GEODYNAMIC REGIME OF FORMATION OF THE MESO-CENOZOIC SEDIMENTARY COVER OF THE ABSHERON ARCHIPELAGO

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Abstract

The main goal of geodynamic analysis is to learn to perceive sedimentary basins as integral natural objects, to determine their genesis, structure and stages of evolution, classification of sedimentary basins and forecast of their oil and gas potential. It is well known that the changes that occur in the earth's crust are mainly the result of subcrustal processes and adjacent plate interaction. The type of the Earth's crust underlying the sedimentary basin determines the physical basis, stability, tectonic restructuring and sedimentation conditions throughout the evolution of the basin. Geodynamic conditions of sedimentary cover formation in the region under consideration were studied on the basis of the principles of tectonic formation of the Caspian basin and the adjacent area, developed by Azerbaijani and foreign scientists (A.A. Ali-Zade, H.B. Yusifzade, A.A. Narimanov, M.M. Veliyev, A.D. Aliyev; B.E. Khain, A.V., Peyveh and many others).

It is proved that this region is a complicated structural complex consisting of a system of island arcs, rift structures with a changing contour of the foot of the continental slope, underwater cordillera, marginal seas, deflections and uplifts. On the structural map constructed from the bottom of the sediments of the Productive strata (Lower Pliocene), in contrast to the maps of previous years, the axial lines of the deflection are shifted to the marginal parts of neighboring tectonic blocks. All this determines new scientific directions of oil and gas exploration in the Caspian basin.

Keywords: Absheron archipelago, geodynamic regime, sedimentary cover, structural map, seismic-geological profile, Productive strata, transgressive bedding, overthrust

I. İntroduction

To date, numerous variants of the sedimentary basin (SB) classifications have been developed from the standpoint of mobilism (Kucheruk, 1984; Perrodon, 1985; Allen, Allen, 1992; Tectonics..., 1995; Dickinson, 1974; Einselo, 1992; Kingston et al., 1983; Picha, 1989; SB..., 2004). Against the background of a variety of classifications, variants are most widely used, in which the position of the main tectonic structures of the Earth is taken as a basis, according to which the type of crust, the modern structure, and the nature of modern geodynamic processes in the basin are determined. Naturally, within the framework of plate tectonics, the SB is determined in relation to the main elements of the system of lithospheric plates and their boundaries. The position in this system is determined not only by the type of crust (lithosphere), but also by a certain geodynamic situation. Both of these factors – geodynamics (i.e., the system of acting forces) and the type of crust determine many features of the SB, including the nature of deep processes, the mechanism of

formation, thermal regime, features of tectonic structure, types of magmatism and sedimentary deposits, oil and gas presence, etc.

One of the urgent problems of the Caspian basin is to clarify the geodynamic conditions of the formation of the Earth's crust and tectonic-sedimentation complexes. Of particular interest is the transition zone from the South Caspian microplate (SCM), which was developed on the young Scythian-Turanian plate (STP) to the deep-sea South Caspian basin SCB (Fig. 1.). Epiplatform troughs have been identified on the southern periphery of the STP, which are distinguished regionally – these are the Apsheron-Balkhanian threshold, the North Apsheron depression (NAD) and the Guba-Divichi depression (on the west of land). Earlier, when there were no materials of ultra-deep seismic method, there were subjective and erroneous judgments about the occurrence of orogens and depressions in the Caspian area. Based on seismology and shallow drilling data on the region, hypothetical assumptions were made about the occurrence of the SCB. In general, the transition zone was presented as a zone complicated by regional faults and with inversion folding (Geology of Azerbaijan, volume 4, 2005; D. Babayev, A. Hajiyev 2006) [2,9].

