆիական ու տեկտոնական բարդ փոխհարաբերություններից: Մի քանի բազային երկրաբանական կտրվածքների միջոցով ներկայացնել հորստ–անտիկլինորիումի հարավային սահմանագծի դիրքն ու վիճակը, որը կնպաստի հետագայում այս կառույցի, համեմատաբար իրատեսական քարտեզի կազմմանը: Մագմատիկ ապարներում ճշգրիտ երկրաքիմիական հենքով պետրոլոգիական, նաև զուգորդվող նստվածքներում հասակային (դեռևս միայն հնէաբանական) մանրակրկիտ հետազոտությունները կնպաստեն սին–օֆիոլիտային ու հետ–օֆիոլիտային ֆորմացիաների տարբերակմանը: Մասնավորապես, «Դեղնագետի շերտախմբի» գոյության հարցն ու տարածման մասշտաբների վերանայումը կարևորությունն են ստացել ոչ միայն հարավ–արևելքում՝ ուլտրաբազիտների հետ ասոցիացվող մասերում, այլև՝ սույն հորստի արևմտյան մասերում, որը գրեթե անտեսված էր մնացել:

Բանալի բառեր և բառակապակցություններ. Փոքր Կովկաս, Հյուսիսային Հայաստան, Բազումի հորստ–անտիկլինորիում, օֆիոլիտային համալիր, երկրա–տեկտոնիկա:

ГЕОЛОГИЯ БАЗУМСКОГО ГОРСТ-АНТИКЛИНОРИЯ (СЕВЕРНАЯ АРМЕНИЯ), СУЩЕСТВУЮЩИЕ ПРОБЕЛЫ И ПРИРОДА ЮЖНОЙ ГРАНИЦЫ ОФИОЛИТОВ

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Аннотация

Базумский горст-антиклинорий в Северной Армении представляет собой уникальную глыбовую складчатую структуру со сложной стратиграфией и историей многоэтапного магматизма, метаморфизма и тектоники. Несмотря на различные виды исследований, проводимых в разных формациях территории, многие вопросы остаются спорными или необъяснимыми. Целью данной статьи является: (1) выделение основных проблем и пробелов в результате более чем двухлетней работы; (2) внесение ясности между породами различного состава и происхождения на основе сложных стратиграфических и тектонических взаимосвязей; (3) представление положения и состояния южной границы горст-антиклинория через несколько основных геологических разрезов, что будет способствовать созданию относительно реалистичной карты этой структуры.

В магматических породах детальные петрологические (с точным геохимическим обоснованием) и возрастные исследования сопутствующих отложений (пока только палеонтологические) будут способствовать дифференциации син-офиолитовых и постофиолитовых формаций. В частности, вопрос о существовании «дегнагетской свиты» и рассмотрение масштабов ее распространения приобрели актуальность не только на юго-востоке, в частях, связанных с ультраосновными породами, но и в западных частях этого горста, которым до сих пор почти пренебрегали.

Ключевые слова и фразы: Малый Кавказ, Северная Армения, Базумский горст-антиклинорий, офиолитовый комплекс, геотектоника.

Introduction

Within the framework of the thematic funding of the Science Committee of the RA MESCS, in recent years, we have paid important attention to the Bazoum Horst (or horst-anticlinorium) exposed in the north of RA. In particular, relying on various studies previously carried out by other geologists, we have highlighted the main frame of current issues related to various pre-Mesozoic (?) and Meso–Cenozoic formations within this structure. Currently, new field geological observations are aimed at gathering the most representative factual material possible, especially at previously cursory (or incomplete) studied and/or problematic nodal sites. Based on the geological, lithologic, petrological, and partly paleontological results, we also expect to perform additional identification, classification, and grouping of various formations into series and suites, according to composition and geochronology. At the end of the thematic works, an attempt will be made to harmonize the formation of various suites and series, as well as the analysis of the general geological evolution of the horst-anticlinorium, with modern concepts or proposed models regarding the formation and further evolution of the Anatolian-Lesser Caucasus-Iranian (or Tethyan) zone in this period. It is important to emphasize that the creation of a new geological map of this structure is necessary based on the adjustments of tectonics and stratigraphy of the study area. Considering the importance of the raised issues and the large amount of work, in this article, special attention was paid only to the last goal, namely, the characterization of the southern border of the horst in the complex stratigraphic and tectonic context of its contact(s).

