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CLASSIFICATION OF NON-ANTICLINAL TRAP TYPES IN THE BINAGADI AND SULUTEPE OIL AND GAS FIELDS IN AZERBAIJAN

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Annotation

The main condition is the precise classification of stratigraphic-lithological traps of non-anticlinal type with the allocation of horizons on the compiled map. Providing accurate and complete information on each perspective horizon of the Binagadi and Sulutepe fields, it is possible to indicate their differences. One of the elements of the forecast of non-anticlinal traps is the study of horizons, interpretation and detection of the zone of stratigraphic and lithological wedging. Thus, on the basis of the constructed maps and the definition of oil contours on the Binagadi and Sulutepe areas, it is possible to estimate the location of oil and gas wells.

Keywords: *productive strata, oil and gas contour, sedimentation process, transgression, regression, consedimentation and postsedimentation, diagenesis, catagenesis, hypergenesis and tectogenesis.*

AZƏRBAYCANIN BİNƏQƏDİ VƏ SULUTƏPƏ NEFT-QAZ YATAĞINDA QEYRİ-ANTİKLİNAL TƏLƏLƏRİN TƏSNİFATI

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Xülasə

Əsas şərt tərtib olunmuş xəritəyə əsasən horizontların müəyyən edilməsi ilə qeyri-antiklinal tipli stratiqrafik-litoloji tələlərin dəqiq təsnifatıdır. Binəqədi və Sulutəpə yataqlarının hər bir perspektivli horizontu haqqında dəqiq və dolğun məlumat verməklə onların fərqlərini qeyd etmək olar. Qeyri-antiklinal tələlərin proqnozunun elementlərindən biri horizontların tədqiqi, stratiqrafik və litoloji sıxışdırma zonasının təsfiri və aşkarlanmasıdır. Beləliklə, qurulmuş xəritələr əsasında Binəqədi və Sulutəpə ərazilərində neft konturlarının müəyyən edilməsilə neft və qaz quyularının yerini qiymətləndirmək olar.

Açar sözlər: *Məhsuldar silsilələr, neft və qaz konturu, çöküntülərin yığılması prosesi, transqressiya, reqressiya, konsedimentasiya və postsedimentasiya, diagenez, katagenez, gipergenez və tektogenez*

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КЛАССИФИКАЦИЯ НЕАНТИКЛИНАЛЬНЫХ ТИПОВ ЛОВУШЕК НА НЕФТЕГАЗОНОСНЫХ МЕСТОРОЖДЕНИЯХ БИНАГАДИ И СУЛУТЕПЕ В АЗЕРБАЙДЖАНЕ

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Аннотация

Главным условием является прецизионная классификация стратиграфо-литологических ловушек неантиклинального типа с выделением горизонтов по составленной карте. Давая точную и полную информацию по каждому перспективному горизонту месторождений Бинагади и Сулутепе, можно указать на их различие. Одним из элементов прогноза неантиклинальных ловушек является изучение горизонтов, интерпретация и обнаружение зоны стратиграфического и литологического выклинивания. Таким образом, на основе построенных карт и определения контуров нефти по площадям Бинакади и Сулутепе можно оценить расположение нефтегазовых скважин.

Ключевые слова: *продуктивная толща, нефтегазовый контур, процесс седиментакопления, трансгрессия, регрессия, конседиментация и постседиментация, диагенез, катагенез, гипергенез и тектогенез.*

Introduction

Due to the fact that the onshore anticlinal oil and gas fields of Azerbaijan are at a late stage of development, it is necessary to expand the exploration and prospecting work in more promising areas associated with promising non-anticlinal traps [1].

It should be noted that the problems identified during the exploration of non-anticlinal traps, such as stratigraphic, lithological wedging, erosional rupture, disproportionate angles, reef formation, etc., are associated with the heterogeneity of trap types, their sizes, bedding elements, accumulation conditions, etc. [1-5].

Taking into account the above, at an early stage of the research, various types of the most common non-anticlinal traps in Azerbaijan were selected [2, 3]. For this purpose, 6 types of non-anticlinal traps were studied - pinching out, surface washouts, tectonic ruptures, consedimentation and postsedimentation, repeated changes, and the process of sedimentation. The studies were carried out according to the specified block diagram of Figure 1 of the sequence. As a result of the studies, the diagram shows the breakdown of the stages of the corresponding fragments of the trap. As a result, the type of identified non-anticlinal traps, stratigraphic affiliation, reservoir properties and their productivity are predicted. At the same time, one can encounter unique non-anticlinal traps that differ sharply from each other.

As shown in the figure, to determine the existence of non-anticlinal traps, the initial geological conditions are first investigated. In the process, the conditions for the formation of traps, paleogeography, transgression and regression of the sea basin, and the location of the coastline were investigated. The effects of sedimentation, the accumulation of terrigenous and carbonate deposits, which play the role of seals, are also analyzed. During the research, tectonic disturbances, their geomorphological results and the relationship between sedimentation processes, the tectonic-sedimentary period, factors of the appearance of modern coastal and coastal zones and other geological processes are widely studied. To carry out these research works, a comparative analysis of the Binagadi and Sulutepe oil and gas fields was carried out.

