

## STRATIGRAPHY OF THE NORTHERN SLOPE ZONE (GONAGKEND-YERFI AREA) OF THE GREATER CAUCASUS AND ITS PROSPECTS FOR MINERAL

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### Abstract

*The article deals with the lithological peculiarities of Middle and Upper Jurassic, Lower Cretaceous and Quaternary sediments distributed on the northern slope of the southeastern plunge of the Greater Caucasus, including the Gonagkend-Yerfi area and the results of the analysis of rock samples taken from separate sections.*

**Keywords:** Greater Caucasus, Gonagkend, Yerfi, Garkhun, Jimi, Berriasian, Valanginian

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The studied area is located on the northern slope of the southeastern plunge of the Greater Caucasus, administratively in the area between the Babachay and Jimichay rivers in the Guba region, corresponding to the areas of the villages of Gonagkend, Jimi, Garavulustu, Yerfi, Talish and Derk (fig.).

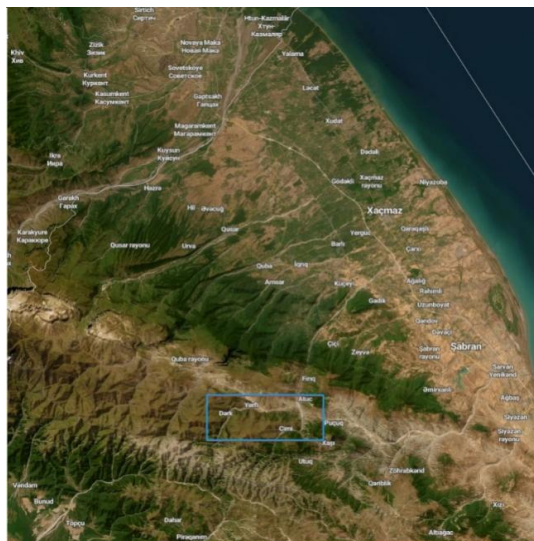


Fig. Relief map of the studied area [11]

(<https://www.scribblemaps.com/maps/view/Azerbaijan/q5FVK2DJpO>)

The Gonagkend-Yerfi area can be recommended as a promising area for the identifying structures suitable for the search for gold and complex ore deposits and occurrences and for conducting precise exploration work. The studied area has favorable stratigraphic and lithological conditions for the formation of stratiform-type deposits and occurrences. On the one hand, the distribution of hydrothermally altered Aalenian terrigenous sedimentary rocks, and on the other hand, the presence of geochemical halos and mineralization points, the determination of 0.3-0.8 g/t gold, 0.06-0.01% molybdenum, 0.06% lead, 0.06 zinc in separate tests taken from clay shales confirm the abovementioned statements [2, 3].

Middle and Upper Jurassic, Lower Cretaceous and Quaternary sediments occur in the Azerbaijani part of the Greater Caucasus and, in particular, from bottom to top in the geological structure of the studied area. Middle Jurassic sediments are divided into the Lower Garkhun semi suite, the Ateshgaya sandstone horizon, the Upper Garkhun semi suite, the Jimi, Khinalig, Keyvan and Zemchay suite from bottom to top [1, 6].

*The semi suite sediments of the Lower Garkhun* are the oldest sediments in the studied area and are distributed in the northern parts of the Tufan anticlinorium. It consists of alternations of clays and argillites, and is rich in numerous clay-siderite conglomerates. The alternation of dark gray, micaceous, carbonate-free argillites prevails. There are thin layers of siltstone up to 10 cm thick. Sandstone layers are mainly fine-grained and very rare. Analysis of the lithological peculiarities of the sections shows that there is a decrease in sandstones and siltstones from northwest to southeast, and an increase in clay shales and argillites in the vertical direction [5].