1. Analysis of the current state of the issue

The review of the general geological, structural, tectonic, biostratigraphic, lithological-petrological, partially geochemical, and geochronological questions of the geological formations spread within the boundaries of the Bazoum horst-anticlinorium is a primary goal. Therefore, as a result, it is necessary to try to explain the geological development history of the horst-anticlinorium in a new way, based on the modern scientific methodology and the analysis of a large amount of factual material (literary and own) acquired in the territory of Armenia and the adjacent regions during the last two decades.

Questions of the general geology, stratigraphy, tectonics, paleontology, petrology, and ore-bearing of the study area were covered by many researchers from the 1930s to the late 1980s (with a noticeable downward trend). In particular, their results are summarized in reports and published works of V.G. Grushevoy, S.S. Mkrtchyan, I.V. Barkanov, K.N. Paffenholtz, V.P. Rengarten, A.T. Aslanyan, A.H. Gabrielyan, V.T. Hakobyan, P.L. Yepremyan, H.H. Sargsyan, S.B. Abovyan, V.A. Aghamalyan, S.A. Palandjyan, A.I. Schmidt, L.S. Melikyan, R.A. Mandalyan and many others.

The Bazoum horst covering the northern slope of the western part of the Bazoum Mountain ridge, which was known since the 1960s as the Bazoum Rise (also known as the anticlinorium or horst-anticlinorium), is the oldest structural element of the Sevan-Shirak synclinorium **[32]**. It is bounded from the north and south by large deep faults of the Cretaceous age, which have undergone numerous renewals over time **[13]**. Various metamorphic rocks present here were considered the oldest and are attributed to the Precambrian–Lower Paleozoic **[9, 27, 28]** or the Upper Jurassic–Cretaceous intervals **[7]**.

Cretaceous formations were carefully studied in the early works of V. Hakobyan **[20, 21]**, who identified five "suites" in the Lower Cretaceous and one more in the Upper Cretaceous. It is noteworthy that Paffenholtz **[27]** attributed the calcareous-marly series to the Upper Cretaceous which was later refuted by Rengarten **[30]**. Nevertheless, in almost all subsequent works, especially in geological maps of different scales, these sediments "remained" as lower and Upper Cretaceous units, excluding the Jurassic ones. Later on, the stratigraphic issues of the horst were also briefly analyzed by **[33]**. However, these and many other questions remain unresolved. Therefore, there is a need to make age corrections in the geological maps by revising the fossil records in the sediments.

Unlike all previous researchers, here, for the first time, S. Palandjyan **[29]** argued against the "intrusive nature" (which had become classical at that time) of the ultrabasic-basic rocks into the Meso-Cenozoic formations, "connecting" them with other components of the ophiolite series (e.g., volcanites, radiolarites, partly limestones). On the principle of analogy (i.e., based on the ideas of the Sevan ophiolite complex), he attributed the ophiolites to the pre-Bajocian or Bajocian ages. And so, the direct dating of the ophiolite complex remained an unsolved question.

No further professional analysis is known about the series of "dacitic porphyries" distinguished for the first time **[20]** within the borders of Horst. Moreover, in recent years (with Armenian-French cooperation) in the eastern part of the study region, in the Stepanavan area, Upper Cretaceous volcanics were described, which have been attributed to the subduction process based on their geochemical composition **[16]**. Therefore, the presence of magmatic (volcanic-subvolcanic) products in the lithostratigraphy is the main key to restoring the geodynamic processes of the given period.

