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Study and investigations of oil and gas reservoirs in Lower Cretaceous (K_1) in Amu-Darya basin, Afghanistan

[1]Abdul Hameed Sediqi

[1]*Assistant professor, Department of Oil and Gas Mines Engineering, Kabul Polytechnic University, Kabul, Afghanistan*

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***Corresponding Author**
Email: abdulhameedsediqi3[at]gmail.com

ABSTRACT

The importance of this research paper is about the structure and the condition of oil and gas formation in the Lower Cretaceous complexes (K_1) in the northern part of Afghanistan in order to determine the depth of the reservoir rocks, to evaluate the formation of the oil and gas reservoirs and to provide clear suggestions in terms of economic possibilities for better performance of exploration and exploitation works in the study area.

With increasing the number of muddy sediments, the amount of organic materials is increased in the depressed parts of the study area in the cross-section of the Neocom complex. Therefore, the Neocom complex rocks are the mother rocks of oil and gas.

It seems that in the areas where the Upper Jurassic evaporitecaprocks are less developed and the faults and fractures are more, it is possible that the hydrocarbons may migrate from Jurassic to the Lower Cretaceous sediments, including Neocom.

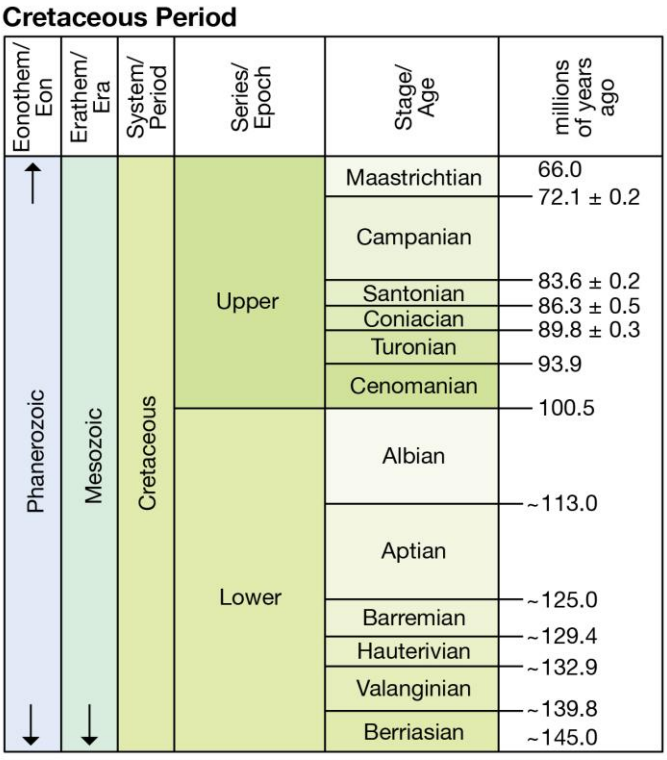
The XIV (Hauterivian), XIII (lower part of Barium), and XII (Aptian Suite) and XIa (sub-Suite of the lower Albian) formations are the collector rocks of this natural reservoir.

1. Introduction

For the first time, the sedimentary section and oil and gas productive formations of the northern part of Afghanistan were studied by V.Y. Bratash in (1970). Jurassic, Cretaceous, and Paleogene (which is related to the Afghan- Tajik depression) sections were separated in the study area. Later, the Mesozoic, Caenozoic sedimentary sections of the northern part of Afghanistan were studied by Eivanove S.D in (1978). Jurassic, Cretaceous, Upper Campan, and Paleogene were separated by him in the study area. The Jurassic and Cretaceous complexes of the north-eastern part of the Murghab depression and the northern edge of Afghanistan were separated by Dr. M. Naser1979).(

According to the previous studies and works done, structural geology, oil and gas formation, and production properties in the study area, we have discoursed three (3) big oil and gas productive formations in the sedimentary section of the northern part of Afghanistan: (1) Triassic- Jurassic, (2) Cretaceous (except the upper part of the Senonian sediments), and (3) Senonian - Neogene formations. Each of these formations is studied and discoursed thoroughly and separately here.

