OİL AND GAS PERSPECTIVES OF THE UMID STRUCTURE IN CONNECTION WITH ITS HISTORY OF GEOLOGICAL DEVELOPMENT

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Abstract

It is known that the preservation of the planet's ecosystem is one of the most important issues in geology and in all spheres of industry. The minimum number of wells drilled during geological exploration plays an important role in eliminating damage to nature. The study of paleogeographic, paleotectonic conditions and lithofacies composition of the stratigraphic section of the studied structure is very important for determining the exact number and location of wells that will be drilled for exploration and production in the future. It is these studies that significantly reduce the risk of drilling unpromising wells.The paleogeographic curve and the depositional rate chart have been analyzed. The Umid structure started its development no later than in Pliocene. Both the paleogeographic and the paleotectonic environments within the area were favorable for the necessary amount of organic matter to be accumulated and preserved. Development of the Umid structure intensely continued in later stages.

Keywords: Umid uplift, depositional rate chart, paleoprofiles, graph of the fold development rate, paleogeographic curve

The tectonic structure of the Umid uplift was once again confirmed, the location of a mud volcano was determined, a longitudinal fault that crosses the crestal part of the uplift was precisely located and the boundaries of the mud volcano breccias were determined. Well 8 with a target depth of 6500 m was drilled 1125 m south from well 1 on the north-eastern limb of the Umid uplift, provided that it cuts horizon VII of the Productive Series (PS) within the vault zone. Logging at 6006 m revealed that horizon V and horizon VII of the PS had been crossed at depth of, respectively, 5475-5582 m and 5923-6006 m. Horizons V and VII of the PS are positively estimated on well logs. Thus, the values of the apparent special resistances of horizons V and VII vary within, respectively, 10-12 and 30-32 Ohm*m. SP curves are well differentiated. Gas shows and drilling mud influx were identified while testing horizons VII and V in the well at 4550 m.

The Umid uplift is located 20 km south-east from the Bulla-deniz oilfield and is separated from the Babek structure by a saddle (Figure 1.) [1, 4].

Thus, only 4 wells (#1, 4, 6, 8) out of 10 drilled within the Umid structure crossed potentially productive horizons. Geophysical properties of the productive horizon's section have confirmed presence of hydrocarbon accumulations in horizons V and VII of the PS (is considered analogous to the FLD (Fasila suite)). Lower Pliocene (PS), Agcagil, Absheron and Quaternary sediments are present in the geological structure of the Umid uplift.

Tectonically, the Umid uplift is a brachianticlinal structure of the north-west to south-east strike (30-35 km long, 4-5 km wide) [3]; its height within the north-eastern and south-western limbs is, respectively, 800m and 1000m. The south-eastern periclinal part of the Umid uplift is complicated with a mud volcano of the same name (Figure 2.).

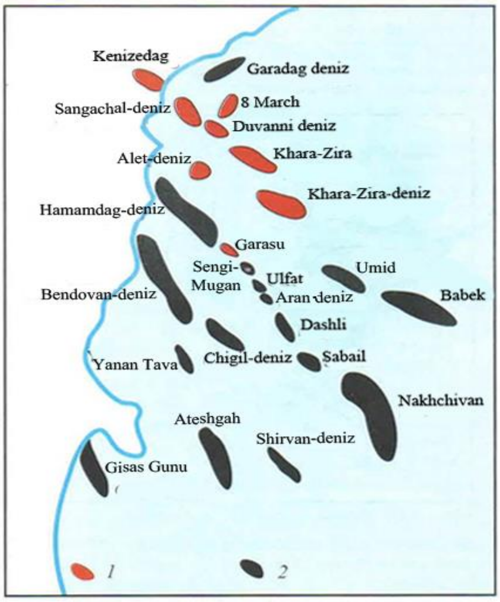

Figure 1: *Location of structures within the Baku archipelago: 1 – identified oilfields; 2 – perspective structures*