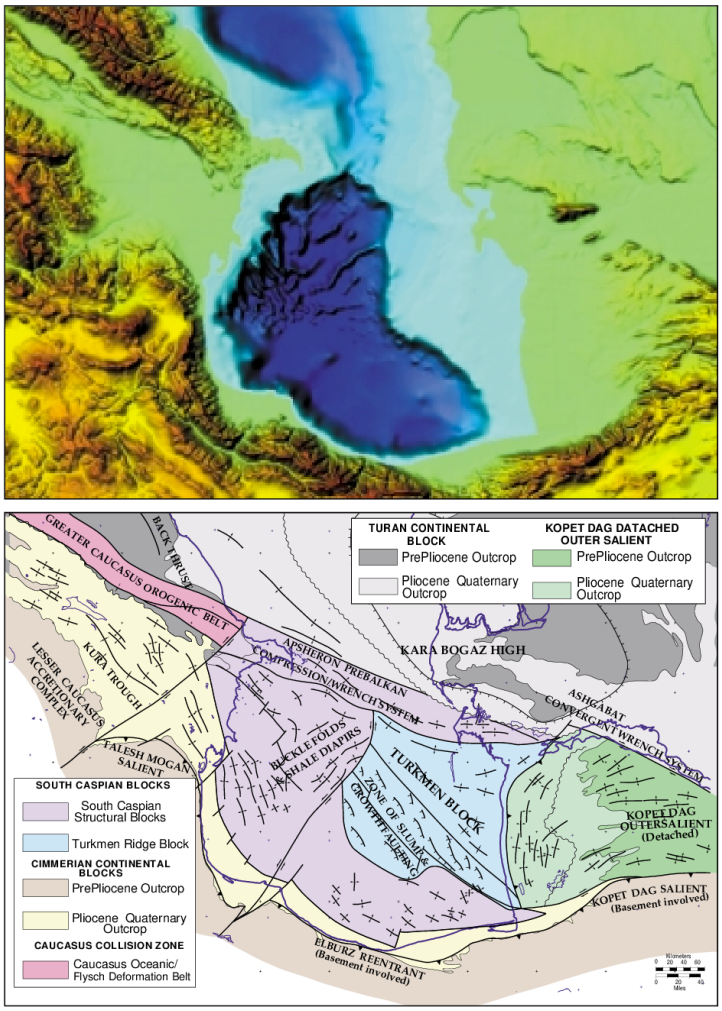

Fig. 1: *Upper: Merged bathymetry and digital topography of the South Caspian Sea and surrounding areas. The elongate subsea ridges present on the bathymetry are the sea floor expression of large, subsurface anticlinal folds. Lower: Structural elements of the South Caspian Sea and surrounding areas (modified from Philip et al., 1989, Berberian and King, 1981; Adamia et al., 1977; Nalivkin, 1976; Huber, 1978)*

In the 60-80s of the last century, the occurrence of sedimentary basins in the Caspian area and their evolution have been explaned by the concept of plate tectonics (P.L. Zonenshain, Le Pichon, 1986; P.L. Zonenshain et al., 1991; Mammadov P.Z. 1982, 2010, 2020). The international programs of MEBE and DARIUS [7], a number of grant studies were carried out, according to the results of

which it was found that the passive continental margin of Mesothetis was developed in the transitional zone in the Paleozoic-middle Mesozoic time. Rifting in middle Jurassic and back-arc volcanism contributed to the opening of the back-arc sea and turned the passive continental margin (PCM) into an active one. From the steep continental slopes, loose sediments were transferred to the Southern Caspian, thick Mesozoic-Quaternary sedimentary complexes were formed, and in the eastern part of the Middle Caspian, starting from the Pliocene, geological bodies of lateral build-up were formed.

In 1995-2000, ultra-deep seismic sounding was carried out in the Middle and Southern Caspian Sea (lasting up to 16-20 seconds), which figured out the structure of the consolidated crust and young sedimentary complexes [5,6]. It turned out that presented for a long time as a geosynclinal basin of the Southern Caspian is a back-arc marginal sea. It was developed on the oceanic crust, which, starting from the Oligocene, began to subduct under the STP. Sedimentary complexes of steep continental margins were subjected to complex folding; an accretion prism was formed from sediments scraped from the surface of the subducting oceanic plate [8]. Thus, the highly informative seismic materials provided objective information about geodynamic processes occurring over millions of years and about the evolution of the SCB and its frames.

Currently, an objective deep model of the Earth's crust is being prepared, a model of an accretion prism subject to zonal folding, which differ both in size and in oil and gas content.

II. Methods

To implement the main objectives of the study, the acquisition, generalization and analysis of extensive literary, geological and geophysical, stock, cartographic materials, deep drilling data, seismic profiles, structural schemes for the areas of Arzu, Gilavar, Khazri, etc. time sections (Fig. 2.), as well as samples of electric logging (Fig. 3.) for individual horizons of PS in the studied region.

