GEOLOGICAL STRUCTURE AND STRATIGRAPHIC POSITION OF COMBUSTIBLE SHALES IN THE PALEOGENIC SECTION OF UZBEKISTAN AND ADJACENT TERRITORIES

T. Kh. Shoymuratov
Institute of Geology and Exploration of Oil and Gas Fields, Tashkent, Uzbekistan

T. N. Yarboboyev, F. O. Jurayev, Yusupov Sh. K
Karshi Engineering Economic Institute, Karshi, Uzbekistan

Abstract: *The article discusses the geological structure and lithological and stratigraphic features of the section of the Paleogene deposits of Uzbekistan and adjacent territories. The review and stratigraphic confinement of oil shales established within the study area and their distinctive lithological features both during the period of accumulation in sedimentation basins of the initial oil shale substrate and in modern conditions are presented. Forecasts made and potentially promising stratified oil-shale ore-bearing areas identified.*

Key words: *oil shale, Paleogene, stratigraphy, stage, formation, layers, member, sediments, basin, rock, section, well, deposits.*

1. Introduction

Paleogene deposits within the territory of Uzbekistan are productive for phosphorites, uranium mineralization, oil shale and oil and gas. They are widely used in the construction industry, as well as mining and chemical and agranomic raw materials (zeolites, bentonites, glauconites, salts, sulfur). When processing one of the specific types of minerals, deposits of another may appear in the overburden, therefore, it is important to consider the geological section of the Paleogene as a whole as inheritedly developing on older Cretaceous sediments [1, 2].

Paleocene (*$₱_1$*) it is composed of rocks of evaporite-carbonate-clay composition and has a mainly two-member structure (lower and vekhne paleocene).

Its lower part ($₱_1^1$*),* characterized by an induction-regressive series of precipitation - a consequence of the general uplift of the territory in the Late Cretaceous. Therefore, even at the end of the Maastrichtian, a series of salt lagoons arose, in which dolomites, gypsum, and red-variegated terrigenous sediments accumulated. The sediments of the Paleocene are considered in certain landscape-facies zones as oil source. So, in the Fergana oil and gas region, among limestones and gypsum, in the roof of which an oil reservoir (horizon VIII) and dark clays with scales of fossil fish are recorded, Bukhara layers are distinguished ($₱_1$bh) the Upper Paleocene 95-100 m thick. In the southwestern spurs of the Gissar ridge, Gaurdak (Kugitang), Badkhyz, the Paleocene section is similar in type to the section of the Afghan-Tajik depression. In its lower reaches, dolomites and limestones are widely developed, overlain by alternating layers of carbonate rocks with a gypsum-anhydrite member, and at their base there are coarse-detrital and sandstone rocks.

In the Amu Darya sedimentary basin and on the Ustyurt plateau, as well as within the Karakum and Kopet-Dag, Paleocene deposits are composed of interbedded marls, calcareous clays with gypsum interlayers (Galdzhik suite of Western Kopet-Dag), or greenish-gray and brick-red sandstones Big Balkhan, Oglakly section). In the Eastern Kopet-Dag, the Tashlinskaya suite is attributed to the

Paleocene, exclusively consisting of quartz or arkose medium- and coarse-grained sandstones with interlayers of small-pebble conglomerates (220 m thick in the Tashli region) [3].

On the Ustyurt, the Lower Paleocene sediments, studied in more detail, consist of light gray, whitish with a greenish shade of clayey limestones: within the troughs - sludge-aphanite, and in places immediately adjacent to the Central Ustyurt zone of uplifts and the Aktumsuk ledge - detritus-afhanite.

Lower Paleocene sediments are somewhat less common than Danish ones, since a further reduction in the thickness of the basin is observed. At the same time, in the zone of the Central Ustyurt uplifts, island areas continued to exist, which obviously impeded communication between the North and South Ustyurt basins.

