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Geological Studies Aimed at Studying the Composition and Properties of Rocks in the Gamyshlydzha Oil and Gas Region

Annaguly Deryaev*

Department of Well Drilling, Scientific Research Institute of Natural Gas of the State Concern "Turkmengas", Azerbaijan

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***Corresponding author:** Deryaev A, Department of Well Drilling, Scientific Research Institute of Natural Gas of the State Concern "Turkmengas", Azerbaijan

ABSTRACT

Valuable information about the geological past of the region can be found in the layers dating back to the Mesozoic era. They provide information about ancient ecosystems, climate and tectonic processes that took place during the Mesozoic era.

The study of these ancient layers has significantly deepened our knowledge of the oil and gas potential of the Gamyshlydzha structure. Significant hydrocarbon reserves may be located in Mesozoic sediments, which opens up new opportunities for the exploration and development of oil and gas fields in this region.

The use of petrographic analysis in the study of sediments under red-black formations is key to the development of geological science and mineral exploration. This method allows you to create more accurate geological models that serve as the basis for successful exploration and development of hydrocarbon resources in these areas.

The study of these deposits not only helps to find new oil and gas deposits, but also opens up opportunities for the discovery of other valuable minerals that can be used in various industries.

In order to effectively develop deep-lying strata, it is necessary to thoroughly understand their geological structure and sequence of stratifications. This allows for a more accurate assessment of their reserves and optimizes the extraction process.

Keywords: Gamyshlydzha structure; Mesozoic sediments; Geological science; Drilling

Introduction

In the southwestern part of Turkmenistan, the main source of oil is rocks that formed during the Pliocene epoch. These ancient geological structures are of great interest to researchers, as a detailed study of their mineral composition and structure allows us to discover many nuances.

This approach helps to more accurately determine the chronology of the layers, as well as to establish their origin and conditions of formation[1].

Recently, geologists have been paying special attention to rocks that are located under the red-colored stratum. Previously, this task was not so urgent, but now it requires an immediate solution.

Increased interest in the study of these rocks is associated with the need to search for new deposits of hydrocarbons and other minerals. The exploration of these geological structures is of key importance for expanding the resource base and meeting the growing demands for energy and raw materials.

The study of these geological formations is of great importance not only for the search for new oil and gas deposits, but also for the discovery of a variety of minerals that can be used in various industries[2,3].

Analysis of the structure and location of these deep-lying layers makes it possible to more accurately assess their potential and optimize the mining process[4].

Materials and Methods

Drilling has uncovered deposits of the Red-Colored formation, the Akchagyl and Apsheron stages and the post-Pliocene. The red-colored sequence is represented by rocks of diverse granulometric composition and mineralogical content, which testifies to the complex geological processes that took place in the region. The upper boundary of the red-colored strata is located at significant depths, lower than in the Ekerem area, reaching 924 m in well No. 6 and 1125 m in well No. 8. This indicates variations in the stratigraphic position of the strata in different parts of the region, which may be related to tectonic movements or differences in sedimentation rates[5,6]. The base of the reddish-colored sequence has not yet been discovered, which leaves open the question of its full thickness and depth of occurrence. The Akchagyl and Apsheron stages have also been penetrated by drilling, which allows a more detailed study of the stratigraphy and sedimentary processes that occurred during the Late Pliocene and Early Pleistocene. These tiers contain a variety of sedimentary rocks deposited under conditions of different hydrodynamic activity and sedimentation, which makes it possible to reconstruct the paleoenvironmental conditions of the region's formation. Post-Pliocene deposits are characterized by sediments accumulated after the end of the Pliocene and include both continental and marine facies, indicating changes in depositional conditions and tectonic activity.

Discussion and Results

The section of the Gamyshlydzha red-colored strata is represented by alternating sandy-siltstone and clayey rocks. Sands and sandstones, grey, dark grey, brown-grey, fine- and fine-grained, calcareous, siltstones and siltstones, grey, bluish grey with greenish tint. Clays, grey, brownish-grey, greenish-grey, chocolate, dense, splintered. The Akchagylian sediments contain mainly clays, grey, greenish-grey, brownish, sandy, with interlayers of greenish-grey fine-grained sand and sandy marl[7]. Typical Akchagylian microfauna were identified in the clays. The roof of the Akchagylian stage lies at the bottom of the characteristic black clays (Benchmark 6) and at the bottom - at the transition to thick sandy-siltstone beds of the red-colored stratum. The total thickness of the Akchagyl is 150-170 m.Deposits of the Apsheron Stage are represented by sandy-siltstone and clayey rocks, in the lower part - grey, sandy clays with sand interlayers, in the upper part - interlayered bluish-grey clays with grey strongly cemented sandstones, sands and siltstones.

