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PETROLEUM-BEARING PROSPECTS OF THE FERGANA VALLEY IN THE LIGHT OF THE RESULTS OF EXPLORATORY WORK DONE IN 1940-1946

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Over the years of the Great National War, much work was accomplished in the field of examining both the geological structure and the petroleum-bearing prospects of the Fergana valley; it was accomplished by the VNGRI expedition in cooperation with a group of geologists of Kalininneft' trust and the Uzbek Academy of Sciences.

Its basic conclusion consisted of the discovery of excellent prospects in the Fergana valley in connection with the development of numberous closed conglomerate structures which appear on the surface as adyrs [adyr: a group of peculiar low hills in Turkmenistan] in the morphological sense.

As a result of exploratory drilling in the closed structures of the adyr zone, a huge amount of interesting material on their geological structure has been accumulated.

The geological construction of conglomerate anticlinal folds appears to be much more complicated than was formerly presumed by the majority of geologists.

Let us examine the general process characteristics of the alpine tectogenesis in the Fergana valley.

The formation of folds in the Mesozoic-Cenozoic deposits,

according to the opinion of S. I. Il'in and V. I. Popova, [1, 3], was caused by a gravimetric factor, the origination of which was due to dislocations in the Paleozoic substrata, considerably uplifted in the adjacent mountain structures if one compares its bed in the depression itself. Under these conditions, a strong tendency was evidenced, of course, at the periphery of the depression to subside gradually toward its central part.

For this reason, a more pronounced folding in the Mesozoic-Cenozoic deposits appeared both at the southern and the northern boundaries of the Fergana valley. Its folds must feature softer forms toward the center; however, their presence under the cover of contemporary formations is, in the authors' opinion, absolutely necessary. Granted sufficient tension in the formation of folds, structures must arrange themselves into the linearly elongated zones; this has been actually observed on the arrangement example of conglomerate folds in southeastern Fergana.

As the tectonic movements originated, the formation of folds took place more or less simultaneously. The folds that were formed on the sides of large anticlines or on monoclines in the foothills will constitute an exception. The Nefteabad and Ayritan structures on the northern side of the large Isfarin anticline as well as Maylisuy and Isbaskent structures on the monocline in northeastern Fergana are examples of such folds. These folds also differ in their shape. In cross-section, they become similar to a flexure with one long, sloping side and one short, steeper side.

In the case of progressive character of folding, the appearance of structures in the shape of very gentle upheavals occurred as early

as in the Paleocene period. The data of S. S. Shult and S. I. Il'in confirm this claim. However, the latter refers to the structures of an equal foundation, so to speak, and does not belong to the secondary flexure-shaped folds, the formation of which had already taken place on the sides of large towering anticlinal structures.

If folds arise simultaneously and are found in the same tectonic zone, they will exhibit more or less uniform dimensions, with the exception of those instances when the influence of Paleozoic substrata ledges becomes an important factor in their formation. The folds must also feature a lesser elongation and softer configuration as they approach the center of the depression. For this reason, the length of Paleocene folds in the adyr zone and closer to the center of depression must not exceed 10 to 15 kilometers near the valley's boundary.

Consequently, the Neocene structures measuring in length up to 30 kilometers form a common cover over at least two Paleocene folds.

Naturally, this discrepancy in the tectonics of Neocene and Paleocene structures "the latter buried under the former) considerably complicates the exploratory drilling operations if the axes of those structures are shifted.

The cause of this discrepancy may undoubtedly be seen in a long interruption of sediment accumulation as well as erosion of a considerable portion of Molassic layer on anticline sides and even of the underlying Paleocene and partially Cretaceous deposits, as this, for example, is seen from a section through the Yuzhnyy Alamyshik depost (Figure 1).

The development of anticlinal folds under the conditions of progressive folding, of course, continued even during the interruption of sediment accumulation. Erosion processes which create a surface relief must have played an essential role in the shaping of anticlinal folds. If a valley was formed in the vicinity of an area under consideration, then the absence of upthrust facilitated a gradual overlapping of the growing anticlinal folds in this direction. As a result of erosion, the load upon the entire layer of sediments resting on top and causing the plicative character of folding was destroyed; for the same reason, there also developed disjunctive dislocations exemplified in the upthrust of anticlinal sides in the direction of the valley and in addition to that, in the formation of cross folds of small amplitude.

We have accumulated actual material from the absolute markings pertaining to the sole position of the Sokha series in drilling holes; the results are summarized in the table.