Upper paleocene deposits (p_1^2), in the lower part, they are represented by calcareous marls, aphanitic with yellowish-gray sludge, tobacco, less often brick-red. Their different shades characterize separate layers of 0.8-1.5 m. The upper part consists of lime greenish-gray, dense marls, which also contain a small amount of fragments of foraminifera shells.

Within the Ustyurt region, the deposits of the Upper Paleocene do not have a clearly pronounced lithological-facies zoning and apparently correspond to the initial interval - the transgressive stage and the expansion of the basin territory, which led to the disappearance of the islands within the Central Ustyurt zone of uplifts. As a result, only a shallow zone remained, as evidenced by a single complex of foraminifera identified in the Upper Paleocene sediments of the Barsakelmes and Assakeaudan troughs. The presence of red-colored deposits of the Upper Paleocene in them is the result of destruction and redeposition of clay-carbonate rocks. The thickness of Paleocene sediments in different structurally, parts of the Ustyurt sharply differ: in the average they reach 36 m (Barsakelmes trough) and 50 m (Assake-Audan trough), and in the peripheral parts adjacent to the uplifts, from the center they are reduced to 5-8 m. In the Sultanuizdag zone, they are represented by massive white limestones, mostly sandy, with a thickness of 3 to 9 m.

The facies transition from limestones to calcareous sandstones is traced in the southern part of the Central Kyzylkum uplift (Aristantau, Sangruntau, Darbaza), where Paleocene sediments wedge out towards the north, giving way to Lower Eocene carbonate-free sandstones. In general, the Paleocene of Uzbekistan is characterized by the development of shell rock horizons with interlayers of dolomites, gypsum, sandstones, clays with phosphorite pebbles and ferruginous concretions. In the south of the territory under consideration, within the Sarykamysh-Sherabad ridge, as well as along the border of the Kugitang, large accumulations of celestine are known (Sherabad deposit). The Eocene sediments located here mark the change of lagoon salt-bearing environments to deeper-water ones with more developed dynamics. They are distributed much more widely than the Paleocene ones and are absent only in the near-crestal parts of paleo-uplifts, such as: Nurata Mountains; island uplifts of Tamda; Sangruntau; Central Ustyurt zones [4].

Eocene ***(p_2)*** and oligocene ***(p_3)*** deposits are subdivided into five stages: lower, middle, upper - eocene; lower, upper - oligocene.

Lower eocene deposits (p_2^1) within the Amudarya and Syrdarya syneclises, as well as the Fergana and Afghan-Tajik intermontane depressions, they are composed of interbedded limestones, marls, carbonate and hydromica clays with a subordinate amount of sandstones, developed along the framing of the paleo-uplifts of the Northern Tien Shan and the paleo-islands of the Central Ky. The largest thickness of the Suzak layers is associated with the area of the Baysun trough of the Surkhandarya megasyncline, the smallest - with the above-mentioned paleo-uplifts. According to paleontologists, the complex geological survey expedition "Tashkentgeologiya", part of the Suzak layers belong to the Upper Paleocene foraminiferal complex in the Afghan-Tajik depression and the southwestern spurs of the Gissar ridge. According to the lithological data, the sections of the Suzak

layers of the Fergana depression and the Pritashkent trough are distinguished by the gypsum content and redness of carbonate-clayey-sandstone deposits and the presence of opoka-like clay horizons. In the orogenic area of the Issyk-Kul region, in the Early and Middle Eocene, outflows of olivine basalts occurred, interbedded in the section with limestones.

In the territories of the Syrdarya and East Aral depressions, the thickness of the lithological-stratigraphic section of the Lower Eocene falls out or is presented in an abbreviated form: alternating variegated sandstones, clays and marls of small thickness (up to 10.0 m).

Middle eocene (p_2^2) it is represented in a large part of the considered territory by Alai layers, composed of interbedded calcareous clays and marls with thin interlayers of bentonite clays. Depending on the paleolandscape, the clay-marl stratum is faciesly replaced by terrigenous in the direction of paleo-uplifts and carbonate in the central parts of water bodies. The maximum thickness of the Alai layers is typical for the Afghan-Tajik (85 - 115 m) and Magian (100 m) depressions. In the rest of Central Asia, the thickness of the sediments of this stage varies within the range of 20-60 m.