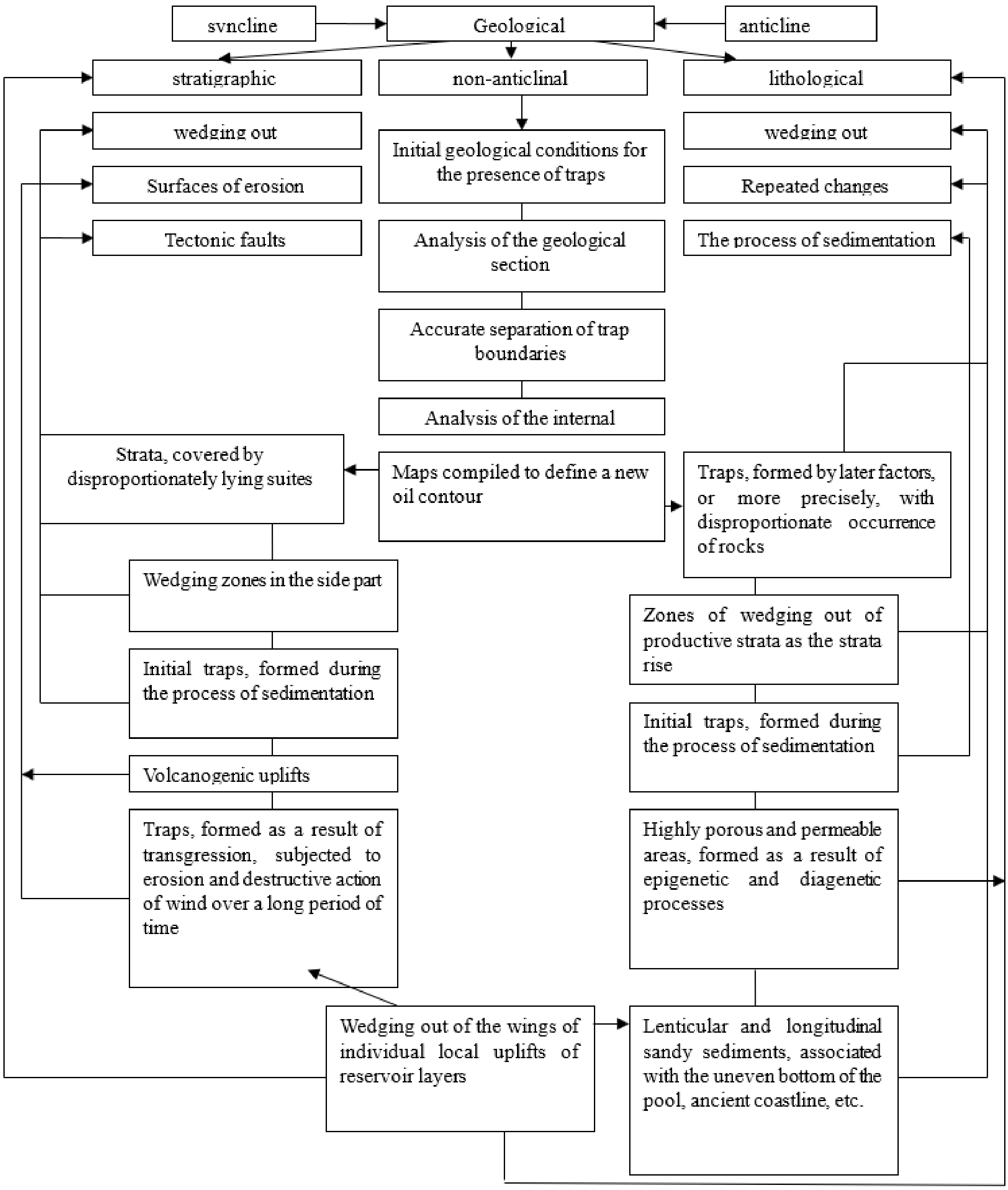


Figure 1. Block diagram of the non-anticlinal trap system approach

At the second stage, according to the studied areas, according to the division of stratigraphic and lithological traps into stages, the causes and time of formation of non-anticlinal types of traps are determined. The concave fold of oil and gas traps of the stratigraphic and lithologic type, reflecting such stages as diagenesis, catagenesis, hypergenesis and tectogenesis, is formed in the process of the evolution of the earth's crust. Therefore, it is necessary to clearly distinguish between stratigraphic and lithologic wedging [1].

Thus, in the second stage, the growth of productive layers is associated with traps with stratigraphic and lithologic wedging or facies replacement.

The formation of lithologic oil and gas traps is associated with the presence of lithologic screening, which has a different structure and genesis. Many horizons associated with wedging are classified as lithologic type traps [1-3]. In our opinion, this is due to the different meanings of the term "wedging". As for wedging associated with the replacement of permeable sediments with impermeable ones, it would be more correct to single out the concept of "lithologic wedging". The basis for identifying lithologic type oil and gas fields is a change in the lithologic composition of rocks. This is genetically associated with a change in the sedimentation process, and at a later stage of development with diagenesis and epigenesis

As shown above, this type of wedging is characterized by an unchanged or slight change in the thickness of the formation, and individual productive layers are wedged out here [2]. Traps with lithological wedging or facies replacement (consedimentation) are formed in the crest part on the bottom of the sedimentation basin as a result of changes in sea level (sand layers are covered with impermeable rocks in a wedge-shaped manner). Stratigraphic and lithological traps were shown on the Binagadi area on the geological section lV-lV (Fig. 2a). Stratigraphic traps are formed here as a result of wedging out of the PKS, KS6, KS_{5c+d} and KS_{5a+b} suites. The noted suites, resting on the roof of the Pontic suite, wedge out from the southeast to the northwest. The wedging area, starting from a depth of 340-350 meters, continues up to 40-50 meters. The dip angles of the layers are 45-50^o [4].