Names of areas (anticlines)	Absolute marking for the sole of the Sokha series	
	northern side, m	southern side, m
Yuzhnyy Alamyshik	+400	+250
Andizhan	+375	-
Palvantash	+370	+200
Nayman	+100	-70
Khodzha-Osman	+50	-120

The spread of erosion in Paleocene structures is most clearly apparent in a southeasterly direction when one compares data referring

to the Palvantash and Khodzha-Osman anticlines, the latter being situated southeast of the former. Thus an absolute marking of the sole of the Sokha series on the northern side of Palvantash is equal to +370 meters, on the souther side to +200 meters, on the nother side of Khodzha-Osman to +50 meters, and on the southern side of the same to -120 meters.

On the basis of these data one may consider the established regularities in the degree of erosion increase in the southeasterly direction as proved. Taking into account that the distance between the Palvantash and Khodzha-Osman structures is 4 to 5 kilometers and the difference in absolute markings for the sole of the Sokha series is 450 to 500 meters, one can speak of a relatively steep inclination (1/8 to 1/10) of erosion surface from south to east, in the direction of the Karachatyrian Paleozoic ridge. This ridge together with the zone of anticlinal Paleocene structures along the Talmazar - Yuzhnyy Alamyshik line had at a pre-Sokhian time evidently surrounded a small depression which was elongated from northeast to southwest.

The Paleocene structures are scarcely of any practical interest in their central portion so long as the intensity of erosion increased toward the axial section of the depression. Moreover, even anticlinal folds, found on the outside of this zone and including Shaarikhan, Boston, and other folds, will evidently prove to be eroded to a considerable extent.

Even at that time the general denudation surface of the Fergana valley was sloping westward; to confirm it, one may quote the very same data from the table, according to which the difference

in the markings for the sole of the Sokha series between Yushnyy Alamyshik and Nayman (along the northern sides) amounts to 300 meters. Since the distance between these two points is about 50 kilometers, an inclination of the order of 1/160 is produced.

It is not possible, however, on the basis of this material, to draw any conclusions with respect to asymmetry and compulsory upsetting of Paleocene folds in the direction of the periphery of the Fergana valley. If one has to do with the pre-Sokhian erosion, the development of each individual Paleocene structure will greatly depend on the relief character of the given area at that time.

This circumstance will undoubtedly also exert influence upon the axial dislocation of Neocene structures. Under the formation conditions of Palvantash Yuzhnyy Alamyshik, and other Paleocene structures discussed above, their simultaneous lifting and upsetting in a southerly direction caused a strong upthrust of the north sides and in turn determined the axial dislocation of Neocene structures to the north.

If, in the process of a continuous development of the structure, the unity of construction is preserved so to speak, along with the accumulation of sediments, both on the plan and in the profile, then in such a case the sediments of the Sokha series were deposited upon the ready-formed folds.

Under these conditions, the sediments of the Sokha series which were deposited onto a level surface did not participate in the formation of individual structures when the Paleocene anticlines grew further; these sediments at once enveloped two or three Paleocene folds like a cover while individual structures were situated linearly or slightly shifted sidewards.

However, as the Neocene structure was formed it received the impression, so to speak, of the position of the buried anticlines, and its axis, being somewhat dislocated, had to bend on the plan while passing from one buried fold into another. These curvatures evidently should have appeared with greater clarity in the lower part of the Sokha series and become more blurred in the upper layers as the thickness of the series increased.

That this is actually true is confirmed by the available drilling material. The axial curvatures of the Neocene structure emphasize the separation of one Paleocene anticline from another; in other words, they indicate the position of their anticlinal terminals. Geologists, unfortunately, have failed to pay due attention to the connection between the said axial curvatures and the Paleocene structural forms. Since the slope angles of the structure axis are usually quite flat, they attributed it to accidental measurements and attempted to level them off on the map.

From what has been said it follows that the sediments of the Sokha series played a passive role in the process of fold formation as they enveloped, so to speak, the Paleocene anticlines. The cap of the Neocene fold shifted somewhat sidewards depending on the development of those anticlines. From the viewpoint of S. I. Il'yin, this is not obligatory in all cases, however, and depends, as already mentioned, on the character of relief which was formed prior to the settlement of the Sokha series.

There are also divergent opinions on that matter, however.

V. I. Popov [3], who was the first to furnish a genetic interpretation of axial shifting phenomena in the Fergana valley

structures, claims that it was caused by the processes of sediment accumulation which took place simultaneously with continuous tectonic movements. The thickness of the Molassic sediments which accumulate on the growing anticline folds will be different. In this case the thickness of Molasses on the north sides of these folds will be greater than on the south sides leaning toward the Paleozoic mountainous structures. Reverse relationship must prevail in the North-Fergana strip. These differences in the thickness of deposits bring about a successive shifting of bends in the upper layers in the direction of the Fergana valley.