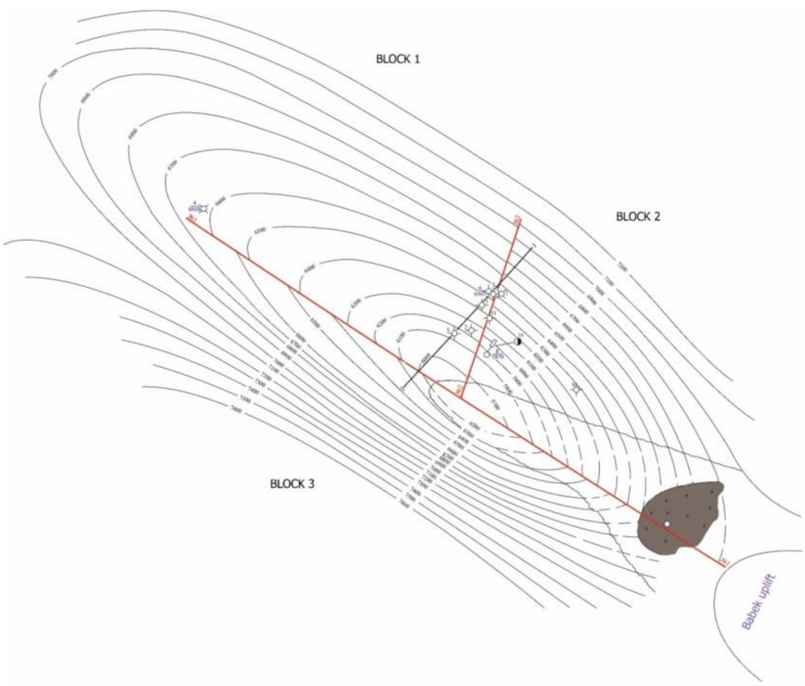

Figure 2: *Schematic structural map for the top of horizon VII of the Productive Series (after R.Jafarov and S.Hajıyev).*

The Umid structure is of asymmetric shape with varying dips of its beds in the limbs. Based on horizon VII data, the bed dips gradually increase with depth and are 20-25° and 35-40° in the north-eastern and south-western wings, respectively. The uplift joins the Bulla-deniz anticline through its north-western pericline by means of a deep and wide saddle and the Babek structure through its short south-eastern pericline. A regional longitudinal fault crosses the structure's crest with 100-450 m throw, the fault crosses the entire stratigraphic section and divides the structure into two blocks that correspond to the north-eastern and south-western limbs. Through that fault the south-western wing of the uplift has dropped by 200 m relative to the north-eastern one. As mentioned earlier, the Umid uplift joins the Babek structure in the south-east through a small narrow saddle. This junction can be observed in the overlying sediments and both structures manifest themselves as a single one in deeper layers. This case is typical for structures located within Baku and Absheron archipelagos. Lokbatan-Puta-Gushkhana, Sangachal-Duvanni-Khara-Zira island, Guneshli-Azeri-Kapaz oilfields are to name a few. This situation is typical for the platform type oilfields and the possible reason is related to a mud volcano activity [2].

As is generally known, sedimentation complexes present in the geological structure of any region form within certain paleogeographic environments and, depending on that environment, source rocks, reservoir and impermeable, that is, cap rocks may develop in the typical lithostratigraphic section of the region to a certain extent. That is why studying the paleogeographic environment for formation of sedimentation sets developed within the region play an important role in estimating hydrocarbon perspectives of the same region.

In order to study some paleogeographic and paleotectonic environments of formation of sedimentary sets of the area under investigation paleogeographic curves and depositional rate charts have been built and analyzed based on typical lithostratigraphic section.

According to typical lithostratigraphic column of the Pliocene and Quaternary deposits, they mainly consist of psammitic and pelitic terrigenous marine facies. Such lithofacial content is the indication of their formation in a relatively shallow basin. Nevertheless, sediments that make up the typical column show that the basin's depth varies within the relatively short timeframe, i.e. the environment favorable for the formation of psammitic facies. At the same time, higher clay content of the column indicates that the basin was of the average depth, which was favorable for formation of pelitic facies. Frequent alternation of clayey and sandy beds is indicative of frequent level fluctuations of the sedimentary basin floor within the geologic time. At the same time, regularly alternating lithostratigraphic sequences can be identified in the typical lithostratigraphic column. For example, every lithofacial sequence is dominated by either pelitic or psammitic layers. This pattern is observed along the entire drilled and studied section of the sedimentary mantle, i.e. the sequential alternation clearly manifests itself along the stratigraphic depth from the Upper Miocene to the Quaternary. This situation, in turn, shows that the basin floor had been subject to rhythmic fluctuations and these movements had been continuous throughout the geological time. As clearly seen from the paleogeographic curve, an average depth basin was present during the Pontian stage in the area under investigation (Fig. 3).