It should be added that one of the most important problems in geology is the question of the genesis and age of metamorphic rocks, depending on which the corrections of geological maps and sections are done. The most famous metamorphic complexes in the region of interest are generalized in the Gargar and Dzoraget Massifs and were first described in detail by V. Aghamalyan **[3, 4]**. However, the period of metamorphism of the Dzoraget Massif remains largely undocumented, unlike the Gargar (or Stepanavan) Massif, where K-Ar (90-80 Ma) **[8]** and Ar-Ar (95-90 Ma and 73.5-71 Ma) **[14, 31]** methods were used for isotopic dating.

In recent years, the "discovery" of the complex of "parallel dykes" on the left bank of the Dzoraget River **[6]**, to the north of the ultramafites, was remarkable in this region. However, like previous works **[29, 1]**, the results of the 2015 field visit of the present author with students do not confirm the belonging of this magmatic body to the "parallel dykes". Our insights were also reported at seminars of the Institute of Geological Sciences. Thus, it is obvious that there are many gaps, and in recent decades, only discrete works or research related to partial issues have been done in this horst-anticlinorium region.

2. Geological structure and brief stratigraphy

One of the most important features of the earth's crust in the territory of Armenia is its structure in mosaic blocks, which is caused by the presence and abundance of deep faults, fractures, and flexures, dividing the earth's crust into many narrow zones and blocks **[e.g., 7]**. According to subsequent and recent studies, the territory of the Lesser Caucasus, in particular, the RA, consists of two parts of the Arabian and Eurasian plates or microplates (microcontinents, blocks, or terranes) and an ophiolitic suture zone connecting them **[e.g., 2, 31, 34]**. Recently, Galoyan et al. **[17]** expressed a different view from the main one, who considered the Somkheto-Karabagh volcano-tectonic zone not the southern active margin of the Eurasian plate, but an independent terrane with its "island-arc origin" nature.

The Bazoum horst-anticlinorium, about 35 km long and 10 km wide, is a part of the "Near-Sevanian intrageosyncline" **[7]** or the Sevan-Akera structural-formation zone **[13]**, or distinguished here as the "Sevan-Shirak synclinorium" **[32]**. However, many geologists attributed this structure to the *sensu* ophiolitic Sevan-Akera zone **[e.g., 4, 5, 29]** or the Amasia-Sevan-Hakari suture zone **[e.g., 14, 15, 22]**. However, Melikyan **[23]** considered Amasia-Stepanavan and Sevan-Hakari as independent zones, based on the peculiarities of their internal structure.

Based on the tectonic position and the fact that it is delimited from the surrounding Paleogene formations from the south and north by tectonic faults, this structure was named "horst-like uplift" **[7]**, and later we also meet the term "horst-anticlinorium" **[13]**. According to Yepremyan **[36]**, the horst-like uplift is limited from the east by another, third fault, which is a northwest spreading Pushkin's reverse fault (with a 60-70° dip to the southwest).

According to Aslanyan **[7]**, also Jurassic formations are spread here, which he grouped into "Black" and "White" suites (based on outer appearance), with thicknesses of 1000 m and 800 m, respectively. In the first suite, metamorphic, volcanic, and sedimentary rocks were described, and in the second one – only carbonate rocks, in which the ultrabasic-basic rocks were considered to be of an intrusive origin.

Later on, studying the formations of this Horst, Hakobyan **[20, 21]** detailed the stratigraphy of the region. Accordingly, the Lower Cretaceous succession is subdivided into the following five suites from bottom to top:

1. "Katnaghbyur" suite; represented by limestones, in which poorly preserved belemnites have been encountered. The thickness of the suite is about 400–430 m.
2. "Arjidzor"; it sits conformably on the previous one and is represented by marls, limestones, siltstones and tuffites. The thickness is 350 m.
3. "Dacite porphyries"; these were described for the first time. Thickness is 100–250 m.
4. The "Spitak" suite is composed of limestones, which are accompanied by sublayers of marls, siltstones, and tuffs. These have a wide distribution, and the thickness is 500–550 m.
5. The "Chakh-chakh" suite is conformably placed on the previous one with gradual transitions. These are represented by limestones, sandstones, siltstones, tuffs, and tuffites. Ammonites of the Albian age have been described here. The thickness is about 500 m.