The dislocation of Neocene axes but to the north in relation to the axes of buried Paleocene folds is thus characteristic of conglomerate structures in south Fergana.

A. M. Gabrilyan and several other geologists accept as true such an explanation of "rolling axes" as stated by V. I. Popov.

A quantitative evaluation of axial dislocation, which is obviously of great significance for ascertaining the position of exploratory holes, is very difficult to furnish.

Referring to actual data, the magnitude of axial dislocation varies considerably and makes up as little as 10-15 percent and as much as 50-60 percent and more, of the Molassic thickness superimposed on Paleocene folds. The average dislocation magnitude may be assumed under certain conditions to equal 1/3 of the superimposed Molasses. In such a case it is necessary to drill the first exploratory holes in the closed Neocene structures of this area, 300-500 meters due south of the surface axis.

Under these conditions, which handicap the disposition of the first exploratory holes, the data on inclinometric hole measurements acquire a great significance as long as the well shaft distortion in the great majority of cases occurs upward along the layer upthrust.

The following circumstance affecting the delineation of the structures deserves attention. The geological map of Fergana shows in the northeast of the zone of adyr-type structures, folds which depart at a sharp angle from the basic anticlines, these being elongated in a northeasterly direction. These "moustaches," as they are called, furnish the idea of fold virgation which has no relationship with the general structure plan of Fergana.

According to S. I. Il'in [2], these are not anticlines, and their origination is due to entirely different causes.

As already mentioned, the Sokha series was deposited on an eroded surface, the relief of which had reflected the local tectonic structure. The anticlines rose over the synclines between them in the course of a further development of tectonic processes and simultaneously with the accumulation of the sediments belonging to the Sokha series. As the structures were situated in echelons at a distance of several kilometers from one another, a bridge was formed in the relief during its upheave; the bridge led from one anticlinal elevation to another and was bound by a synclinal depression on one side and by a general monoclinal slope on the other, the latter being formed by the outer side of one anticline and a part of the side of another anticline. Figure 2 shows various cases of connection between the Paleocene structures.

As the Sokha series enveloped these anticlines, being itself a product of such a tectonic structure, it formed pseudo-anticlines.

On the spot these "moustaches" are cut off owing to contemporary erosion; they are connected with a single basic structure. Their presence may serve, to some extent, as an indication of a direction where another anticline buried under the cap of contemporary formations may be found.

It is necessary, furthermore, to dwell on the characteristics of structures in northeast Fergana, especially on those of Mayli-su and Isbaskent.

On account of their construction peculiarities, the axial surfaces of the latter flexure-shaped folds will reflect on the surface in the Neocene deposits with lesser intensity than in the aforementioned case of structures in the adyr strip in southeast Fergana. The bends of the Neocene axis, which are quite evident in that area, here will be more subdued.

Evidently, the exploration of these flexure-shaped folds piled up on the surface in the form of Molasses will be considerably more complex.

The construction of such structures as Ak-chop, Ak-bel', and Supe-tau in northwest Fergana is entirely unclear; they feature the phenomena of diapirism in Neocene deposits and probably the lack of agreement in tectonics of both Neocene and Paleocene.

The Fergana valley faces the urgent problem of prospecting for new buried Paleocene structures located closer to the central portion of the valley, perhaps in its very center, and concealed under

the cover of contemporary formations. This problem can be solved only by giving preference to gravimetric research which will furnish a general idea as to the location conditions of the surface of the Paleozoic substrata.

Evidently, and in contrast to the prevailing views, the depth of the Paleozoic substrata in the central portion of the valley does not exceed 2 to 3 kilometers. If this is proved, then the reserves of petroleum-bearing lands will increase many times.

There exists a good possibility that the thickness of Molassic deposits in the central portion will decrease. Another possibility is also not ruled out, namely, that the phenomenon of sediment erosion prior to the deposition of the Sokha series, which is revealed in the vicinity of depression boundaries, will appear here with much less intensity, and possibly will be absent altogether in the center of depression.

Under these conditions, the difference is tectonics of both Neocene and Paleocene, which is noticeable in the structures in the adyr zone, will come to light here with considerable lessening and, perhaps, will disappear altogether during a continuous process of deposit sedimentation.

All these factors, including also the regional distribution of petroleum phases, permit an optimistic evaluation of prospects in the central portion of the valley, provided the supposition of a shallow depth for the Paleozoic foundation is confirmed.

There is a certain danger in applying such geophysical prospecting methods as gravimetry and electro-prospecting in search for buried structures. For this reason, seismic methods must be used.