The Quaternary sediments are about 450 m thick and include alternating sandy-siltstone and clayey rocks. For the first time, the lithological and mineralogical composition of Pliocene sediments, mainly the red-colored Gamyshlydzha Formation, was studied in detail by us and dissected into two main parts. These studies allowed us to reveal a significant diversity in the composition of rocks and to establish the structural heterogeneity of the strata. The upper part of the red-colored strata was divided into three mineralogical zones, each of which demonstrates unique features in mineralogical composition, granulometric characteristics and degree of carbonation. Each of the identified mineralogical zones was further subdivided into mineralogical horizons **(Figure 1)**, which allowed the internal structure of the strata to be detailed. The mineralogical horizons differ in the content of key minerals such as garnet, epidote, pyroxenes, hornblende, zircon and others.

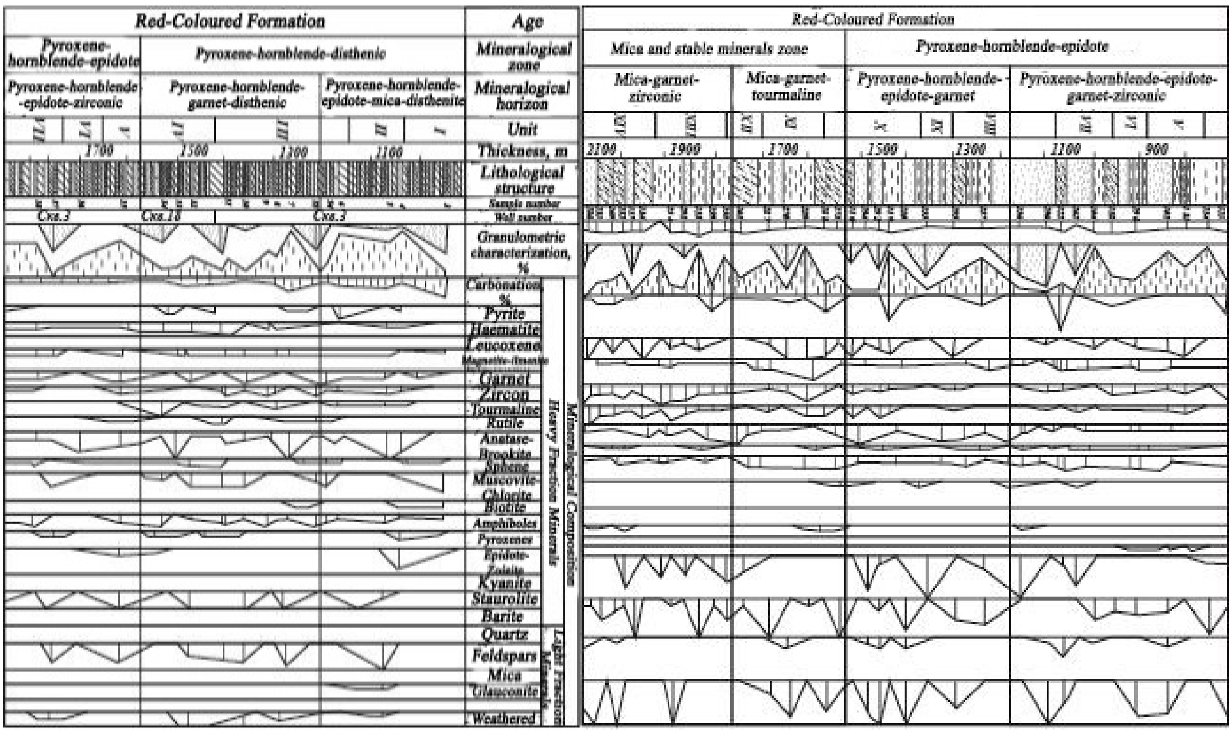

Figure 1: Lithological and mineralogical section of the Gamyshlydzha red-colored strata.

Note: Rocks: 1- sandy-silty; 2- clayey; 3 - alternating sandy-silty and clayey.

These differences reflect changes in depositional conditions and subsequent geological processes such as metamorphism, weathering and hydrothermal activity[8]. The upper zone, characterized by elevated garnet and zircon content, indicates the significant role of metamorphic processes in its formation. The middle zone, dominated by hornblende and pyroxenes, indicates more intense magmatic influences. The lower zone, rich in epidote and zoisite, reflects complex hydrothermal processes and interaction with deep fluids. Each mineralogical horizon, in its turn, shows variations in the content of fine and coarse fractions, which allows us to draw conclusions about the dynamics of sedimentation and tectonic activity during different periods of formation of the strata. The analysis of the granulometric composition showed that sandstones, siltstones and clays differ in the degree of sorting and carbonation, which is also an important indicator of paleoenvironmental conditions.

The mineralogical composition of the Lower Redstone is characterized by a high content of barite - up to 80.8%, garnet - up to 32% and pyrite - up to 81.6%.

Hornblende debris occurs - up to 2.1%, the content of epidote with zoisite is low, not exceeding 0.9%. This part of the section is conditionally called mica-garnet zone. The Upper Redstone is divided into three mineralogical zones according to changes in the content of correlative minerals. The zone of micas and stable minerals is characterized by the absence of pyroxenes and sporadic presence of hornblende, the content of which does not exceed 2.8%. Compared to the upper zone, the content of epidote with zoisite in this zone is lower and does not exceed 13.9%. At the same time, the zone is characterized by high content of several key minerals. Garnet ranges from 35.1% to 46.6%, indicating its significant dominance and role in the formation of the zone. Zircon, important for geochronological studies, is present in amounts up to 15.3-17.8%, showing stability and persistence in different layers.