A distinctive feature of this time of sedimentation is the general expansion of the paleopodem transgression relative to the Early Eocene. Another feature of the period is the development of black and brown bituminous marl horizons at the base of the section of the Alai layers of the Northern Kyzylkum, the lower reaches of the Amu Darya and Syr Darya, with layers of granular phosphorites.

The described position is associated with the horizons of combustible shales occurring on glauconite sands with phosphorite grains, which are most developed in the lower reaches of the river. Syr Darya (Baykhodzha, Bukhar Mazar). And, finally, one of the main features of the Middle Eocene section is the establishment of industrial phosphorite horizons in the roof of the Alai marls in the tracts of Sardar, Tashkur, Karakat, etc. in the Central Kyzylkum, which is associated with the abundance of foraminiferal shells covered with a phosphate film. An interesting section of the Middle Eocene of Badkhyz and Karabil. Here, on the shore-safed horizon, folded in the Kushkin section by limestone-shell rock with interlayers of marls and sandstones (30-40 m), lies a member of reddish-gray sandstones similar in thickness, overlain in turn by andesites, andesite tuffs and tuff breccias up to 40 m thick The effusive cover is overlain by a horizon of sandstone-shell rocks with a thickness of 11 m, along the top of which the boundary is drawn between the Alai and overlying Turkestan layers. We have already mentioned the manifestation of the Lower-Middle Eocene volcanism in the Issyk-Kul region, and within the Terskey-Alatau ridge, volcanic rocks of basaltic composition, synchronous to the Badkhyz volcanics, are also recorded [3, 4, 5, 6].

Upper Eocene deposits (p_2^3) surpass the Middle Eocene in thickness, which indicates an ever expanding Paleogene transgression in Central Asia. Unlike the Paleocene and the Lower-Middle Eocene, fragmentarily developed in the Northern Tien Shan, the Upper Eocene deposits cover the territory of the Chu-Sarysu depression of the Northern Tien Shan, the entire space of the foothills of the Southern and South-Western Tien Shan and the adjacent plains of the Turan plate. In the Afghan-Tajik depression, BKhR and Kyzylkum, these deposits were partially or completely destroyed by the pre-Neogene orogenic processes.

The Bodrak Stage is almost everywhere represented by Turkestan layers of greenish-gray non- or weakly carbonate clays, which are faciesly replaced in the Fergana sections by a sequence of similar interbedded clays with marls and shell limestones. On the Ustyurt plateau, in the southern Aral Sea region and Turkmenistan, where the “Caucasian scheme of stratigraphic dissection” was previously adopted, the nature of the Bodrakian section changes somewhat: the Turkmen layers correspond to the deposits of the Kerestinsky horizon and the overlying zone of planktonic foraminifera; in the Fergana lithological sections, where the Turkestan and Rishtan layers are referred to the Bodrak

stage. In the upper part of the greenish-gray strata of interbedded clays and limestones-shell rocks, the upper Rishtan horizon with tobacco clays containing interlayers of marl, calcareous clays and oysters stands out [7].

In the Surkhandarya megasynecline and the southwestern spurs of the Gissar ridge, where the Rishtan layers are also attributed to the Bodrak stage, the clays of the Turkestan layers are overlain by greenish-gray sandstones, replaced up the section by clays of a similar color. These layers are eroded in places (Pashkhurt section of the Sherabad-Kelifskaya ridge). The Upper Eocene is most fully represented in the Ustyurt, where it is composed of rocks of the Kerestinsky, Kumsky, and Beloglinsky horizons.

Deposits of the Kerestinsky horizon differ little lithologically from the Middle Eocene and consist mainly of clayey limestones and marls, which characterize a more leveled and deeper sea basin within the Ustyurt. These sediments are associated with gradual transitions from the Middle Eocene to the overlying Kuma. Lithologically, they are a mixture of pelitomorphic calcite and finely dispersed clay material. Of the organic components, they mainly contain whole foraminiferal shells, less often their fragments in the form of sludge [4].