The Triassic- Jurassic terrigenous, Carbonate and Evaporite productive formations are subdivided into the probable Triassic terrigenous productive formation, the lower and middle Perspective complex Jurassic terrigenous, and the Upper Jurassic carbonate, anhydrite, and salt proven productive formations, which are covered by Gavardag(Upper Jurassic) sulfate and salt regional formation from the upper side, superimposed by Karabile(lower chalk) mud deposits. [1].



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Source: 2012 International Stratigraphic Chart produced by the ICS.

According to the studies, the huge Cretaceous terrigenous complex (formation) is also subdivided into 4 types by us: (1) Neocom, (2) Aptian- lower Albian, (3) middle- and upper Albian (which is mostly terrigenous complexes Perspective complex), and (4) the Senonian-Turonian probable complex (formation). The caprock of this huge complex is related to the Torun and the lower part of the Senonian (upper Cretaceous) deposits.

The huge Senonian – Neogene Perspective carbonate-terrigenous Perspective complex is made of Senonian - Paleogene carbonate- terrigenous complex in the study area, and the terrigenous probable oil and gas productive complex (out of the study area). The caprock of this big size complex here is the muddy sediments of Paleogene- Neogene.

It is worth mentioning that in this paper only the structure and the condition oil and gas productive complexes of Neocom and Aptian- lower Albian have been investigated.

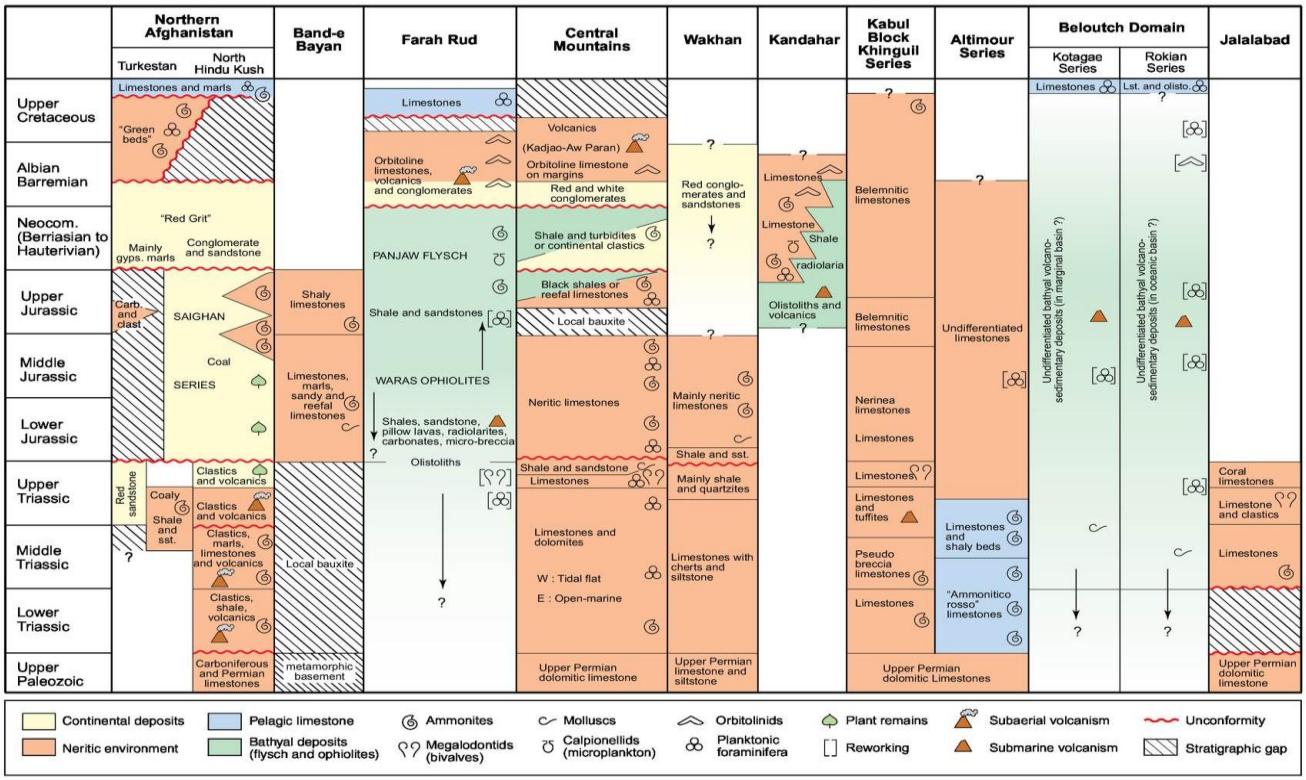

Fig.1.Mesozoic sequences in Afghanistan. [3]