Tourmaline, with contents up to 20% and mica, reaching 34.6-52.6%, also play a major role in the mineral composition of the zone. Of the ore minerals, magnetite and ilmenite, with grades up to 21.2%, are constantly present in the zone. These minerals are critical components of magmatic and metamorphic rocks, which indicates the complex geological processes involved in the formation of this zone. Pyrite, whose content reaches up to 34.4%, indicates the presence of processes related to sulphide mineralization and hydrothermal influences. Leucoxene, with a content of up to 18.5%, is formed as a result of weathering of titanium-bearing minerals such as ilmenite and indicates metamorphic processes. The content of stable minerals varies along the section, i.e. the maximum zircon content is in the lower half of the zone, so the latter is divided into two mineralogical horizons: mica-granite-zircon (Units XIV, XIII) and mica-granite-tourmaline (Units XII, XI).

The pyroxene-hornblende-epidote zone is distinguished by the diversity of mineralogical composition. In this zone, hornblende, although occurring in the range of 1-3%, can reach significant concentrations up to 9.2-19.6% in some areas. Pyroxenes are found sporadically, with contents ranging from 0.5% to 1.4%. Epidote with zoisite is present in slightly higher amounts in this zone compared to the lower zone, reaching levels up to 19.3%. Resistant minerals maintain high concentrations, with garnet occurring up to 27.3%, zircon up to 13.5% and tourmaline up to 3.2%. Barite is an almost constant component, indicating its stability and predominance in this zone. In contrast, mica content in the zone is decreasing. The ore minerals reveal magnetite and ilmenite, reaching up to 20% in different samples. Pyrite also occurs in significant amounts, up to 76%, indicating its significant presence in the zone. Limonite is found up to 11.3% and leucoxene up to 8.9%. In the upper part of the zone there is a distribution of metamorphic minerals, their content is up to 1%. According to the changes in garnet and zircon content, the zone is divided into two mineralogical horizons: the pyroxene-hornblende-epidote-garnet horizon (Units X-VIII) and the pyroxene-hornblende-epidote-zircon horizon (Units VII-V). The lower horizon is characterized by a high garnet content, while the upper horizon is distinguished by an increased zircon content.

The pyroxene-hornblende-disthenic zone is distinguished on the basis of high content of hornblende, which in some samples can reach values from 23.4% to 37.1%. This indicates the significant presence of these minerals and their stability in this zone. Pyroxenes are also observed, but in smaller amounts, up to 3.1%, indicating their sporadic distribution. Metamorphic minerals, including distene, are present in the zone up to 1.9%, also highlighting the diversity of the mineralogical composition. The content of stable minerals in the zone decreases compared to previous layers[9,10]. Ore minerals occur sporadically, including magnetite with ilmenite, which content reaches up to 19.5%. Pyrite is found in amounts up to 41.2% and leucoxene up to 17.7%. Limonite, in turn, has a significant content of up to 74.8%, which may indicate certain conditions of sedimentation or changes in the geological environment. In the upper part of the zone, there is a slight increase in the content of epidote with zoisite, which is an important sign of a change in mineralogical composition. This change also affects the structure of the zone, dividing it into two mineralogical horizons: pyroxene-hornblende-granate-disthenic (units IV, III) and pyroxene-hornblende-epidote-disthenic (units II, I). This division allows a more precise description of mineralogical diversity and geological conditions of formation of these layers[11].

In terms of mineralogical composition, the Akchagylian sediments do not differ significantly from the upper layers of the reddish-coloured stratum, indicating that the conditions of sedimentation and mineral formation between these strata are similar.

Conclusions

In the course of our research, we examined the physical properties of some minerals. Although we have described their main characteristics, a more detailed analysis of their typomorphic features and optical constants has not yet been carried out.

We paid attention to general physical properties such as colour, density and hardness, but did not investigate more specific aspects, including morphological characteristics and precise optical parameters. The latter include refractive indices of light, double refraction and other optical properties that are important for understanding the origin and formation of minerals.

For a deeper understanding of these processes, it is necessary to take into account typomorphic characteristics, which include crystal shape and structure, as well as optical constants.

A detailed study of these aspects makes it possible to more accurately determine the geological conditions of mineral formation and their significance in the context of the studied sedimentary rocks.

The study of the distribution of minerals in the section demonstrates that the following minerals are of particular importance in the red layer: hornblende, pyroxenes, micas, distene, epidote with zoisite, garnet, zircon, tourmaline, pyrite and barite. These minerals are important indicators of the ratio of different parts of the red-coloured stratum in southwestern Turkmenistan.

Based on these changes and the composition of the minerals, the stratum can be divided into two parts: the lower and the upper.

The composition of minerals in the heavy fraction is similar to that of the upper layer of the red-coloured stratum. This indicates that the ratio of minerals at different levels remains constant.

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