The Kerestinsky horizon within the Central Ustyurt and Aktumsuk dislocation zones is composed of clayey limestones with pyrite. In the Kosbulak trough, marls, and in the Assake-Audan and Daryalyk-Daudan troughs - clay limestones (foraminiferal-aphanitic, whitish with a greenish tint, in the upper part, light gray, slightly brownish, massive, dense).

The thickness of the Kerestinsky horizon within the Ustyurt, in most cases, is no more than 10-15 m. And only in the Barsakelmes trough do they exceed 20 m, reaching 45 m.

Deposits of the Kuma horizon are ubiquitous in Ustyurt, except for the zones of subsequent erosion in the Central Ustyurt series of uplifts. There are two main zones of different lithological-facies nature, corresponding to two types of sections. The first, composed of marls and clay marls, is distributed within the Central Ustyur and Aktumsuk zone of ledges, as well as the Barsakelmes, Sudoch and Kosbulak troughs. On the northern slopes of the North Ustyurt troughs, sand interlayers are noted in the Kum sediments. The Kuma deposits are well deflected by gamma-ray logging due to the persistent increased content of radioactive elements within the member. There are also noticeable amounts of rare elements (molybdenum and vanadium), like the oil shale of the Central Kyzylkum.

The member of bituminous marls contains thin (up to 5 cm) interlayers of bluish-gray non-carbonate fine-pelitic rock, in which the main role belongs to pyroclastic ash material, which is transformed into bentonite clays.

On the territory of the Bukhara-Khiva region and Central Kyzylkum, the deposits of the Kuberlinsky and Kerestinsky horizons corresponding to the Turkestan layers are represented by calcareous clays with interlayers of marls, overlain by a stratum of weakly calcareous clays of the Kum horizon. They have not been preserved everywhere from the pre-Neogene erosion.

In general, in the Middle-Late Eocene, the entire territory where the expanding transgression of the sea took place, it moved even further - to the north. Small early Eocene islands of the Central Kyzylkum ceased to exist and were overlapped by the sea. Only the Northern Kyzylkum and the Dzhusalinsko-Novokazalinskaya group of uplifts remained in the same state under the small isolated islands protruding above the water.

The Middle Eocene is characterized by manifestations of volcanism - in Badkhyz (andesites, tuffs), as well as continued volcanic activity - in the Northern Tien Shan (northern slope of the Terskey-Alatau ridge and others). On the plains between the Amudarya and Syrdarya rivers, in the Middle Eocene section, among marls and clays, frequent interlayers of "lilac" bentonite clays (0.5-2.0 m

thick) with superimposed pyrite mineralization are established. In the Badkhyz region, manifestations of zeolite products of volcanism are noted. At the same time, the oxide-manganese with tungsten mineralization of the Tossor region of the Southern Issykkul region, possibly, has a paragenetic connection with the Lower and Middle Eocene basaltoid volcanism. [7].

In the oligocene *(p_3)*, as well as in the lower miocene *(N_1^1)*, a thick stratum of greenish-gray, mostly lime-free clays was deposited. At the border of the Eocene and Oligocene, there is a sharp change in the conditions of sedimentation. In the Oligocene, the carbonate-argillaceous deposits of the Eocene are replaced by argillaceous ones. This is mainly due to climate change and, to a lesser extent, to an increase in the input of terrigenous material from the areas of demolition. This is typical for the entire vast basin of the south of the arid zone of Kazakhstan.

In the Eastern Ustyurt and in the lower reaches of the Amudarya, the lower+middle oligocene is represented by the Khadum and Batalpashinsky horizons, lying on the white clay horizon with gradual transitions. The lower-middle oligocene sediments in the Kyzylkum parallelize with the lower parts of the lower rybatyr subformation, composed of a variegated clay member with interlayers of yellow sandstones at the top of the section. Oligene deposits in the Afghan-Tajik depression are practically absent.