. The lithologic trap is located within the KS_4 suite. The trap pinches out at a depth of 120-130 m and has a dip depth of 300 meters. The angle of dip of the trap is 35-40^o. These types of traps are formed within the same formation as a result of facies pinching out of porous or low-porosity productive rocks. They are directly related to the sedimentation process, especially the movement of the sea line and the deep part of the sedimentation basin. Therefore, the formation of KS_4 is assumed under the conditions of synsedimentary accumulation. The same horizons that lithologically pinched out as a result of uplifts and regressions, coming to the surface of the earth, were subjected to erosion and were washed out in the crest part. As a result of the subsequent fall and transgression, they are covered with a transgressive layer of sediment at a disproportionate angle. As a result, horizons with lithologic pinching out withdisproportionate surfaces are formed. It would be more correct to relate them to the lithological-stratigraphic group of traps.

Along profile VI-VI (south-west-north-east), penetrable rocks, being replaced by impenetrable ones, form a successive stratification of the observed layers (Fig. 2g). The traps formed as a result of this are associated with the anticlinal folds of the sedimentation basin. Here, on the wings and periclines of the basin, lithological wedging is also observed as a result of the action of sea waves. From the bottom up, within the various suites, the depth of wedging changes significantly. This proves that the bottom of the basin was in intensive movement during the sedimentation period.

At the third stage, eroded surfaces, exposed to erosion and wind action for a long time, are associated with traps formed as a result of consedimentation and postsedimentation.

Due to various inconsistencies, stratigraphic traps formed as a result of oscillatory movements make it possible to substantiate this type from a genetic point of view. Another group of stratigraphic traps is associated with transgression and disproportionate occurrence of reservoir layers (Fig. 2a, b, c, d, e). This disproportionate form is formed slightly further from the coastline. Here, as a result of the continuous approach of the coastline, reservoir layers are formed, which are directly related to the process of pinching out of the consedimentary transgression and disproportionate tilt. Within the redistribution of layers, a disproportionate tilt is also observed. Wedge-shaped layers are also formed during consedimentary regression (Fig. 2a). The noted groups of traps can also be taken as traps associated with stratigraphic pinching out [4].