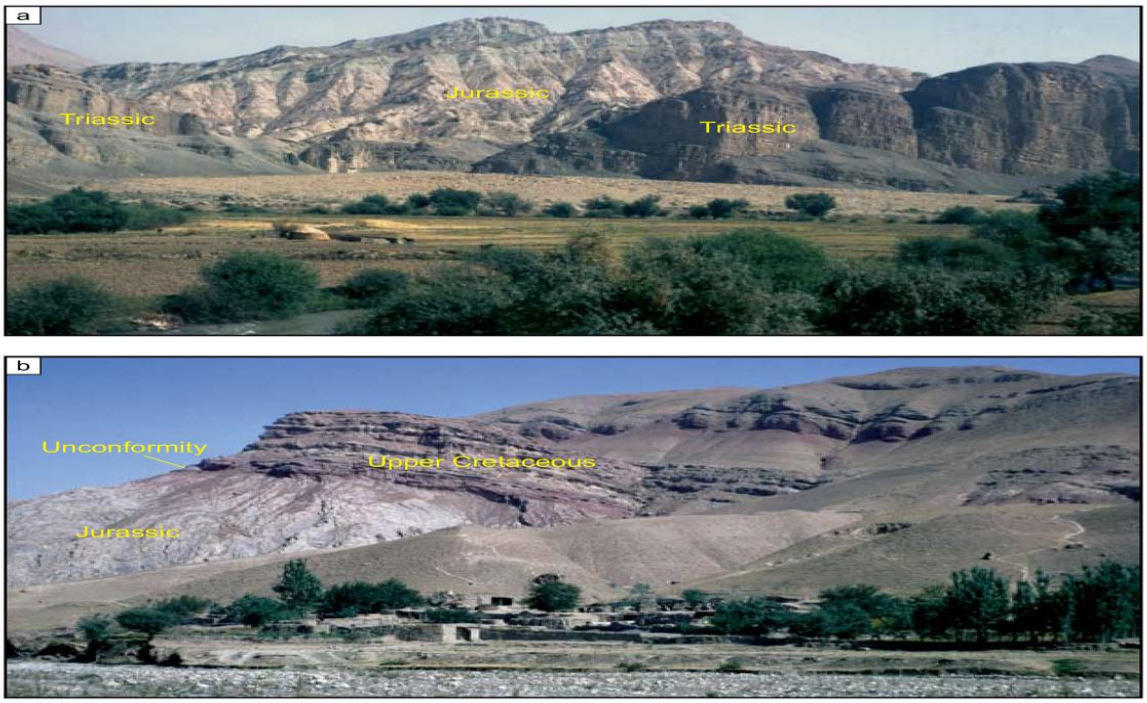

Fig.2.In northern Afghanistan, the Jurassic Saighan Series is commonly contained by unconformities below (a) and above (b).

(a) Major unconformity between dark-colored Triassic sandstones and light-colored Jurassic variegated marl, plant-bearing sandstone, coal, and conglomerate of the Ichpouchta (Saighan) Series;
(b) Light-colored Jurassic continental shale and plant-bearing sandstone of the Saighan Series unconformably overlain by dark-colored Upper Cretaceous (Senonian) marine deposits near Gudah, Band-e Turkestan. [3]

2. Research aim and Methods

The main goal of the research is to determine the certain strengths of exploration works and to confirm the existence of the industrial hydro-carbon reservoirs among the Neocom, and Aptian- lower Albian complexes in the northern part of Afghanistan, considering the geological structures and the oil and gas productive complexes.

Our research methodology is analyzing and scientific evaluation of the latest geological and geophysical statistics and data about the structure, condition of the oil and gas productive complexes of Neocom and Aptian- lower Albian in different tectonic structures in the northern part of Afghanistan in order to determine the depth of the reservoir rocks, to evaluate the formation of the oil and gas reservoirs and to provide clear suggestions in terms of economic possibilities for better performance of exploration and exploitation works in the study area.