*The Ateshgaya horizon* sediments are distributed in the basins of the Jimichay, Babachay and Garachay rivers. It opens in the Jimichay and Zaratchay (Babachay) anticline folding on the wings of the Yerfi anticline in Babachay. Observations show that the horizon in the Jimichay basin has altered from south to north. So, while the thickness of Ateshgaya sandstones is 80m in the south, it decreases to 20-25m in the north - in the Jimi anticline and is subjected to wedging in the northeast direction. Lithologically, it consists of alternations of light-gray, light-green-gray fine-grained sandstones with uneven dark, dark-gray and black argillites and clayey shales. Sandstones are medium-grained and their thickness reaches 2-3m in Jimichay. The thickness of the Ateshgaya horizon is 60 m in Babachay.

*The sediments of the Upper Garkhun semi suite* are more widespread than the sediments of the Lower Garkhun semi suite. These sediments occur in the geological structure of the Gurush-Gonagkend and Bazarduzu-Saribash anticlinoriums of the Tufan structural-formation zone. As a result of the gradual subsidence of the Tufan anticlinorium in the Caucasus direction to the east, the thickness of these sediments in the Jimichay basin is 500-600m.

Outcrop of these sediments are also observed in the arched parts of the Tengji-Beshbarmag anticline.

There is a decrease in sandstone layers and an increase in siderite lenses and clayey-siderite conglomerates in the sections of the Upper Garkhun semi suite. The semi suite consists mainly of dark gray and black clays. The sandstone thin layers are gray and ash-colored. The clayey shales are weakly sandy, mainly carbonate-free, solid, sometimes have sheet-like and flake-like segregation.

Fractures filled with white quartz-calcite veinlets are found in the rocks. The suite is characterized by pyrite impregnations and sulfide mineralization.

The total thickness of the semi suite in Garachay is up to 400m.

Sandstone-clayey shales of the *Jimi suite* are widespread in the geological structure of the Gurush-Gonagkend anticlinorium. A banded alternation of sandstone layers, clay shales and siltstones is observed in geological sections. A decrease in siderite lenses and concretions compared to the Upper

Garkhun semi suite is observed in the section. A typical section of the Jimi suite is outcropped in the Jimichay basin. The suite is represented by argillites, siltstones and fine-grained sandstone layers here. The argillites are dark gray, accompanied by pyrite mineralization. The sandstone layers are light-colored, sometimes dark-colored, fine-grained and have a plate-like cleavage. The thickness of separate layers of sandstones and siltstones ranges from 5cm to 20cm, sometimes reaching 50-60cm [8].

The thickness of the Jimi suite is 350m in the Garachay.

The Bajocian stage is represented by the *Khinalig suite* in the studied area. The Khinalig suite is observed in the form of a wide strip from west to east, to the Jimichay basin. The predominance of sandstones in the section is the main feature that distinguishes this suite from Aalenian sediments. The sandstones are gray, fine-medium and coarse-grained, sometimes reaching a thickness of 2.5-3m. Sandstone and siltstone layers alternate with siltstone-argillite layers in Garachay and Babachay. Alterations in the section are observed in the upper reaches of the Jimichay River, as the thickness and number of sandstone layers decrease from Garachay and Babachay to the east. The Khinalig suite is accompanied by an alternation of black argillites and dark-gray, fine-grained sandstones here. The thickness of the argillaceous layers ranges from 0.2m to 1.0m, the thickness of the sandstone layers ranges from 25cm to 60-70cm, and rarely reaches 2.0m. There are clayey shale layers containing clayey-siderite concretions with a thickness of 3.0-5.0 m between the sandstone layers [6].

The total thickness of the Khinalig suite in Garachay is 500m.

The Bathonian stage is represented by *the Keyvan suite* in the studied area. It is relatively less common in the area compared to the Khinalig suite. It is found on the southern flank of the Tufan anticlinorium, in the upper reaches of the Garachay and Babachay rivers and is observed southeastward to the Jimichay basin and outcrops on the surface on the right bank of the Jimichay. Lithologically, it consists of alternations of gray, fine-grained sandstones, siltstones and dark gray argillites. Sandstones form layers with thickness of 10-30cm, and argillites with thickness of 20-50cm. The upper part of the section is accompanied by a fine rhythmic alternation. So, the thickness of sandstone layers is 5-10cm and the thickness of argillites decreases to 15-20cm. The argillites are mainly carbonate-free, dark gray and black. The sandstones are gray and well sorted. It contains quartz, feldspars and sometimes clasts of effusive rocks. The thickness of the Keyvan suite in Garachay is 320m.