Uplifting and subsidence processes alternated during the lower Productive Series age, i.e. Qala suite (QaS) period. Thick pelitic facies indicate presence of the average depth basin in the area. Rhythmic alternation of sandstone and clay beds in the Qala suite section is the sign of temporary shallowing of the basin at the time. During sub Qirmaki suite (SQS) period rhythmic alternation of sandy and clayey beds is observed. SQS column shows dominance of pelitic facies in the lithofacial sequence. This case also indicates that the basin floor has been subject to rhythmic fluctuations, i.e. to uplifting and subsidence during some geological time.

In spite of presence of alternating sandy and clayey beds during initial periods of the Qirmaki suite (QS) column, the lithofacial sequence is dominated by pelitic facies. This is indicative of the basin floor being subject to fluctuational movements as well, that is, uplifting and subsidence during certain period of time. More frequent alternation of clayey and sandy layers suggests frequent variations of the sedimentary basin floor level during geological time. Uplifting and subsidence processes alternated each other at that period.

Psammitic facies only (that contain gas at that time) are observed in the VIII horizon's section. Formation of psammitic facies is a sign of the shallow basin floor. Frequent alternation of sandy and clayey beds is observed within the supra Qirmaki clayey suite (SQCS). Relatively rhythmic alternation can be tracked all along the column as well, what is indicative of the basin floor being subject to rhythmic fluctuational movements, i.e. rising and subsidence within some geologic time. Rhythmic alternation of sand and clay layers is observed during the upper Productive Series, that is, in horizon VII section, which is oil and gas bearing. Pelitic and psammitic facies predominate throughout certain intervals. We can infer that rising and subsidence processes alternated during that period. Horizon V is oil and gas bearing as well and rhythmic alternation of sand and clay beds is also seen in this horizon. Psammitic facies predominate in the lithofacial sequence. Alternation of uplifting and subsidence processes can also be deduced. Alternation of sand and clay layers is observed by the end of the upper Productive Series. The typical lithostratigraphic column shows no signs of sedimentation complexes at approximate depths of 1700m and 4380m, i.e. sedimentation break is present, what leads to a conclusion that the area under investigation was the region of erosion. The beginning of the Agcagil stage shows alternation of clay and sand beds with alternating rising and subsidence processes.

Alternating sandy and clayey beds at the onset of Absheron stage are considered as a sign of frequent basin floor fluctuations during geological time. Greater thickness of pelitic facies by the end of the Absheron stage is associated with the average depth of the basin at the time. Interruption in sedimentation is also observed by the end of the Absheron stage. It should be noted, that the great thickness of sediments that represent stratigraphic units under consideration indicates relatively higher depositional rates and, for this reason, the paleogeographic environment was favorable enough for accumulation and preservation of organic matter in most of them during corresponding time intervals. In researchers' opinion, there is direct proportionality between depositional rates and amount of accumulated organic matter in the basin. Taking this into account and based on the typical lithostratigraphic column of the area we tried to identify the potential of corresponding lithological targets as source rocks by means of determining the depositional rates during individual geological time intervals. By source rocks we mean a sedimentary bed that is capable of generating commercial hydrocarbon volumes in an environment with favorable temperature and pressure conditions [1].

According to the depositional rate chart the Pontian stage is characterized by sedimentation rate of 83 m/my. Sedimentation rate dramatically increased in Lower Pliocene (lower Productive Series stage) relative to other geological time intervals and was 1970 m/my. The depositional rate decreased to 432 m/my during the upper Productive Series stage and further drastically decreased during Agcagil stage to 52 m/my. Starting from the Absheron stage the deposition rate tripled relative to previous periods and was 181 m/my (Figure 3.).