The "moustache" direction showing location of a connecting anticline may be used in the search for buried structures, especially at the inner periphery of the adyr zone.

Geophysical work in this region suffers under particularly unfavorable conditions owing to the development of coarse fragmentary accumulations in the Molasses. Drilling as deep as 200-300 meters may therefore be necessary in order to probe the structures as may the correlation of the holes according to core sampling diagrams. Should this method be justified, the problem of prospecting will be considerably facilitated.

In conclusion, we would like to dwell on the problem of selecting new areas for exploratory drilling, or more exactly, on the criteria which must prevail, in our view, during the drilling, as well as on the methods of conducting exploratory drilling.

The study of the history of Tertiary period in the Fergana depression as well as the analysis of Paleocene phases and petroleum-bearing areas of the productive horizons indicate the absolute necessity of giving first preference to deep prospecting in the anticline folds found in the eastern portion of the Fergana valley. Both the thickness of oil-bearing strata and the number of productive horizons are on the increase in the latter. Such an important factor as is the qualitative content of the crude, which markedly improves in Fergana from west to east, may also be cited in favor of superiority of the eastern portion of the valley over the western portion.

In view of these considerations, geophysical investigations in the central portion of the valley ought to be started from its eastern side. There is no general agreement among geologists as to

the methods of conducting deep exploratory drilling in the closed structures in the Fergana valley. The exploration of the largest possible number of areas where, as a rule, only a single hole was drilled has constituted the standard procedure until now, it permitted accumulation of exhaustive actual material for passing a judgment on the structure of these folds. It is doubtful, however, whether this method may be retained in the future.

A. M. Gabrilyan claims that starting the first exploratory hole in reliance on the data furnished by surface geology makes it hard to assure that the presumable petroleum-bearing Paleocene will be opened up in the top portion of the buried structure.

It is necessary to do simultaneous drilling by two rigs at new places in order to accelerate the exploration, which does not increase the risk of getting a higher percentage of dry holes.

The first exploratory hole must be fixed with regard to the axial deflection: in a southerly direction from the surface axis in the south Fergana strip, in a northerly direction in the north Fergana strip; the second holes are fixed along the surface axis. After the limiting Paleocene horizons have been opened up by two holes, the third hole is drilled either between them or in the upthrust direction of the Paleocene strata revealed in holes 1 and 2. If this system of drilling is used, it is advisable to increase the distance between the holes in the profile up to 500 meters.

S. I. Il'in is in agreement, on the whole, with the necessity of reducing the time for exploratory work and conducting the drilling by two rigs in the same section.

As far as the inner edges of the folds are concerned, he is not sure whether the relationship in position of the Neocene and Paleocene axes remain in force in this case, too. The exploration of Severnyy Alamyshik will furnish the material needed for the final solution of the given problem.

CONCLUSIONS

1. A considerable quantity of large anticlinal structures to be explored or which are being explored by deep drilling, as well as the general geological factors which are favorable for prospecting for new buried structures in the central portion of the valley, make it possible to state that the problem of "abundant Fergana crude oil" may be solved successfully if drilling operations are developed correspondingly.

2. There are established instances of a sharp angular non-conformity between the Okha series and the underlying series, the latter being eroded as much as the upper chalk.

One may also consider as proved the phenomenon of axial deflection in the case of anticlines in Fergana, which undoubtedly must be kept in mind while fixing position of the first exploratory holes.

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Figure 1. Cross-Section Through the Geological Profile

1-Sokha deposits; 2-Chagatayskiy series - Massagetskiy stage; 2-Upper Fergana series - Sumsarskiy stage; 3 - Upper Fergana series - Khanabadskiy, Isfarinskiy and Rishtanskiy stages; 5-Lower Fergana series - Turkestanskiy and Alayskiy stages; 6-Sogbiyskiy series - Suzkskiy and Bukharskiy stages; 7-upper chalk (Goznau gympsum); 8 - upper chalk; 9 - conglomeration.

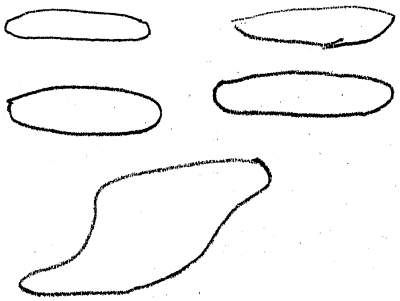

Figure 2. Various Cases of Interlinking Among the Buried Paleocene Folds Under a Single Neocene Structure.

1-Subterranean relief of Paleocene structures; 2-axis of Neocene structures; 3-axis of Paleocene structures.

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