Finally, the Upper Cretaceous: lower Senonian sediments form the "Urasar suite", which have a limited distribution and are exposed in the core of the syncline. They are represented by marls, limestones, siltstones, and tuffs with a total thickness of about 400 m.

Then, these ideas were subjected to deep analysis and discussion in the work **[29]**, where the "Arjidzor suite" was considered to be older than "Katnaghbyur". In addition, the role of ophiolite association rocks, represented by: (a) basalt-radiolarite-limestone and (b) plutonic basic-ultrabasic facies, was highlighted in the composition of the "Black suite". This author also paid the most important attention to the lithologic-petrographic questions of the sediments and the stratigraphic-tectonic nature of the contacts between individual suites. Nevertheless, the age issues of the metamorphic rocks, the ophiolite complex, and several other sedimentary formations remained unexplained. The issue concerning the petrology of other volcanic rocks, such as "dacite porphyries", is also not addressed.

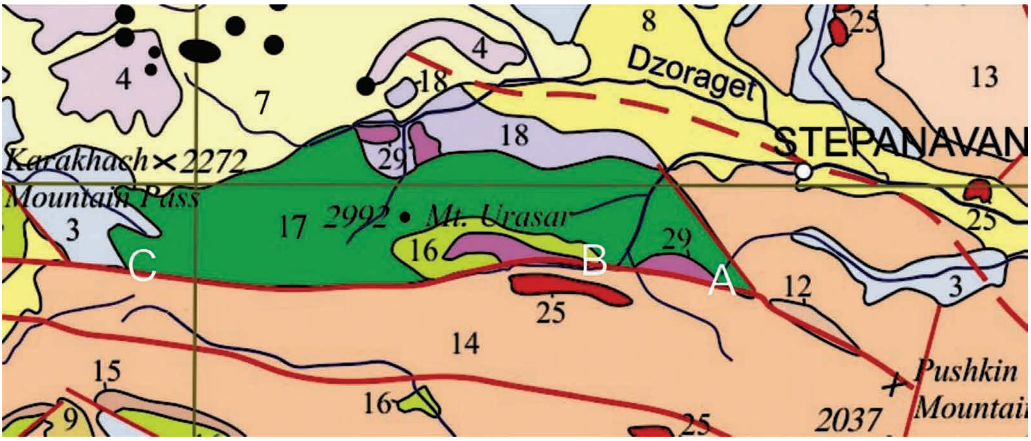

Figure 1. Bazoum Horst site map taken from the 1: 750,000 scale geological map of the territory of Armenia after the National Atlas of Armenia **[25,** p. 26-27**]**. 3 – modern sediments, 4 – Neopleistocene lavas. Upper Pliocene: 7 – differentiated basalt-andesite-dacite-rhyolite lavas, 8 – dolerite basalts. 12 – lower Oligocene sedimentary formations, 14 – middle Eocene volcano-sedimentary series, 15 – Paleocene sedimentary formations. 16 – upper Cretaceous sediments, 17 – lower Cretaceous sediments, shales, and lavas, 18 – upper Jurassic-lower Cretaceous volcano-sedimentary series. 25 – upper Eocene-lower Oligocene granitoids. 29 – ophiolitic ultrabasic rocks. A, B, and C correspond to the presented cross-sections in Figures 2, 3, and 4, respectively.

3. Volcanic-sedimentary facies: radiolarites and their age issues

Certainly, the role of volcanogenic-sedimentary covers in the ophiolitic domains cannot be overestimated. These are important both in petrological-geochemical studies and in the clarification of the geodynamic setting based on geochemistry, as well as in the dating process. Here, the determining role belongs to the dating of sediments using radiolaria.