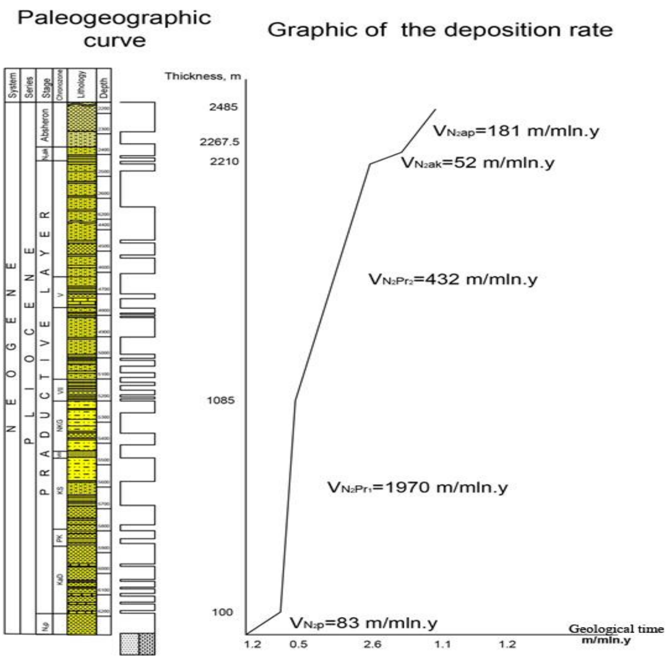

Figure 3: *Depositional rate chart*

According to N.B. Vassoyevich, V.A. Sokolov et al., if the depositional rate in a basin is below 50m/my, the amount of organic matter accumulated in potential source rocks, as a rule, is below the Clarke number. In other words, this type source rocks are not capable of generating commercial oil and gas. In case the depositional rate within a favorable (subaqueous) paleogeographic environment is 50-140 m/my, then the possible amount of the organic matter in potential source rocks may be up to 1-2%.

If the depositional rate is from 140-160 m/my to 600 m/my, potential source rocks may accumulate above 2% and, in favorable environments, up to 10% of organic matter. Finally, if the depositional rate in a basin is from 600 m/my to 1400-1600 m/my, then the amount of organic matter accumulated in potential source rocks may reach 16-20% and, in exceptional cases, up to 30%. Thus, by comparing the depositional rates during individual time intervals of the area under investigation with the abovementioned figures, we can infer that the amount of organic matter accumulated in corresponding potential source rocks was above the Clarke number, to say the least, what is indicative of presence of a favorable environment in the source rocks.

The built depositional rate graph shows the maximum sedimentation rate at the lower Productive Series stage and the figure is, as mentioned above, 1970 m/my. It should be noted, that in spite of a relatively low rate observed during the Pontian stage it is above 50 m/my, i.e. even at that time the amount of organic matter is greater than the Clarke number. Thus, analysis of the paleogeographic curve and the depositional rate graph show that the area had paleogeographic and paleotectonic environment favorable for accumulation and preservation of required amounts of organic matter.

In order to successfully complete the exploration works, paleoanalysis is considered as the deepest and most successful analysis method. To objectively estimate oil and gas perspectives of the area under investigation, we built a number of paleoprofiles based on a profile through the Umid structure and a graph of the fold development rate on the basis of these paleoprofiles (Figure 4.), in order to clarify the time of the structure origination and its further development features. A paleoprofile built for the end of the Pontian stage shows that the sedimentation process covered the entire area at the time. Nevertheless, the depositional rate at that stage was greater than the fold development rate. A paleoprofile built for the lower Productive Series stage shows that during this period of geologic time the depositional process continued to encompass the entire area, but the thickness of sediments lessened towards the crests of the structures. This is a sign of simultaneous fold development and sedimentation processes. Yet, the depositional rate was greater than that of the fold development too.