Geodynamic conditions for the formation of the sedimentary cover of the studied region are considered in conjunction with the principles of tectonic zoning of the Caspian megadepression, developed in the 80-90s by Azerbaijani and foreign scientists (H.B. Yusifzade, A.A. Narimanov, M.M. Veliyev, A.D. Aliyev; V.E. Hain, A.V. Peiveh and many others) [3,4].

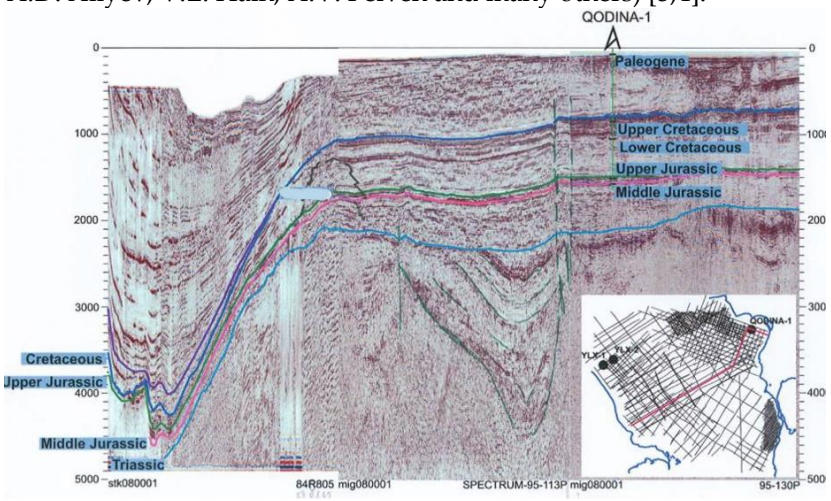

Fig. 2: *Interpretation of seismic section based on BP data*

These developments are based on the time of formation of the continental crust of the transitional type, the indicator of which are the areas of formation of granite-metamorphic layers of different ages - the formation of molasses formation; complexes of rocks of the shelf, continental slope, foot, etc.