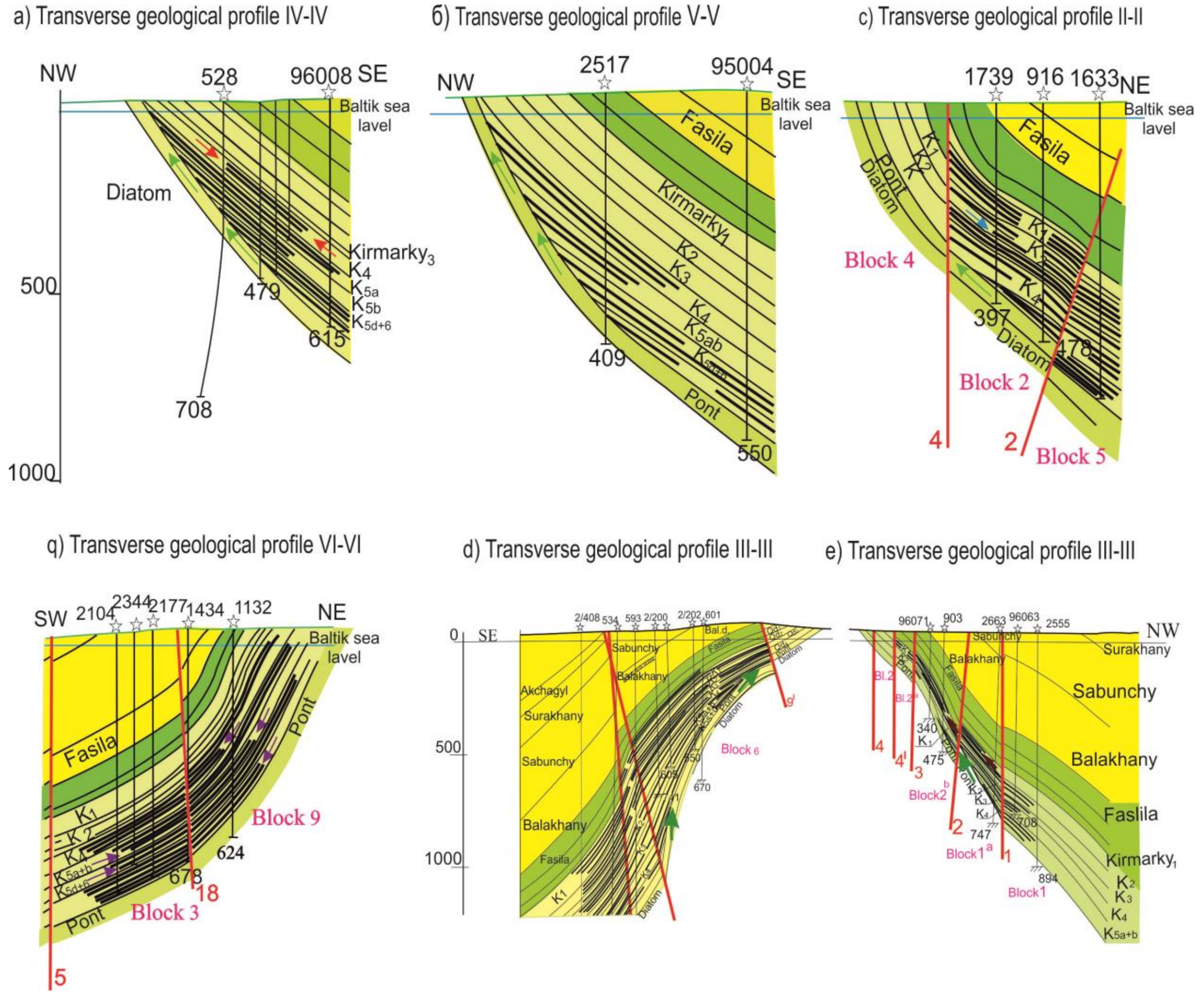


Figure 2. Binagadi oil field. Stratigraphic and lithological oil and gas traps by geological traps.

- *Reservoirs bounded on all sides by impenetrable rocks or lithologically bounded traps;*
- *Stratigraphically wedging horizons (regression and transgression);*
- *Traps associated with sand formations formed as a result of diagenetic and epigenetic features of sedimentation;*
- *Lithological wedging of horizons uplifts of productive strata or lithological wedging as a result of sea level change on the slopes of the basin due to secondary movements occurring on the floor of the sedimentation basin or traps formed by wedge-shaped replacement of sand beds by impenetrable rocks with the formation of synsedimentary traps of facies replacement;*
- *Lithologically wedging traps associated with the replacement of penetrable rocks by impenetrable ones.*

Studies of the stratigraphic traps found at the Binagadi field, as well as the conditions of formation of oil and gas fields show that they are associated with both transgressive cover and regressive bedding forms. To determine the oil contour of the KS_4, KS_{5a+b}, KS_6 and PKS horizons, structural maps were compiled and the difference in the structural structure of the PKS and KS_6 horizons (Fig. 3) from that of the KS_{5c+d}, KS_{5a+b} and KS_4 horizons (Fig. 4) was determined. This shows that during the accumulation of the PKS and KS_6 horizons, as a result of the uplift of the earth's crust in the area of the Boyuk-dag mud volcano, the withdrawal of sea waters is the cause of regression (stage I) (Fig. 3). And during the accumulation of the horizons KS_{5c+d}, KS_{5a+b} and KS_4 as a result of the expansion of the sea boundary (stage II) a transgression occurred, as a result of which the river boundary shifted 5.8 km to the west.

The sedimentation zones of the horizons KS_6 and PKS do not differ much. Therefore, they can be attributed to stage I. And the sedimentation zones of the horizons KS_{5a+b}, KS_{5c+d} and KS_4 for the same reasons can be attributed to stage II.

In the marginal parts of the sedimentation basin, a transgressive cover is observed in the horizons KS_{5c+d}, KS_{5a+b} and KS_4. Here, the transgressive cover successively covers previously eroded monoclinal layers with a stratigraphic wedge in the direction of the coastline (Fig. 2b). The disproportionately covered transgressive layer consists of impermeable rocks. In its formation during breaks in sedimentation, the main role is played by erosion and washing out of reservoir layers (post-sedimentation processes).

Thus, they are associated with traps formed in the fourth stage as a result of tectonic disturbances.

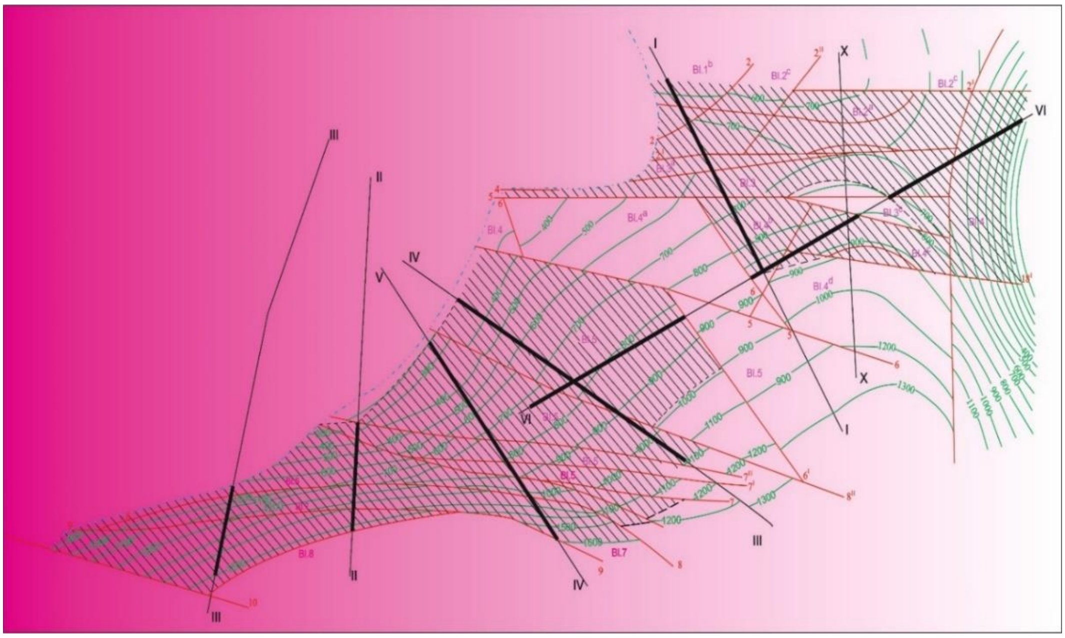
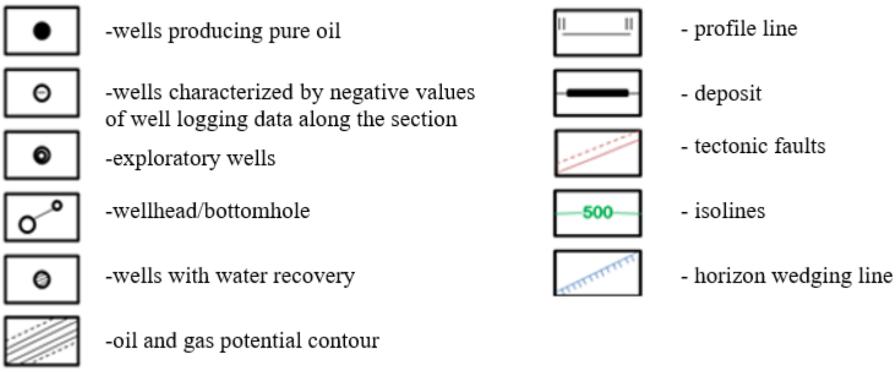