Subject of research

The cross-section of the Neocom oil and gas sedimentary complex consists of Valangin Suites (Carabil and Al-Murad formations), Hauterivian (Qazelbash formation), and Barium (EcozBolaq formation), the rocks which are spread in all parts of the study area and consist of Red sandstone-mudstone sediments with alternative sandstones, gray Siltstone, dark gray and thin layers of rocks such as hydrates.

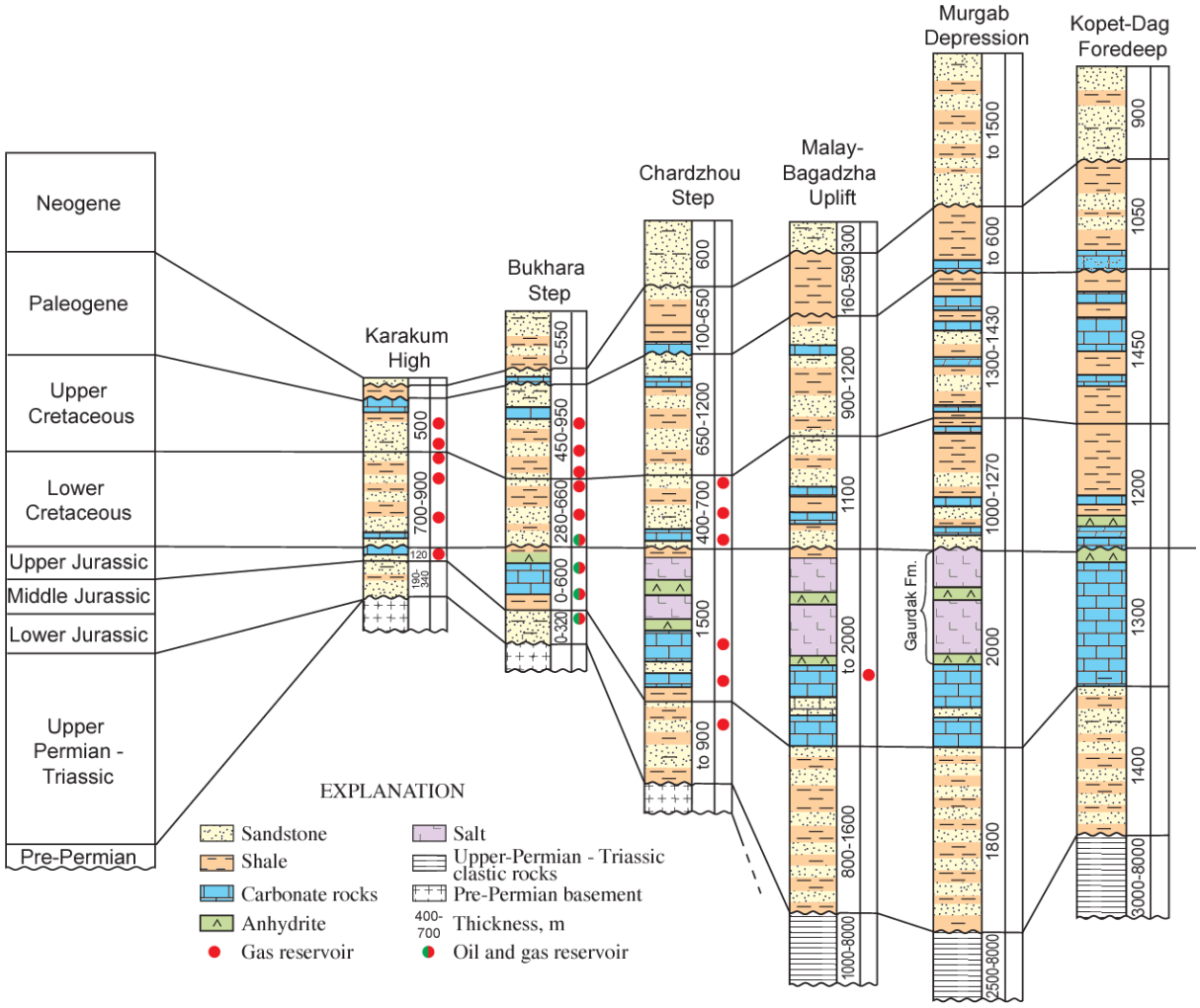

Fig.3. Stratigraphic columns of Amu-Darya for location of structural units[4]

At the cross-section of this complex, three natural-stratified reservoirs are separated: (1) Layer of (XIVa) in the formation of Carabil and Almurad, (2) Layer of (XIV) in the Hauterivian sediments, and (3) Layer of (XIII) in the Lower Barium sediments.