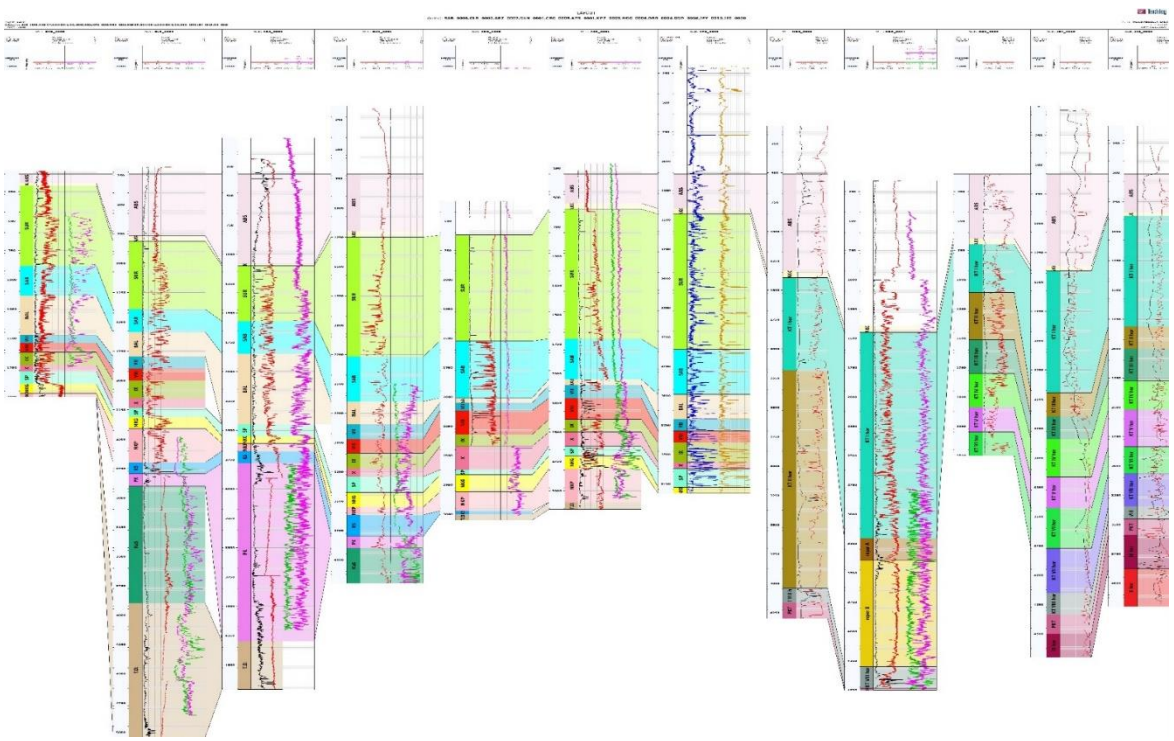

Fig. 3: *Well-correlation scheme through Absheron archipelago [1]*

In the course of the work, the general patterns of the geological development of the Caspian basin were taken into account, detailed for the Azerbaijani part of the Caspian Sea, the underwater slope and the deep-water part of the Southern Caspian basin.

All this made it possible to produce new structural constructions for the region under consideration; to develop a legend and draw up a scheme for the formation of the Apsheron non-volcanic island arc, regional profiles in the western frame of the North Apsheron marginal trough, in the zone of the Apsheron archipelago; to create a new structural map for the bottoms of the PS on a scale of 1:100000, as well as design profiles for the Apsheron archipelago in order to identification of structural floors of the Meso-Cenozoic sedimentary cover.

All this gave rise to a new approach to determining the directions of oil and gas exploration.

III. Results

In order to identify large-amplitude thrusts in the region under consideration, four regional profiles were compiled that revealed the Meso-Cenozoic sedimentary cover.

These profiles show for the first time such thrusts changing the structural plans of Mesozoic, Paleogene and Pliocene-Quaternary deposits. According to these profiles, in the adjacent zones of the North Apsheron Trough and the Apsheron archipelago, these thrusts are distinguished in Mesocenozoic sediments, as well as tectonically limited structures and transgressive occurrence of Late Miocene rocks with a break in sedimentation overlapped the Mesozoic.

To identify common patterns of tectonic reconstructions in the zone of the North Absheron marginal trough and the adjacent area of the Absheron archipelago, a profile (III - III) along the line was selected: Shurabad-deniz, Garbi-Absheron, East Absheron, Khazri, Gilavar, Khali, Chilov, Janub, Bahar.

This profile is carried out (Fig. 4.) in the north-western pericline of the Goshadash structure, along the near-water part of the Gharbi-Apsheron structure and the Apsheron bank in the direction of the Khazri structure, from which the Gilavar structure crosses from north to south. Then it passes through the near-water parts of the Khali-Chilov structures, continues between the periclinal of the Janub structures (I - II) and ends at the immersion to the Bahar structure.

According to the profile, the structure of the Chilov on its immersion in the periclinal part of the Janub structure is characterized by a transgressive overlap of the Jurassic sediments by the Sarmatian layer; lower, Upper Cretaceous and partially Maikop. The deposits of the Oligocene-Miocene are eroded here.

According to the profile, the structure of the Chilov on its immersion in the periclinal part of the Janub structure is characterized by a transgressive overlap of the Jurassic sediments by the Sarmatian; Cretaceous and partially Maikopian deposits.

According to the profile, the transgressive occurrence of Sarmatian sediments on the eroded surface of the Paleogene-Miocene looms on the Khali-Janub-Bahar line; the hinge part of the uplift in the Jurassic and Cretaceous sediments is complicated of large-amplitude horizontal thrust. The formation of the Mesozoic strata occurs along the shelf complex of the Triassic, represented in the Paleozoic folded basement [10]