Upper Jurassic sediments participate in the structure of all structural-formational zones, including in the studied area in the southeastern plunge of the Greater Caucasus. According to their composition and character, these rocks differ from Middle Jurassic sediments by their carbonateness and increasing carbonateness towards the upper parts of the section. Besides these, the occurrence of limestones and their analogues in the sections is one of the main features of the Upper Jurassic sediments [8].

*The Zemchay suite* sediments were first observed under the Zemchay suite in the Garachay basin, on the northern slope of the Greater Caucasus in the studied area by V.Y.Khain (1933). The abundance of light green siliceous and pelitomorphous limestones is typical for this suite. The alternation of argillites and medium-coarse-grained sandstones prevails in the lower part of the section. The thickness of the argillaceous layers ranges from 15-30cm to 0.8-1.0m. The characteristic peculiarities of the Lower Callovian half stage are the increasing thickness of the alternating layers in the upper part of the sections and the presence of conglomerate layers throughout the section. The thickness of the Zemchay suite in Garachay is 300m.

Middle-Upper Jurassic sediments are represented by the Ilisu suite. The sediments of the suite are distributed in the upper reaches of the Garachay, Babachay and Jimichay. It consists of flysch of sandstone-silty-clayey shales. The increase in sandstones, the red shade of the rocks and the absence

of silica distinguish it from the underlying Zemchay suite. Sandstones and siltstones dominate in the section. Sulfide mineralization is found in sandstones. Carbonate rocks are represented by various analogues of limestones in the sections. The thickness of the Ilisu suite in Jimichai is 600m.

Upper Jurassic sediments (Upper Oxfordian half stage – Kimmeridgian-Tithonian stages) occur in all structural-formational zones in the southeastern plunge of the Greater Caucasus. It is found as a strip between the Garachay and Jimichay basins and it is observed as several strips in folding in the east. Lithologically, they are represented by gray, green-gray sandstones, sometimes gravelites and argillites. The thickness of the sediments in the Dahnechay is 320m [9].

The sediments of the Lower Cretaceous of the Cretaceous system are observed on the northern and southern wings of the Tufan anticlinorium. It covers a large area in the Shahdag-Khizi and Sudur structural-formational zones in the north and in the Zagatala-Govdag structural-formational zones in the south [7].

The *Berriasian stage* (Keshchay suite) sediments are observed as a narrow strip from the northwest to the southeast, between the Garachay basin and the village of Yerfi. No outcrops of sediments are observed to the south and southeast of the village of Yerfi and they are covered by Quaternary sediments. Outcrops of carbonate flysch of the Valanginian stage are found a little to the east, in the area of Nohurduzu village. Lithologically, it consists of medium and fine-grained, gray calcareous sands, pelitomorphic limestones and greenish-gray argillites. The thickness of the Berriasian stage sediments in Keshchay is 140m.

*The Valanginian stage sediments* participate in the geological structure of the Shahdag-Khizi synclinorium. Lithologically, it consists of alternations of gray and light gray polytomorphic, brecciated, oolitic, sandstone limestones and greenish-gray clays. The total thickness is 120m and its thickness increases gradually to 800m in the southeast direction. The thickness of the Valanginian stage sediments in the Gonagkend region is 280m.

*The Hauterivian stage sediments* are developed in the trough of the Khaltan syncline on the northern slope of the Greater Caucasus. As a result of the gradual plunge of the syncline trough in the eastern direction, it participates in the structure of the syncline wings from Jimichay to the east. Lithologically, it consists of dark-gray clays, marls and siltstones up to 10cm thick. The incomplete thickness of the Hauterivian stage is 200m in Garachay.