Figure 3. Map of the oil-bearing contour definition along the KS_6 horizon at the Binagady field



Geological profile II-II of the Binagadi area cuts the southwestern and northeastern wings of the structure. Stratigraphic and lithologic traps rich in hydrocarbons are involved here. Lithologic traps are distinguished in the upper part of the NKS suite, as well as the KS_{5c+d} and KS_{5a+b} suites. And stratigraphic traps are associated with the pinching out of the PKS, KS_6, KS_4, KS_2, KS_1 suites (Fig. 2 c, e). Each wing of the structure is complicated by numerous vertical tectonic faults. As a result, traps of a mixed structural-stratigraphic type are also involved here. As a result of tectonic shift, individual reservoir layers are covered with impermeable layers. It should be noted that these types of traps refer to local uplifts that are eroded in the crest part and covered with impermeable rocks (with an inappropriate angle).

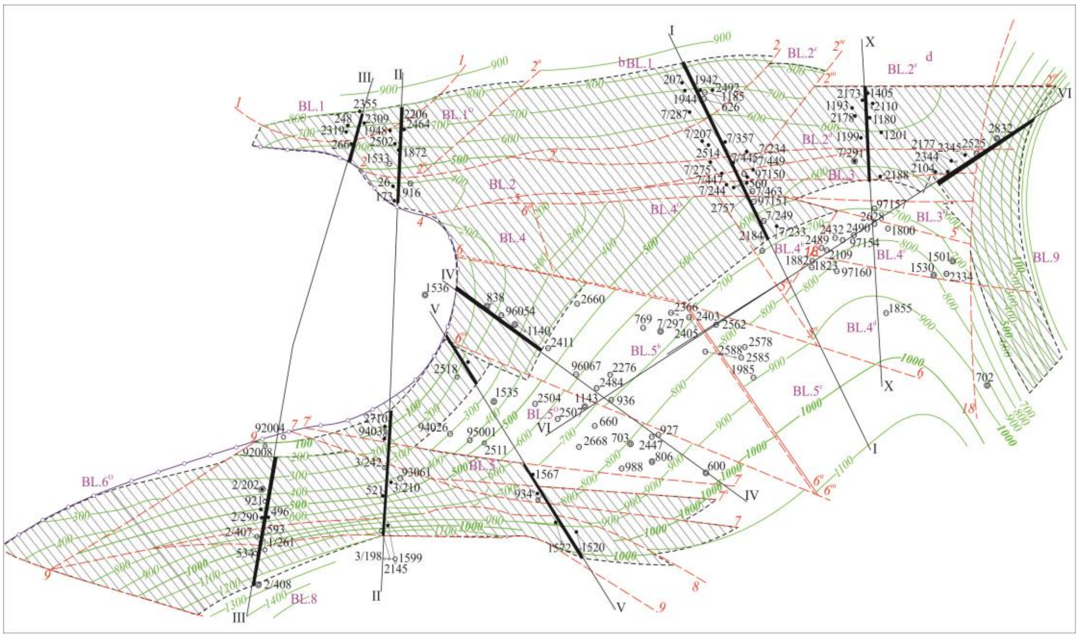


Figure 4. Map of the oil-bearing contour definition by the horizon KS_{5a+b} at the Binagadi field