Due to the transgressive location of the Carabil-Almurad reservoir sediments on the old Paleozoic rocks, these sediments are not spread and extended in a wide area. However, these sediments do not exist in the areas of Maimana high and many other parts of the northern high of Afghanistan.

The collector rocks of Layer (XIVa) of the reservoir consists of alternating sandstones, limestone, gravel, and gray to reddish-brown conglomerates with thin layers of Siltstones and mud. The combination of pebble-siltstones is increasing from north to south and from west to east in the Layers of the study area. With changes in the location, the properties of sandstone, and siltstones of the Layer (XIVa) also vary in different areas. However, their volumetric properties in the

Jarquduque Mining area are 2.59%, and it varies to 22.24% in Angut mining area. The filtration properties are also changing from 242.9mD(milli-Darcy) in the Angut mining area to 1mD in the Khwaja-Bolan Mining area.

The maximum thickness of Layer (XIVa) is measured (up to 200 m) in the drilled wells in the southwestern part of Dawlatabad, and in the southwestern part of the Aqderia and Angut local structures of the northern high of Afghanistan, it is measured (144 and 120 m, respectively). The thickness of the sandstone layer has started to decrease and it will continue to disappear completely in Maimana high. It means that the height of the sandstone layers started to decreasing until completely disappearing in the eastern and northern sides of the above-mentioned areas. In the vicinity of Wall-Andkhoy, the thickness of the Layer (XIVa) reaches up to 30-45 m. Under this Layer, muddy layers with different thin sections of gypsum, siltstone, and different colored muddy sediments are located. In some parts of this layer thin sections of siltstones, sandstones have taken place which is widely spread in the lower parts of the study area.

In the Dawlatabad and Abrochive (Khamab) depressions, Andkhoy high and the western end of the northern high of Afghanistan the thickness of these sediments is changing from (24m) in (KhwajaGugerdak area) to 140 m in (Qartamash area) respectively. The caprocks of this layer are made of red-colored muddy sediments with thin sections of Siltstones, gypsums, limestones, and dolomites of Al-Murad formation. Thin sections and lens-shapes of sandstone and gravel also can be seen in the cross-section of these sediments. The maximum height of this caprock in Dawlatabad depression and the south-western part of northern high of Afghanistan is proven to be ranging between (55-75) m.

Towards the south-western (Maimana high) and east (the central areas of the northern high of Afghanistan) its thickness decreases and eventually disappears. The thickness of this caprock is ranging between (36-46) m in Wall Andkhoy.

The collector rocks of layer (XIVa) have been tested in the areas of Khanaqa in Maimana high and Yatim-Taque mine areas, and as a result, the stratified water flow with dissolved gas has been obtained from the Yatim-Taque area.

In the natural reservoir of Hauterivian-Barium, the XIV (Hauterivian) and XIII (lower part of Barium) layers are proven as collector rocks.

Layer (XIV) is more extended in the study area and is composed of reddish small, medium, and rarely large grain sandstone with feldspar and quartzite, in which thin sections of siltstone and muds are also observed and its amount is increasing upwards of the cross-section. The upper part of the cross-section consists of siltstones and brown or greenish-gray colored muddy sediments with mica rock.

Three types of structures can be distinguished in the cross-section of the layer with (approximately 10-15 %) combination of siltstone: The first type has a larger amount of sandstones and has a widespread in the southeastern parts of the study area (the western slope of the northern high of Afghanistan). The sandstones of this area have a big grain size compare to other areas. The cross-section here is made of (3-5 %) from the above-mentioned sandstone with an average grain size of (35-40 %) and small grain size sandstone is (32-35 %). The second type of the cross-section of the layer is characteristic of the northwestern areas of the region (Juma and Aask areas), in which the amount of mud increased. It should be mentioned that the amount of mud here is almost doubled by comparing the Ingut mine area and forms about 45% of the cross-section. The cross-section of the well here is small-grained sandstones and their amount increases up to (60-63 %). The third type of the cross-section is proven in the drilled wells of the southeastern part of Dawlatabad, which is characterized in comparison to other types of cross-sections in terms of the increasing amount of muddy sediments and equal-sized thickness of sandstones and mud layers.