At the Stepanavan (or Gargar) ophiolitic site, for the first time, radiolarites from the volcano-sedimentary cover documented an upper Jurassic, Late Kimmeridgian-Early Tithonian age for this part of the Tethyan oceanic crust **[10].** The Amasia ophiolite in the extreme northwest of Armenia, which spatially forms the western continuation of geological units included in the Bazoum horst, is isolated by young lavas and makes the eastern continuation of the Anatolian Izmir-Ankara-Erzincan suture zone **[e.g., 2, 12, 14, 22, 26, 34]**. In silicate sediments of oceanic origin, three groups of radiolarians were distinguished here, two of which have upper Jurassic–lower Cretaceous (Oxfordian–Kimmeridgian and Berriasian) ages, while the third group gave a Late Barremian (late Early Cretaceous) age **[12]**. The ages of the Upper Jurassic–Lower Cretaceous succession are comparable to the ages of the radiolarites of the Stepanavan, Vedi, and Sevan ophiolitic sites. In addition, the youngest Upper Cretaceous radiolarian fauna of a Cenomanian age was found at the Amasia site **[11]**, documenting thus the latest period of submarine volcanism.

Considering the importance and effectiveness of this type of dating, we found it necessary to continue similar research in the unexplained areas of the Bazoum horst. Analysis of thin sections (in 2023) of numerous reddish-gray jasper-radiolarite samples taken within this structure revealed that only six of them contained radiolaria. Moreover, only one of them (sample St.11.13) was distinguished by the abundance of well-preserved radiolarias, which is taken in a locality exposed in the watershed of the Gargar-Sevget Rivers, in a small ravine (coord.: N 40.94531°, E 44.32325°). Here, a reddish-gray and black radiolarite section more than 10 m thick covers the surface of the basaltic lavas, in which the pillow appearance is not clearly defined. About 50 m to the east of this outcrop, limestones with alternating pink and gray layers are exposed, which are probably Upper Cretaceous in age **[20]** and unconformably cover the basalt-radiolarite section. According to the identifications of T. Danelian at the University of Lille (France), these radiolarians indicate the Late lower Cretaceous epoch (Hauterivian–Barremian) **[19]**.

4. Nature of the southern limit of the Horst or ophiolites

Usually, in geological sections, and especially in conditions of poor exposure to the terrain, the most difficult thing is to find the contacts of ophiolite complexes and to clarify their nature in those sections. Therefore, through several examples, let’s present the contact relationships of the southern border in the presence of this or that component including the ophiolite complex.

In the south-eastern edge of the Horst-anticlinorium, about 2.5 km north of the Todor mountain peak (altitude: 2787 m), the oldest serpentinite rocks in studied section are overlain by the diabase (basalt)-radiolarite (St.11.05) series, which ends with a thick radiolarite cover. The ophiolitic section is sheard and complicated in serpentinites with internal, north-facing two reverse faults, one thrusts serpentinites on itself and the other on the radiolarites of the cover. To the south, the ophiolite complex is bounded by the middle Eocene volcanic-debris formations (namely andesites: St.11.04 and lava breccias) which unconformably and gently (30° dip) overlie reddish-gray radiolarites.

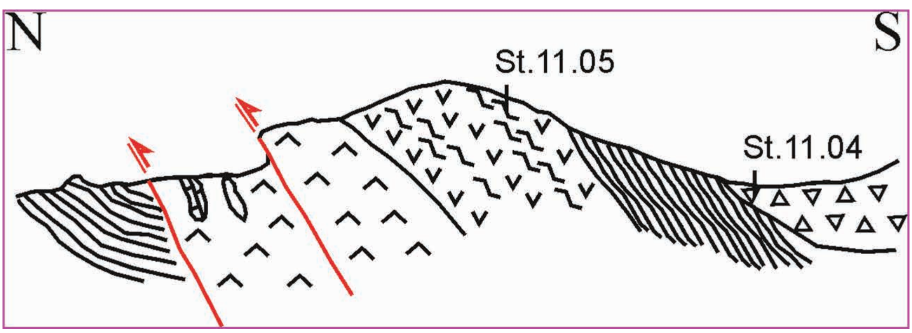

Figure 2. More than 350 m long geological cross-section with a south-north watershed axis, on the left bank of the upper stream of the right tributary (known as “Cold Springs”) of the Gargar River.