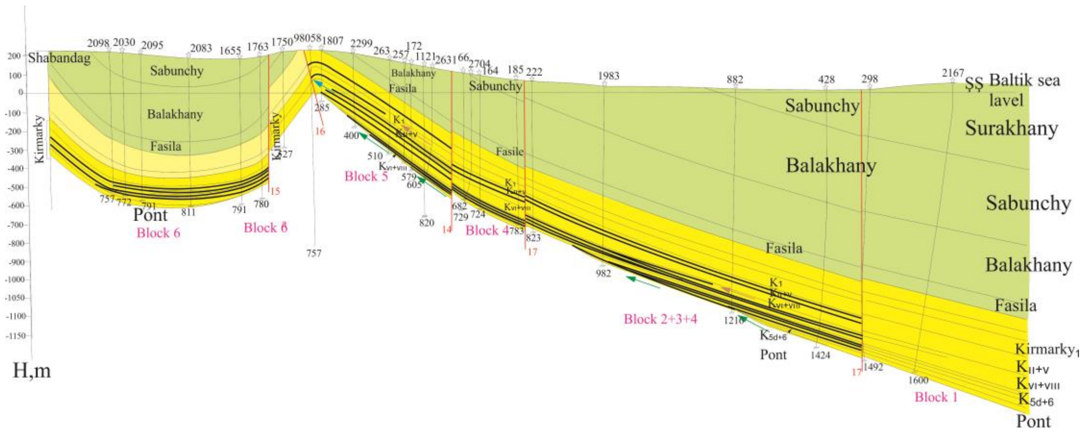


Figure 5. Transverse geological profile VIII-VIII at the Sulutepe field

On the northwestern wing, the angle of dip of the suite is 45-50˚. Here, the presence of tectonic faults is the reason for the development of a large number of structural-stratigraphic traps. But in many suites (KS_{5a+b}, KS_2) as a result of the replacement of sandy rocks with clayey ones, the formation of lithological traps is observed. The stratigraphic trap is associated with the KS_{5c+d} suite.

Repeated change of lithological traps at the fifth stage, refer to lenticular and cord sandy deposits associated with the bottom of the basin, the ancient coastline, etc.

Lithological traps in the Sulutepe oil and gas field are located only along the line of the geological profile VIII-VIII within the horizon KS_{II+V} (Fig. 5).

As the productive strata rise, the lithological traps of the KS_{II+V} horizon are associated with traps of wedging out or facies replacement. This type of wedging out, as shown above, is characterized by an unchanged or slightly changed thickness of the layer, and here individual productive strata are wedged out.

Due to repeated movements occurring on the bottom of the basin, traps with lithological wedging out or synsedimentary facies replacement are formed in the crest as a result of changes in sea level, and sand layers are replaced by impermeable rocks.

Thus, at the sixth stage, the results of the conducted studies are analyzed, the locations of non-anticlinal traps are determined, the allocation of the corresponding fragments of the sections is studied, and the definition of the oil-water boundary is more accurately and widely specified to determine a new oil contour based on the compiled maps.

Maps have been compiled to determine the oil contours of the horizons KS_{II+V}, $KS_{VI+VIII}$, KS_{5d+6}, PKS of the Sulutepe field.

From the map compiled for the horizons KS_{5d+6} and PKS (Fig. 6, 7), it is evident that only stratigraphic traps are open on the geological profiles IX^a-IX^a and IX-IX.