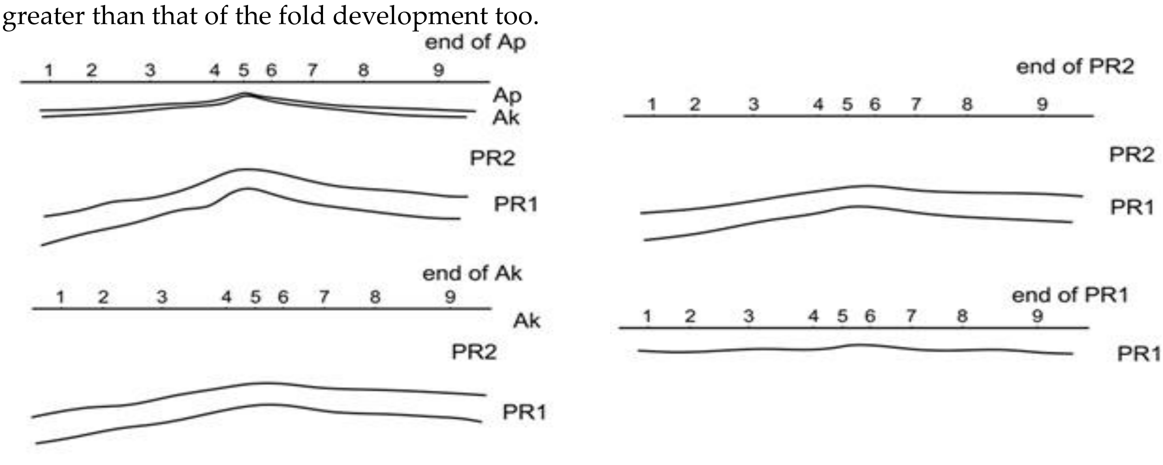

Figure 4: *Paleotectonic profiles*

A paleoprofile built for the end of the upper Productive Series stage reflects a continuing depositional process. The thickness of the accumulated sediments also attenuated towards the crest of the uplift during this span of time. The paleoprofiles plotted for the end of the Agcagil and Absheron stages show sedimentation processes going on and covering, as during previous time intervals, the whole area. The conducted paleoanalysis lets us infer that the development of the uplift under investigation and sedimentation processes occurred simultaneously and increase in the development rate is observed by the Quaternary. Based on paleostructural and paleotectonic development properties the Umid structure may be positively estimated from point of view of oil and gas perspectives. The paleosections enable tracking the onset of development of the local uplifts, their further development features during the time span under consideration, generation and further development of individual faults. The graph of the development rate of the local uplifts enables determining generation time of the uplift and its further development rates. Identifying the onset of the local uplift development, whether its development syndepositional or postdepositional in nature, allows more objective estimation of its hydrocarbon perspectives (Figure 5.).

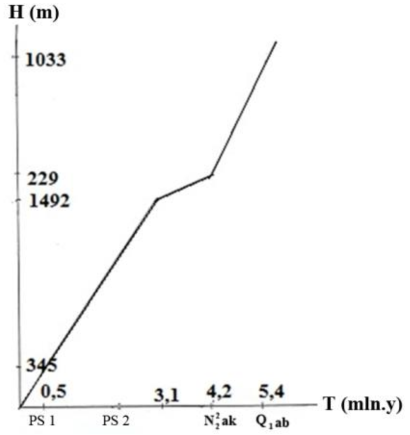

Figure 5: *Graph of the fold development rate*

According to the graph of the fold development rate the Umid structure started to develop no later than in Lower Pliocene and continued its development during the following time spans.

Conclusions

1. Based on analysis of the paleogeographic curve and the depositional rate chart we can infer that both paleogeographic and paleotectonic environments were favorable for accumulation and preservation of required amounts of organic matter in the area.

2. The Umid structure started its development no later than in Pliocene, which intensely continued in later stages and was syndepositional in nature.

3. Based on the location of the Umid structure, which is within the same tectonic area as the highly saturated with gas condensate Bulla-deniz field, similarity of the parameters for horizons V and VII, favorable fluid migration pathways within the depression zone, presence of a favorable environment for hydrocarbon migration and accumulation, the results of conducted paleoanalysis back up the statement that this structure is also hydrocarbon bearing.

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