We made the next section in the Deghnaget Valley, on the left bank of the river, about 200 m west of the place called “Great Collapse”. On the left bank of Deghnaget, in a sub-latitudinal direction, an ultrabasic-gabbroic (predominantly serpentinite) body of varying apparent thickness (i.e., the width at the surface), almost continuously, stretches for about 7 km to the west, parallel to the river. This was previously known as a segment of the “big dyke” or “great intrusion”. In the west, the width of the body (i.e., the “bulge”) reaches about 400 m, while in the east it decreases up to 5 m. In the past, this “body” was mainly suggested to be associated with the region’s mineralization, while relevant exploration work was carried out in the first half of the 20th century. According to the dominant views **[e.g., 1]**, the “ultrabasic dyke” was emplaced in a reverse fault zone between the Cretaceous and Eocene formations. According to Palandjyan **[29]**, the southern zone of the ophiolite outcrops stretches here for more than 20 km, starting from the region of Mount Urasar in the west to the right bank of the Gargar River in the east. The only site where these outcrops are missing is the place where the Deghnaget and Sevget Rivers join and, where, they are covered under modern alluvial-diluvial sediments.

As can be seen from the presented image, crumpled, foliated serpentinites are exposed in the middle of the cross-section, which are cut by a vein-like body of listwanite (as well as other small bodies). The serpentinites are again overlain from the north by basaltic brecciated lavas of the ophiolitic series (in which traces of radiolarites are inferred?) which are overlain, probably, by an angular unconformity with a suite of whitish platy limestones, dip NW – 355°, angle 50°. From the south, the serpentinites are bordered by terrigenous, grayish-black conglomerates, in which boulders (more than 50 cm) and pebbles of black diabase (predominant), reddish-gray radiolarites, partly listwanites are noticeable. To the south, the coarse-grained terrigenous-sedimentary material gradually passes into fine-grained rocks (e.g., black shales), and then the color of the layers lightens as light gray (white on the surface) organic limestones are exposed (the dip SE - 175°, angle 80°). By the way, it is not difficult to assume that ophiolite rocks can be bounded by tectonic faults on both sides, which is more logical in the way of explaining their present situation.

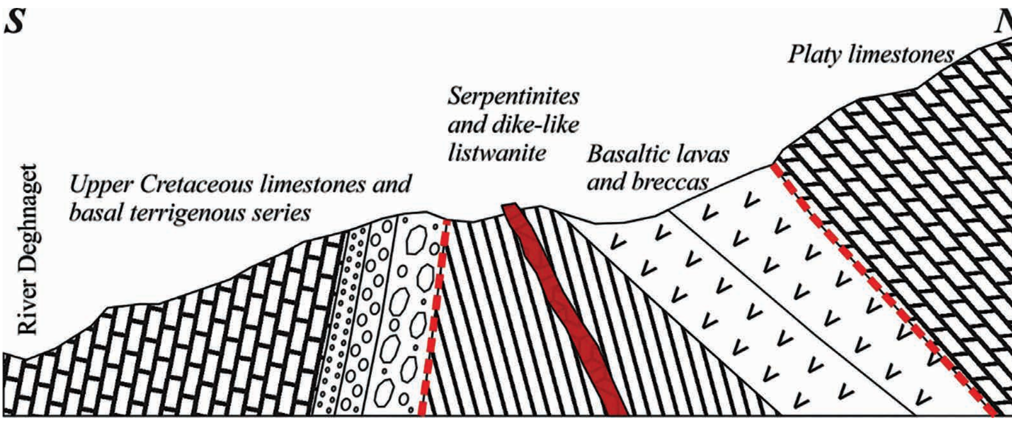

Figure 3. A geological cross-section, 400 m long, along a left tributary of the Deghnaget River, through the south-north axis; the dashed red line is a contact of probable tectonic nature.