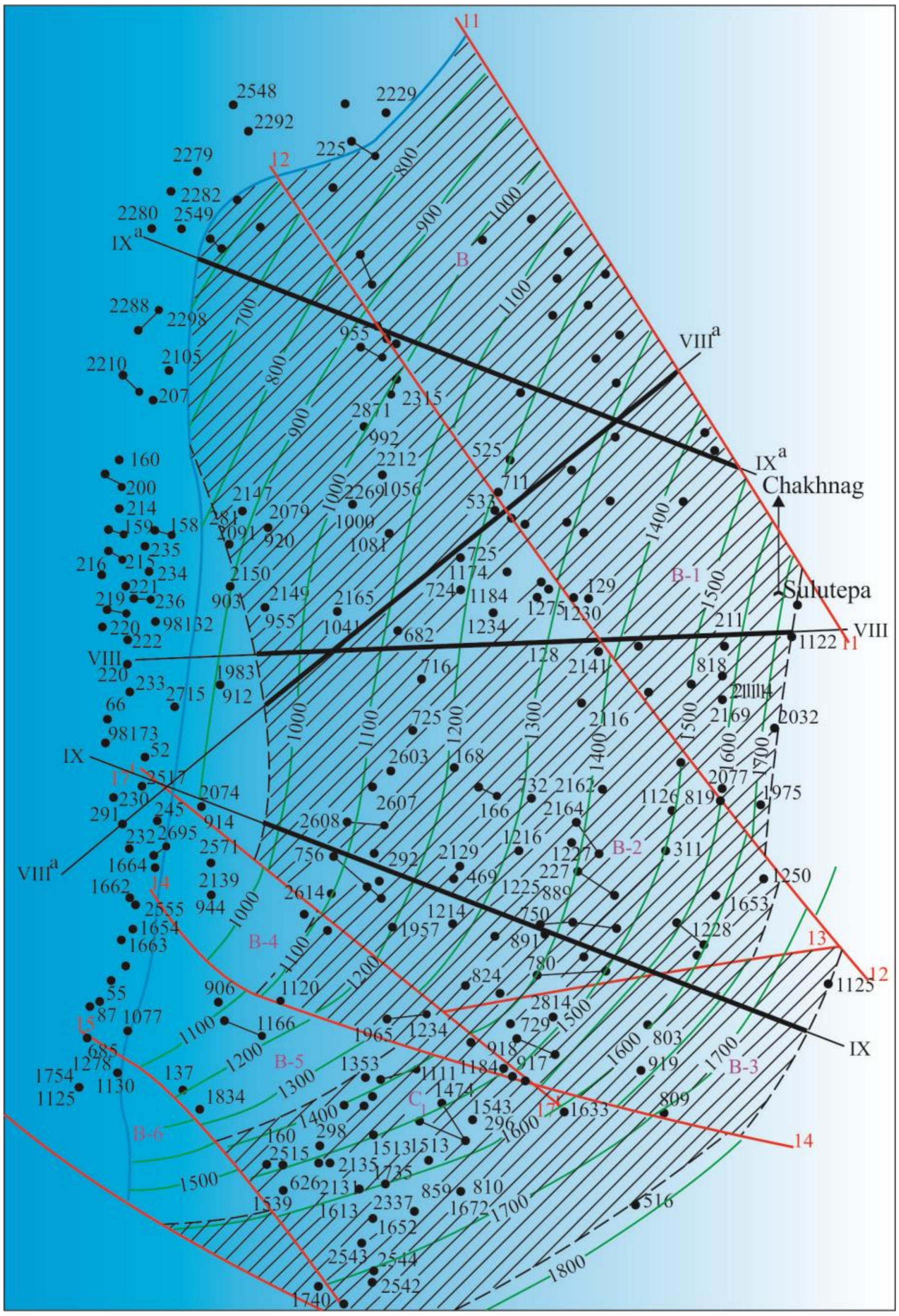


Figure 6. Map of the oil-bearing contour definition for the KS_{5d+6} horizon at the Sulutepe field

It is evident from the section that the $KS_{VI+VIII}$, KS_{5d+6} and PKS suites, starting from a depth of 1600-1750 m, were completely saturated with hydrocarbons. Starting from a depth of 500 m, the KS_{II+V} suites are also saturated with gas and oil. And this group includes the KS_{II+V}, $KS_{VI+VIII}$, KS_{5d+6} and PKS horizons, which are disproportionately based on volcanic uplifts.

The maps take into account the oil and gas, water and various contacts along the sections corresponding to each suite. At this time, it is necessary to make a more accurate choice of petrophysical parameters and lithofacies composition. The correct choice of parameters is a prerequisite for the existence of traps and its productivity. For the first time at the modern level, we have constructed a 3D model to clarify the boundaries of non-anticlinal traps along the KS_{5d+6} horizon of the Sulutepe oil and gas field (Fig. 8).