The minimum thickness of the layer in the Maimana high has been confirmed from (0 to 50) and sometimes up to 75 meters, but in the areas of Khamab, Andkhoy High, and its adjacent areas, its thickness reaches up to (115-145) meters.

The maximum thickness of the layers drilled in the Dawlatabad low and Sar-e-Pul block has been confirmed (160-175 meters). The thickness of the collector rocks in the cross-section of the XIV layer, even in the range of one tectonic element varies from 15-30 to 80-100 meters. In this case, the effective thickness of the oil and gas saturated layers changes from 5 to 35 meters, sometimes 6 to 53 meters (in Jarquduque oil and gas mining area), and even it changes from 70 to 80 meters (in Yatim-Taque and Khwaja-Gugerdak mining areas).[2 and 3].

The porosity of the sandstone and Siltstone of this layer changes a lot, even in a local structure it varies more than 2 to 3 times. The porosity varies between 6- 28% in the study area. The permeability of the collector rocks is related to the grain size and their porosity; therefore, it varies on a large scale, from a less permeable to tens milli Darcy (mD), and finally from 500 to 633 and 798.6 mD in Khwaja-Bolan, Khwaja-Gogerdak and Angut areas respectively. The average permeability of the collector rocks in the Qashqari mining area is 243.6 mD, without only one measurement which exceeds 3.6 mD.

Till date, (11) hydrocarbons mines have been discovered in the productive layer of (XIV), from which (4) mines have gas-condensate and gas, one mine has gas-condensate with an oil margin, and in the remaining (6) mines oil has taken place. The accumulation of gas-condensate and gas in the Yatim-Taque, Khwaja-Gogerdak, Jarquduque, and Shakarak gas mining areas, and gas-condensate with oil margin in the Khwaja-Bolan mining area (which is tectonically related to Khwaja-Gogerdak block of the northern high of Afghanistan) and Wall-e-Andkhoy, have been discovered (fig.4). Oil accumulations have been discovered in the Sar-e-Pul block of the northern high of Afghanistan (Angut, Aqdarya, Qashqari), Zamarudsai, Bazarkami, Dawlatabad depression, the southwestern part of Maimana high (Jagdalak high zone), and Ali-Gul mining areas.

The majority of stratified dome-shaped mines are composed of dis-unactive fractures and contain tectonic-clad elements (eg. Angut and Bazarkami mining areas). In some mining areas, mines are completely stratified (Yatimtaque, Khwaja-Gogerdak, and Jarquduque) and many of them are floating on water (Angut, Qashqari, Aqdarya, Shakarak, Bazarkami, and Zamarodsai). In the Jarquduque mining area (2) gas mines have been discovered (Fig.5).

The oil saturation of the collector rocks in the mining areas ranges from 57% (in Zamarudsai) to78.2% (in Angut) and gas saturation in the collector rocks varies from 58.9 (in Khwaja-Bolan) to 75% (in Jarquduque).