Furthermore, we recorded another remarkable relationship of the southern contact in the westernmost part of Horst, near the village of Salut, about 25 km west of the previous cross-section. Here, in the bed of a small stream with local sub-meridional strike, we encountered reddish-gray jasper-radiolarite pebble-fragments, thanks to which we found out the existence of an ophiolite body above, and the nature of this contact explained. The basaltic (sometimes faintly pillow-like) lavas, with occasional reddish-gray radiolarite (R) pockets and lenses, were previously overlain by layers of middle Eocene tuffites. Then, as a result of the tectonic contractions of the region, the ophiolite formations from the north moved on the tuffites by a reverse fault overturning them.

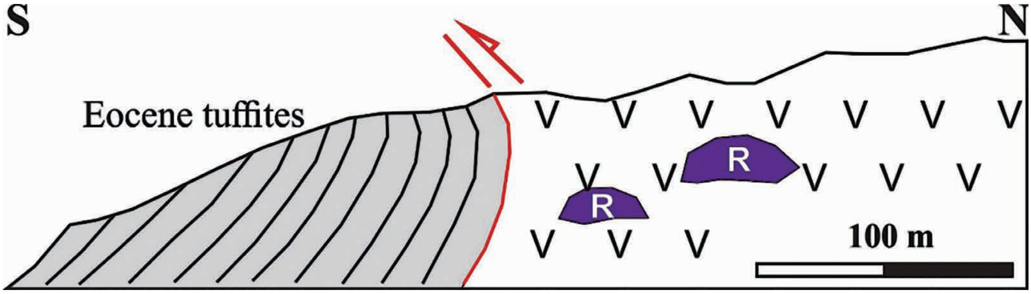

Figure 4. Geological cross-section near the village of Salut, the overthrusting of basalt-radiolarite(R) rocks of the ophiolite complex on Eocene tuffites.

4. Discussion and conclusions

Serpentinites and serpentinized peridotites are the most common in "southern ultrabasites", followed by gabbroids (i.e., gabbro-norite, gabbro) and vein-like pyroxenites. According to Barkanov **[9]**, the "southern dyke of ultrabasites about 19 km long" is located in a normal fault zone, where the Senonian and Eocene formations contact each other. On the contrary, according to Abovyan **[1]**, this is a reverse fault, with a dip of the plane to the north (60-80°) and an amplitude of more than 1 km, by which the Cretaceous formations were raised onto the Eocene. Meanwhile, in Yepremyan's **[36]** work, it is known as the "Gogaran overthrust" with a north dip (35°), by which the "Gogaran block" thrust over the "Bazoum block" in the south, with an amplitude of 2-3 km. However, it is evident from our work, exemplified by Figure 3 and others, that the ophiolites and the rest of the Cretaceous sediments of the Horst were mainly uplifted in different azimuths on the middle Eocene volcanogenic-sedimentary formations, excluding the normal faulting here, because the context is contractional, in which the horst-like uplift has been "thrown out", and is currently surrounded by mainly of Eocene formations. Thus, this overthrust is the main reason why in some places (for example, in the upper reaches of the Deghnaget River and to the west) the Eocene lava flows and tuff layers are found in an inverted state with sub-vertical or steep dips to the north.

Referring to the internal structure of this Horst, K. Mkrtchyan **[24]** noted that it is characterized by strongly contracted internal dislocation, inversion of layers, folding, many internal faults, and the degree of metamorphism. It was also considered to be an 8–10 km wide "wedge-shaped" structure bounded by faults and characterized by a "fan-like" internal structure **[24, 36]**.

During the detailed cartographic works, Hakobyan **[20]** divided the Eocene formations, here, into three parts: (a) lower or "Deghnaget" volcanic (lower(?)–middle Eocene), (b) middle, "tuff-sedimentary" and (c) upper or "Pambak" volcanic suites. According to him, the Deghnaget suite is represented by "porphyrites, quartz porphyries, tuff-breccias, tuffs, sandstones and tuff-sandstones" (about 500 m thick). It is spread on the left slope of the Deghnaget valley, and to the east, crossing the right bank of the same river, then it passes into the valley of the Sevget River, creating a wide zone of volcanic rocks on the northern slopes of Mount Todor.