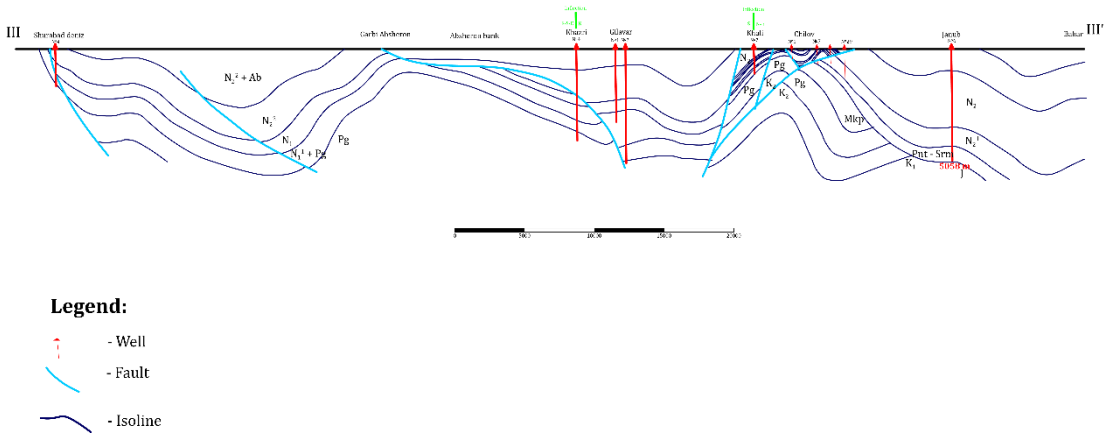

Fig. 4: *Seismogeological profile III-III'*

In the well No. 6 Janub, at the depth of 5058 m, erosive protrusions of Jurassic rocks were revealed, and on the eastern extension of the Janub - Bahar profile, the PS sediment's thickness are sharply increasing. The swelling of the productive thickness reaches 3125m.

Deep erosion of Paleogene sediments on the profile (III – III') is shown on the Khali field (well No. 7) where the PS lies on Paleocene-Eocene sediments.

The transgressive overlap of PS Paleogene sediments in the area of Khazri, Gilavar, Khali gives grounds to make a judgment about a regional break in sedimentation at the Paleogene-Miocene stage in the region under consideration. These data once again confirm the earlier conclusions (Aliyev, 1996) about the formation of an island arc in the zone of the Absheron archipelago.

The structural discrepancy between Mesozoic and Paleogene-Miocene sediments is clearly visible from the compiled regional profiles: Mesozoic structures are characterized by steep angles of incidence, fan-like expanding scaly thrusts, tectonically shielded structures. The Paleogene-Neogene is characterized by transgressive occurrence with interruptions in sedimentation overlapping the Mesozoic complex.

The revealed large-amplitude thrusts forming zones of rock crushing and an increase in sediment capacity, of course, as mentioned above, create conditions for the formation of oil and gas deposits. In order to identify additional search criteria, seismic-geological profiles, structural maps for the lower PS and Upper Cretaceous sediments limiting the gas-generating clay strata

were compared. These comparisons revealed the discrepancy of structural plans, the sharding of the above-mentioned strata and the inflating of thickness at various stratigraphic levels of the Paleogene-Miocene; the sharding of the clay strata led to the formation of tectonic breccia, crushed clay shales, calcareous sands and sandstones, which significantly increases the reservoir properties of the strata.

On the compiled structural map (Fig.5.) along the bottom of the PS, the influence of geodynamics of tectonic basement blocks on the formation of folded structures of the region along the bottom of the "Fasila" suite is outlined, where tectonic blocks are clearly traced, articulated by paired faults. At the same time, the articulation of blocks from north to south is ledge-like, and from west to east stepwise.

The axial lines of study region shown on the structural maps of previous years (1970-83), according to new developments, turn out to be shifted to the marginal parts of linear folded structures, which are inherited folds of the foundation, reflected in the bottoms of the upper part of the Productive Series.

The linear folded zone of the Azi Aslanov, Palchig Pilpilasi, Neft Dashlari, along the latitudinal fault is shifted 5-6 km south of the structures of Guneshli, Chirag, Azeri, and Kapaz. The subsurface parts of the structures are complicated by transverse discontinuous disturbances with a small amplitude of vertical displacement (50-100 m).