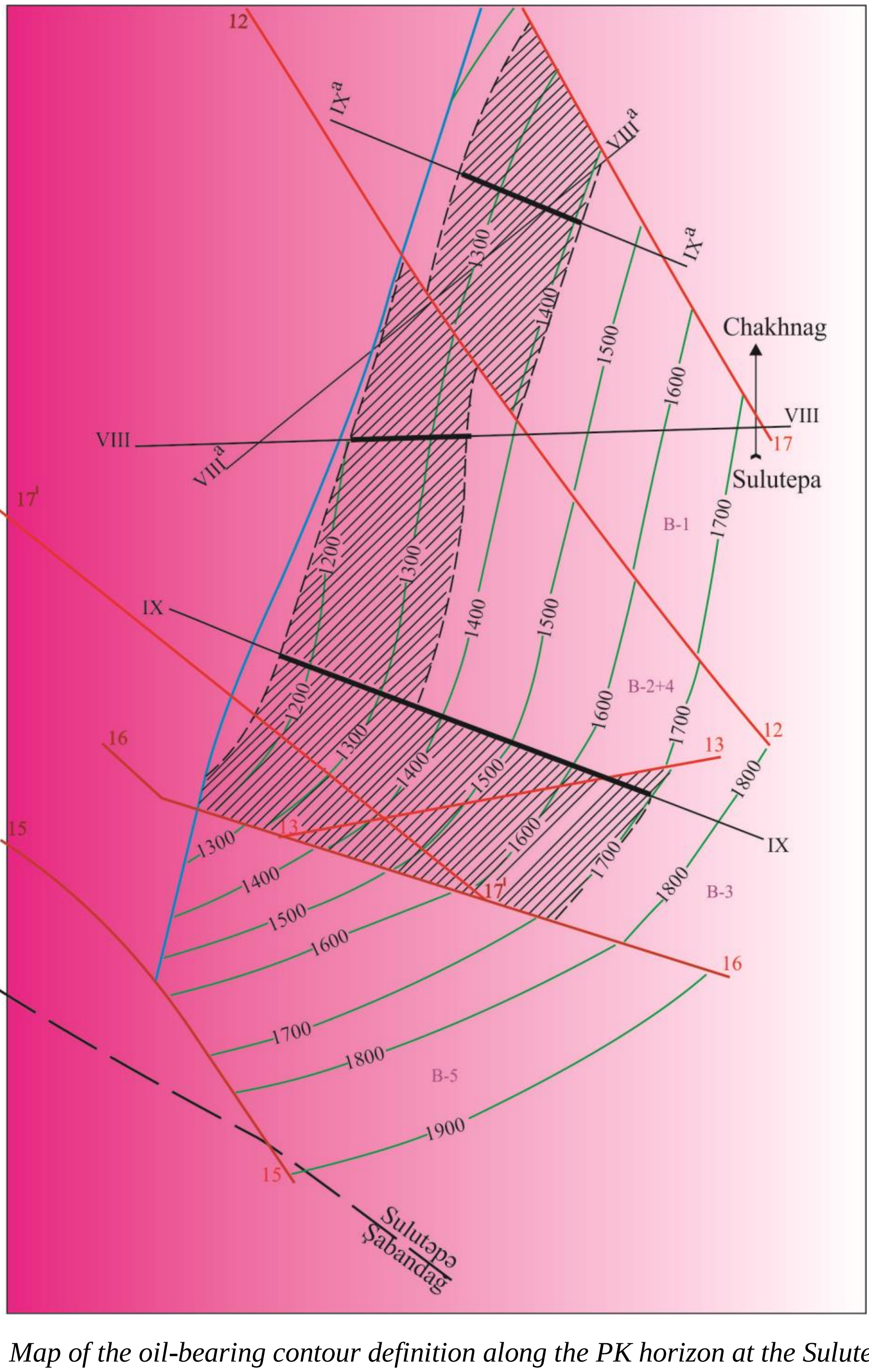


Figure 7. Map of the oil-bearing contour definition along the PK horizon at the Sulutepe field

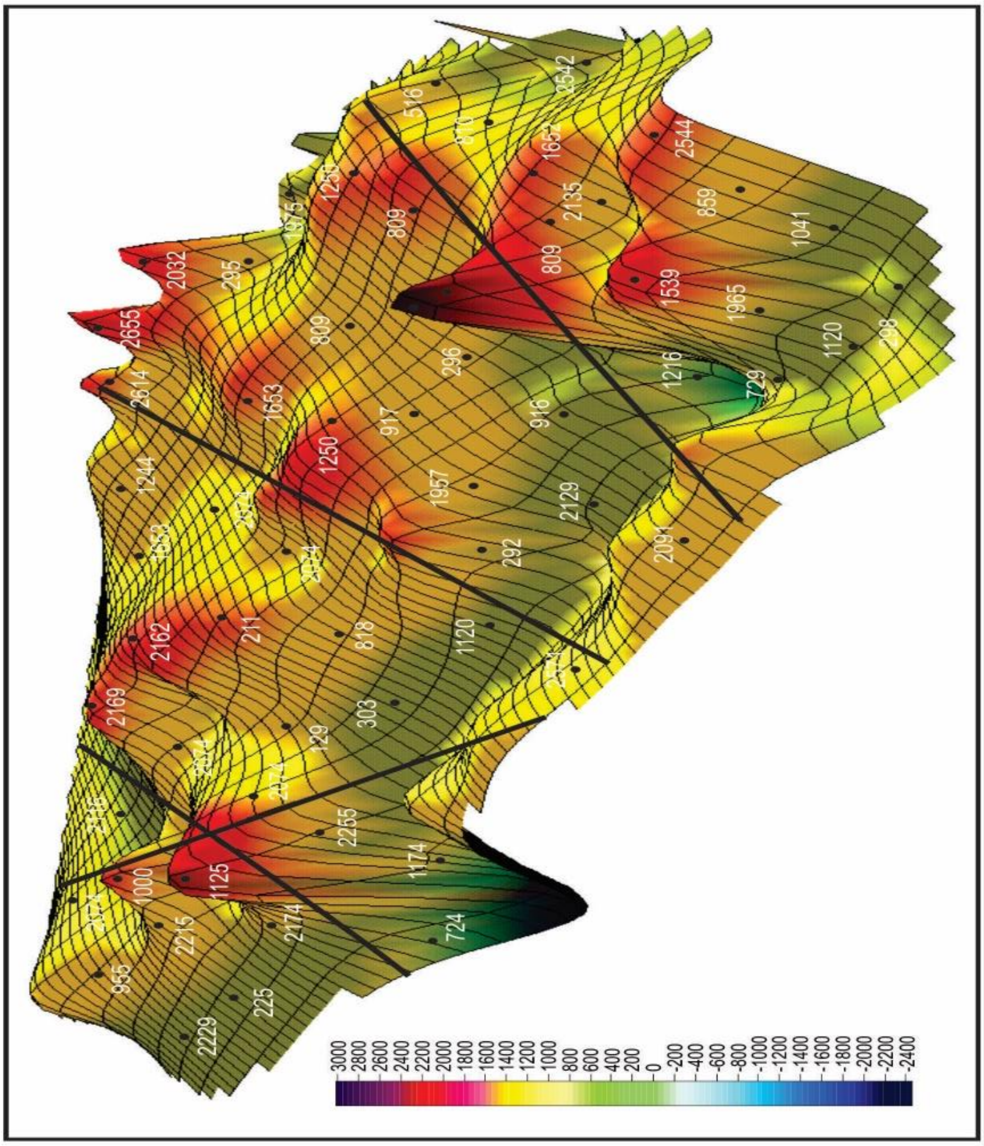


Figure 8. 3D model for horizon KS_{5d+6} of the Sulutepe oil and gas field to clarify the boundaries of non-anticlinal traps.

Almost all types of non-anticlinal traps shown below can be found in the northwestern and southwestern parts of the Binagadi and Sulutepe fields.

- Lithological areas formed as a result of diagenetic and epigenetic processes;
- Zone of lithological wedging out of productive horizons as layers rise;
- Primary traps formed during sedimentation.
- Lenticular and longitudinal sandy sediments associated with an uneven basin bottom, ancient coastline, etc.

Stratigraphic

- disproportionately covered layers in the flank parts of depressions;
- zones of stratigraphic wedging out in the flank parts of depressions;
- Buried uplifts of paleorelief;
- Volcanogenic uplifts;

Stratigraphic-lithological

- Wedging out of reservoir layers on individual local wings of uplifts

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