Referring to this question, Galoyan et al. **[18]** stated that there is an unconformity between the Deghnaget suite and the Eocene tuffite (or tuffite-limestone) series. They presented with solid facts that the Deghnaget suite needs serious revision, because, according to today's understanding, the Mesozoic serpentinite bodies could not be intrusive in the Eocene series. S. Palandjyan **[29]** substantiated this fact in the course of detailed cartographic works and revealed that the old volcano-sedimentary rocks appear in a narrow, linear-extended zone at the base of the "Southern" or "Main thrust", thus, everywhere associated with ultrabasites. Nevertheless, a few years later, this view was completely ignored in a report (Schmidt et al., 1978) and other studies.

As a result of 2004–2008 joint Armenian-French fieldwork on ophiolite research (also with my participation), it was discovered that in the watershed of the Sevget and Gargar Rivers and on the right bank of the Sevget River, we have volcanic rocks that are associated with serpentinites, so they cannot be of Eocene age. However, the issue remained controversial and was discussed several times in the seminars of the Institute of Geological Sciences. Towards the east, in the right part of the Gargar River valley, radiolarites alternating with Late Jurassic (Middle Oxfordian to Early Tithonian) basalts were described **[10]** for the first time in the region.

Further (2011, 2014) and, especially, recent (2022, 2023) field visits of our group in the borders of the Bazoum horst confirmed that both aphyric and porphyritic basaltic or basaltic andesite composition effusive rocks are widespread, accompanied by reddish-gray jaspers, radiolarites, and siliceous limestones. These vulcanites often have pillow structures and are undoubtedly part of the ophiolite complex.

Logically, there are contemporaneous tuffites, as well as gray pelitomorphic (?) limestone cement between spheres (e.g., on the right bank of the Sevget River), as well as black agglomerate tuffs (on the left bank of the Deghnaget River). Therefore, the so-called "Deghnaget suite", if not completely, then a significant part of it should be distinguished as a volcano-sedimentary component of the ophiolite complex, excluding its lower(?)-middle Eocene age **[18]**.

Thus, it becomes obvious that there will be serious structural geological and cartographic revisions, not only here, but also in the rest of this Horst. Undoubtedly, the results of detailed (based on geochemistry) petrological, as well as age, especially, paleontological research will be decisive on the way to finding out the relationships and succession between various formations and suites of different ages. Finally, based only on the study of ophiolites of the Bazoum horst (or any other site), it is difficult to achieve a realistic solution to the problems. In this sense, local analyses and regional comparisons (i.e., territories of Turkey, and Iran) are inevitable in the context of finding more logical explanations.

In terms of lithological composition (serpentinites, peridotites, gabbroids, basaltoids, jasper-radiolarites, limestones, metamorphic blueschists, amphibolites, etc.), there are significant similarities between the Bazoum horst ophiolites and the westward-striking Armenian Amasia **[e.g., 22]** and Anatolian Refahiye **[e.g., 35]** ophiolites. However, unlike the Refahiye ophiolite, the older Paleozoic and lower Mesozoic formations are completely absent or hidden under the surrounding rocks here. Until we don't have new and detailed geochemical data on basic (gabbro, basalt) rocks, it is impossible to reconstruct the geodynamic situation of past magmatism. The only parallel that can be drawn with the Refahiye ophiolites, which we suggest, is the emplacement of this ophiolite on its subduction-accretion complex as a "backstop" (for details see **[35]**).

The ophiolitic formations have mainly tectonic contacts with the Lower Cretaceous (or Upper Jurassic–Lower Cretaceous) suites mentioned above, and the oldest (known us) sedimentary rocks that cover the ophiolitic complex are the Upper Cretaceous terrigenous and carbonate formations, which are in places transgressive onto the serpentinites and or basaltoids. In this region, the Upper Cretaceous series is followed by the lower–middle Eocene volcano-sedimentary formations of the cover, which can be easily distinguished (also our own experience) from the ophiolite basaltoids and tuffs in appearance.

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