*The Barremian stage sediments* are represented by clay facies in the Shahdag-Khizi syncline. The clays are greenish-gray, carbonated and layered. It differs from the Hauterivian stage clays by increased carbonateness and lighter colors. The section includes clayey, sandy, oolitic limestones, green marly siltstones and sandstone layers. The thickness of the sediments in the Garachay area is 300m.

*The Aptian sediments* are represented by the lower Aptian half stage and are distributed in small areas in the Shahdag-Khizi structural-formational zone. They are represented by gray, yellow-green-gray carbonate clays. Conglomerates of Upper Jurassic limestones, separate blocks and fragments occur in the form of layers in the clays in some areas. Ochre nests formed by the disintegration of large pyrite conglomerates are characteristic of the sediments. The thickness of the sediments is 460m.

The southeastern part of the Greater Caucasus was considered to be an unpromising area in terms of mineral resources by geologists until the late 20<sup>th</sup> century. However, complex studies conducted in this area have proven the opposite in recent years. As a result of the conducted exploration work, a number of metallic and non-metallic, including oil, gas, oil shales, titanium-magnetite, hematite, copper, molybdenum, nickel, gold, silver, mercury, titanium, zircon, zinc, lead and other minerals have been found [1].

So, the Aalenian “black clay shale” layer is widespread in the studied area, and the gold and silver associated with these rocks are of great importance. Sulfuric and hydrogen-sulfide water springs such as Istisu, Khashi, Khaltan, etc. are known in the studied area [9].

As a result of exploration and planning work carried out on the northern slope of the southeastern plunge of the Greater Caucasus by expeditions of the Geological Exploration Service of the Ministry of Ecology and Natural Resources (currently Geological Exploration Agency) in recent years, a number of ore occurrences – copper-polymetallic, copper-gold, titanium-zircon occurrences and Au, Ag and Hg mineralization points have been discovered in the Tahirjalchay River basin and the Khasi copper-polymetallic occurrence in the sediments of the Jimi suite in the Dahnachay River. According to the results of spectral analysis, the western part of the latter zone contains Cu-0.015-0.02%, Zn-0.03-0.01%, Pb-0.0003-0.04%, Mo-0.0005%; the eastern part contains Cu-0.0003-0.0014%, Pb-0.0003-0.12%, Zn-0.003-0.007%, Mo-0.0001-0.0008%.

The Mesozoic, including Middle-Upper Jurassic and Cretaceous sediments of the southeastern plunge of the Greater Caucasus are considered promising for oil and gas. The prospects of these age sediments have been studied by T.Gorshenin, A.Alizadeh, G.Ahmadov, A.Aliyev, etc. [10].

The oil occurrences of the area cover the interval from the Lower Jurassic to the Quaternary. The oldest rocks related to oil occurrences are the Lower Aalenian clay shales (around Shahdag). Oil and gas occurrences in the Gonagkend zone are associated with Middle Jurassic sediments. Many oil and gas occurrences are associated with Cretaceous sediments [1].

#### **Conclusion:**

The northern slope of the southeastern plunge of the Greater Caucasus is considered a promising area for various minerals, primarily oil and gas, construction materials, as well as ores, mineral and thermal waters.

1. Sulfidation zones and fracture systems in black clay shales create favorable conditions for the formation and arrangement of gold-sulfide, tin-silver, vanadium-molybdenum, polymetallic, iron-manganese and phosphorus deposits. In this regard, the Gonagkend-Yerfi area is no exception, and the results of the analysis of Middle Jurassic sediments distributed in the studied area suggest potential prospects of these rocks, primarily for gold and molybdenum.

2. Oil occurrences are associated with the Lower Aalenian clayey shales spread around Shahdag, and oil and gas occurrences are associated with Middle Jurassic sediments in the Gonagkend zone. Oil and gas occurrences associated with Cretaceous sediments are also known in the studied area.

3. It is considered important to drill or increase the number of exploration wells to conduct research into deeper horizons to determine the mineralization and oil-gas prospects of the research area.

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