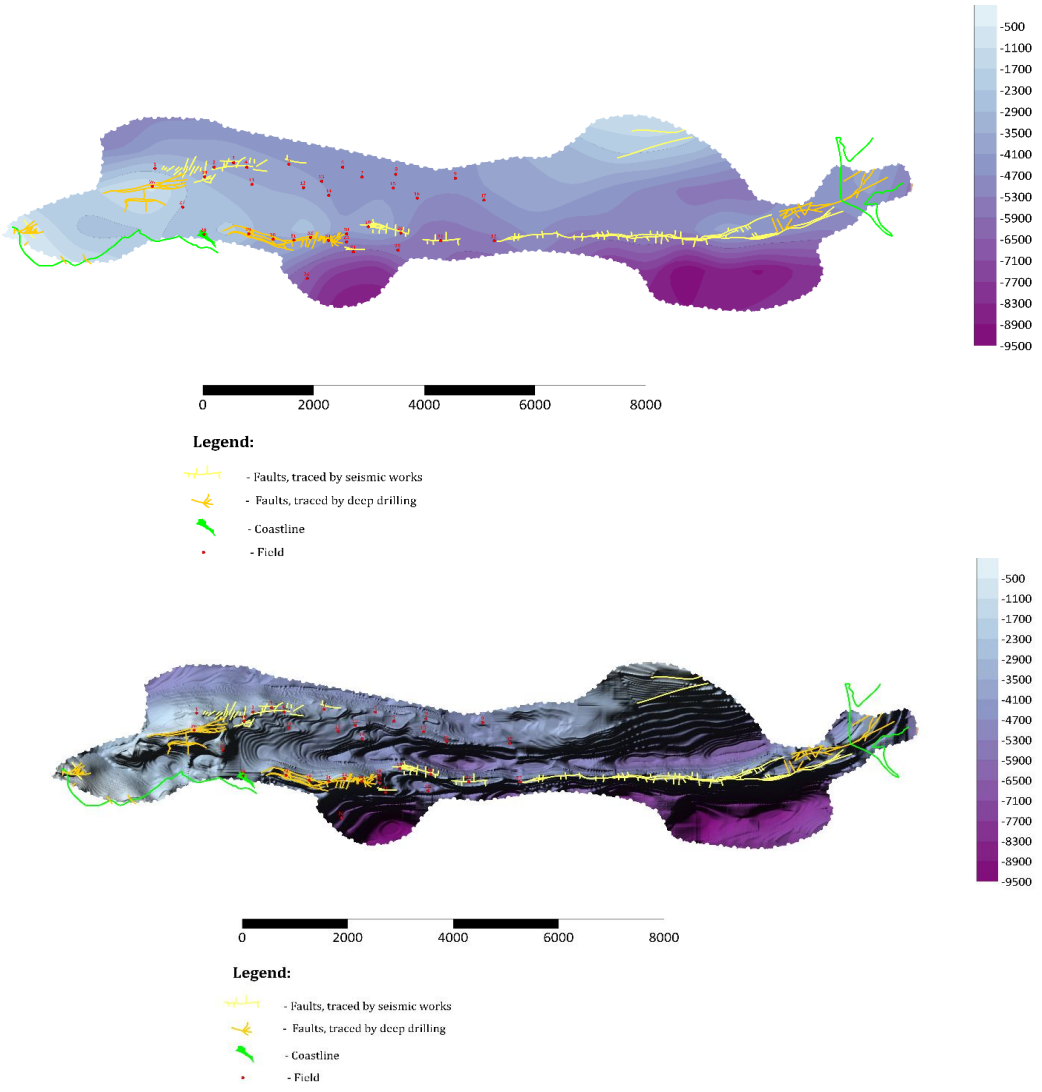

Fig. 5: *Structural map: bottom of PS sediments (contour and relief maps)*

The Gosha Dash fold - located in the northwestern part of the Absheron Archipelago along the bottom of the "Fasila" suite - is a flat structure, closing along an isohypse of 1500 m. The axial line of the fold is shifted to the southwest at an angle of 25-30 °, relative to the longitudinal fault, along which the northern limb is lowered by 500 m.

The southeastern periclinal of the Gosha Dash fold is shifted by a transverse fault to the south in relation to the Gharbi Apsheron structure and through a small saddle, through discontinuous disturbances, it articulates with the Agburun-deniz fold. In general, the structure of the Gosha Dash at the bottom of the upper part of the PS is elevated relative to the edge of the adjacent lowered tectonic block, where the sole of the "Fasila" suite lies at a depth of 1500-2000 m.

A comparative analysis of the developed graphic materials, the identification of structural plans for various stages of Meso-Cenozoic sediments, transgressive occurrence of Paleogene sediments in the Mesozoic, gave the basis for the selection of directions and the construction of project profiles (IV-IV).