The upper oligocene (Khat stage) occurs in depressions consistently, in the lower-middle eocene, with erosion - in the regions of development of dome structures. The upper oligocene is often combined with the lower neogene deposits. In such cases, strata are distinguished as oligocene-miocene.

The Khatta stage in the Fergana depression includes the upper sumsar layers, consisting of interbedded variegated (green-red) clays and brown sandstones with a total thickness of 10-12 m. The same “variegated” sections with comparable thicknesses are presented in the upper oligocene of the Pritashkent region and Kyzylkum. In the Aralsea region and Ustyurt, light brown and greenish-gray calcareous clays, reaching a thickness of 50 meters, prevail.

Paleontologists of KGSPE "Tashkentgeologiya" in the Afghan-Tajik depression and the southwestern spurs of the Gissar ridge attribute the sediments of the shurysai, gissar layers and the kyzylkiy suite to the lower miocene of the neogene. Actually, the upper oligocene sediments here are apparently completely eroded. The upper oligocene in the region of Samarkand includes a member of variegated silty calcareous clays with interlayers of siltstones and sandstones 72 meters thick.

In the oligocene-miocene, the structural plan of Central Asia undergoes a radical reorganization with a successive change (in some areas) of transgressive series of sediments to regressive ones. Areas of epiplatform orogeny are isolated along the zones of large faults of the "antitienshan", northeastern direction. The entire territory is a mosaic of basement blocks of different height and different scale, overlain by mesozoic-paleogene sediments. Oligocene-miocene and pliocene regressive series of deposits are represented by continental and lagoon-continental variegated-red sediments filling intermontane depressions of orogenic areas and overlapping the Turonian plains. In the pliocene-quaternary, the growth of mountain structures with a regressive series of sediments located at their foot continues. As a result, the territory of Central Asia acquires the features of an almost modern morphostructural plan.

Within the Bukhara-Khiva region, known for the development of oil and gas structures in the jurassic sediments, oil shales ("gamma-active units") are continuously distributed and were recorded according to core drilling and GC data in the domes of the Yangikazgan, Uchkyr, Kulbeshkak, Kagan, Urtabulak, Dengizkul structures, Pamuk, Kultak, Zevardy, Maimanaktau, Kassantau, Kungurtau, Setalantepa, as well as in a number of depressions such as the Ulus-Jam trough and the Panjikent intermontane depression. For the first time in the Jama area, oil shale was

uncovered at a depth of 350 meters and was characterized as “carbonaceous shale”. After the discovery of the Sabyrsay deposit and its assessment, the general prospects of the Ulus-Dzhamsk trough for the development of oil shale were determined. In the Syrdarya combustible shale basin, on the territory of the Kyzylkum, all occurrences of combustible shales are confined to the lower reaches of the Lower Eocene (Sangruntau, Aktau, Dzharyk) and only in the lower reaches of the Syrdarya, on the territory of South Kazakhstan, are deposits of the middleeocene age known (Baikhodaz, Bukhar - Mazar and others). [9. 10].

It should be noted that in the paleogene section of the territory of the Republic of Uzbekistan, a number of stratigraphic levels of accumulation of bituminous rocks with sporadic occurrence of oil shale and "fish horizons" enriched in pyrite are noted. These levels tend to shift in age from the areas of the Afghan-Tajik depression and the Amudarya depression - in the southeast of the territory to the Caspiansea region and, further, in the northwest - to the Caucasus, where the neogene maikop oil shales are known.

Thus, in lithological terms, the stratigraphic levels of the distribution of oil shales in the paleogene sediments are traced in the study area from the paleocene to the upper eocene and oligocene. In the modern structural plan, part of the shale-bearing areas is eroded, while others are overlain by younger sediments and submerged to different depths. According to the types of the paleogene sediments section, the conditions of occurrence and safety of the oil shale layer, three regions are distinguished, geographically combined mainly with Uzbekistan (partially Eastern Turkmenistan and Southern Tajikistan): Kyzylkum (Syrdarya); Sredne-Amudarya; Verkhne-Amudarya.

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