As can be seen from the project profile IV-IV (Fig. 6.) and a structural map along the bottoms of the PS, gentle dome-shaped uplifts are revealed here; in the lower section of the PS deep faults crossing Gala suite, Sub-Girmaki suite, Girmaki suite are traced. Paleogene-Miocene deposits transgressively lie on the blurred surface of Mesozoic rocks, forming secant thrusts in the clay gas-generating thickness.

Disjunctive dislocations in Mesozoic sediments are characterized by large-amplitude horizontal thrusts at various stratigraphic levels of the Lower, Upper Cretaceous and Jurassic rocks, with the formation of tectonically shielded structures.

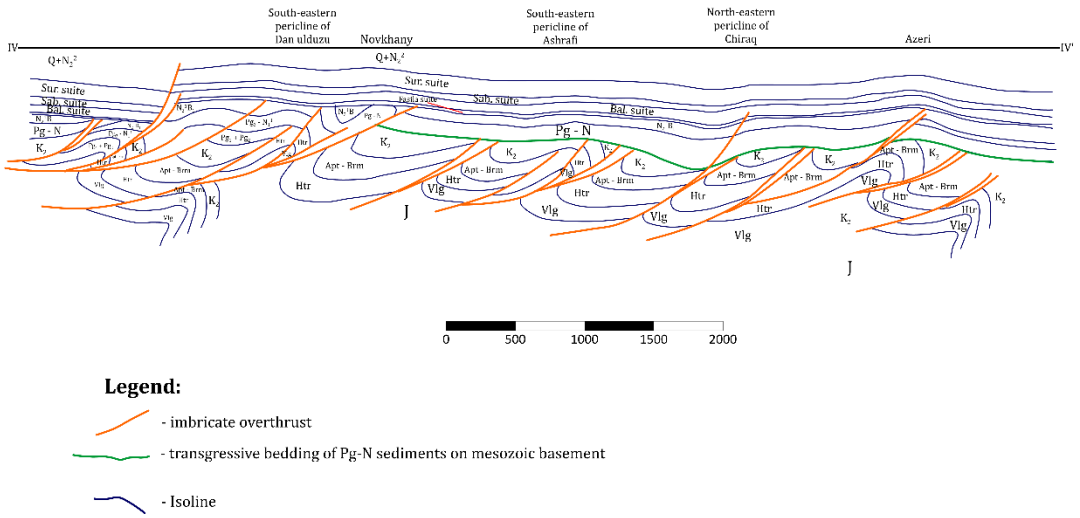

Fig. 6: *Seismogeological profile IV-IV'*

According to the profile, the discrepancy of structural plans is clearly traced in the Mesozoic, Paleogene—Miocene, Lower and Upper PS sections. Mesozoic sediments are characterized by large-amplitude thrusts forming tectonically shielded structures in the section of the sedimentary cover. On the erosive surface of the Mesozoic, the Paleogene-Miocene strata lies transgressively, forming an independent structural plan.

The data of structural constructions and the fact that the structural plans for the bottoms of the PS and the surface of the Mesozoic (Aliyev, 1967) give reason to assume the formation of secant thrusts here, along which there is a sharing in the section of the PS with the subsequent overlap its retinue "Fasila" suite - the bottoms of the Balakhany suite.

III. Conclusions

In general, it should be noted that the studies carried out during the investigations made it possible to clarify the geodynamic conditions for the formation of the Meso-Cenozoic sedimentary cover of the region in question to predetermine folding processes in second-order geostructural elements against the background of the continental slope.

Large-amplitude thrusts in Mesozoic sediments and transgressive occurrence of Paleogene-Neogene sediments on Mesozoic protrusions along the lines of profiles: Nardaran-Zorat; Agburun-Sitalchai, Shurabad; Shurabad-deniz, Gosha Dash, Gilavar, Khali, Chilov, Janub were revealed.

- secant thrusts in the cross-section of the V-V profile, in the northeastern limb of the Kapaz structure, where the capacity of the Meso-Cenozoic sedimentary cover is doubling.

On the structural map by the bottom of the PS, the displacement of the axial lines of deflection is traced, tectonic blocks are distinguished by ledges sinking from north to south and stepwise from west to east; the study data confirm the prolonged activation of tectonic processes in the region under consideration.

All this significantly expands the idea of the formation of zones favorable for the accumulation of hydrocarbons and contains elements of a new approach to the search criteria for oil and gas.

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