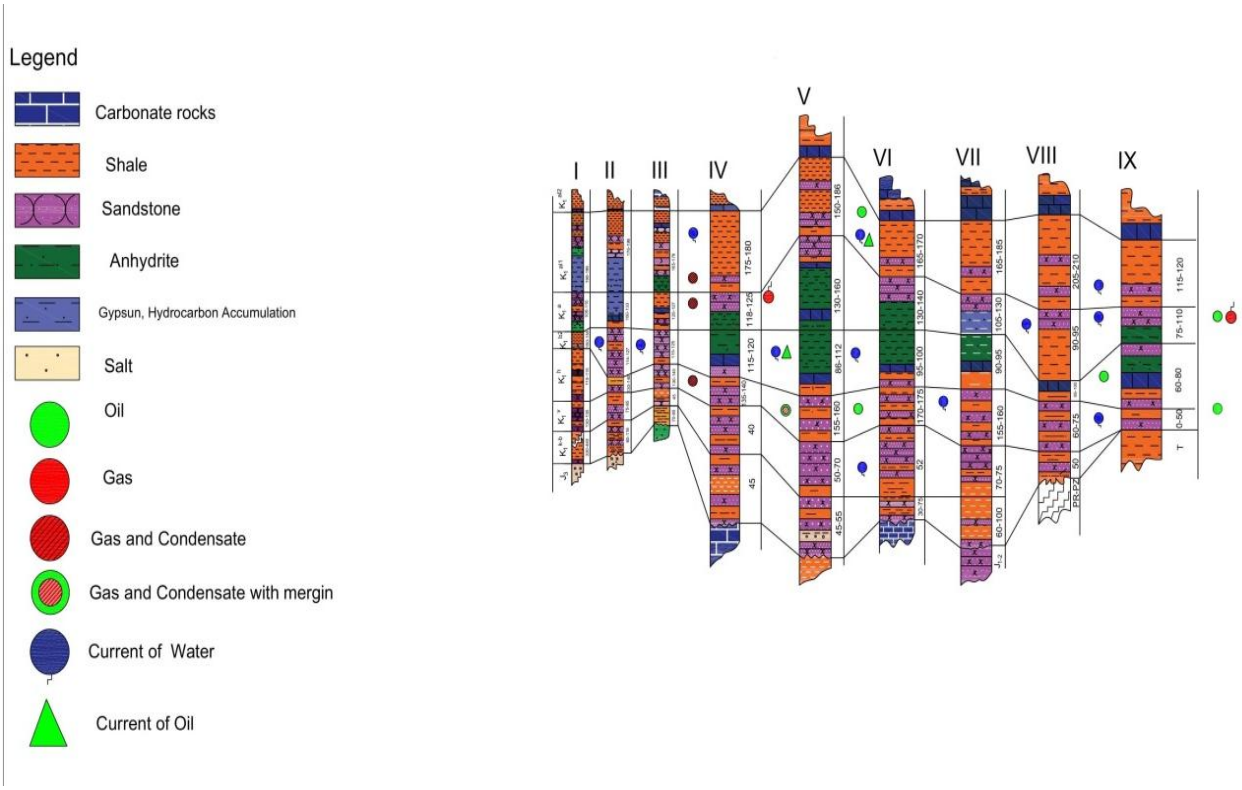

Fig.4: Comparative schematic of the cross-sections of Neocom and Aptian- lower Albian complexes.(Modified from unpublished reports provided by the Kabul Polytechnic University of Afghanistan)

Khamab Depression: I- Jangal-Kalan structure; Wall-e-AndKhoy: II - Juma, Asak,

Bashikord structures; Khwaja-Gogredak block: III-KhwajaGogordak, Yatimtaque structures, IV – Structures of Khwaja-Bolan, Bainghure; Sar-e-Pul block: V – Angut and Aqderya structures;

Dolatabad Depression: VI- Gul-Tepa and Sar-e-Pul structures, VII- Bazarkami and Aqsai structures;

Maimana high: VIII- Khanaqa structure, IX- Ali-Gul, Jagdalak structures.

The quantity of the formation pressure is low in the mining areas, as in the mining area of Sar-e-pol ranges from 13.4 to 170 Mega Pascals(MPa); in the mining areas of Dawlatabad depression from 21 to 23.4, and from 19.2 MPa (in Khwaja Bolan) to 24.6MPas(in Khwaja-Gogerdak mining area).

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The formation temperature varies between 54 to 58 C◦ in the Angut and Qashqari mining area, and up to 81C◦ in the Khwaja-Gogerdak, Zamarudsai, and Bazarkami mining areas,

Many changes in volumetric properties, especially in the filtration properties of the collector rocks of the formations have highly affected the hydrocarbons reservoir, both in the region and in the separate oil and gas fields, such as the minor oil debit in the mining areas of Khwaja-Bolan, Aqdarya, and Bazarkami, it has been proven, which varies from 0.2 to 25.0 cubic meters per day. The maximum amount of the product has obtained from the mining areas of Angut(12.8-340 cubic meters per day), Qashqari(9.0- 12.6 cubic meters per day), and Zamarudsai(22.5- 72.0 cubic meter per day)

The gas debit of the mines in the mining areas of Khwaja-Gogerda block changes from 200-700 thousand cubic meters per day, but in the wells of Khwaja-Gogerdak and Khwaja-Bolan mining areas, this debit reaches up to 1725 and 2300 thousand cubic meters per day, respectively

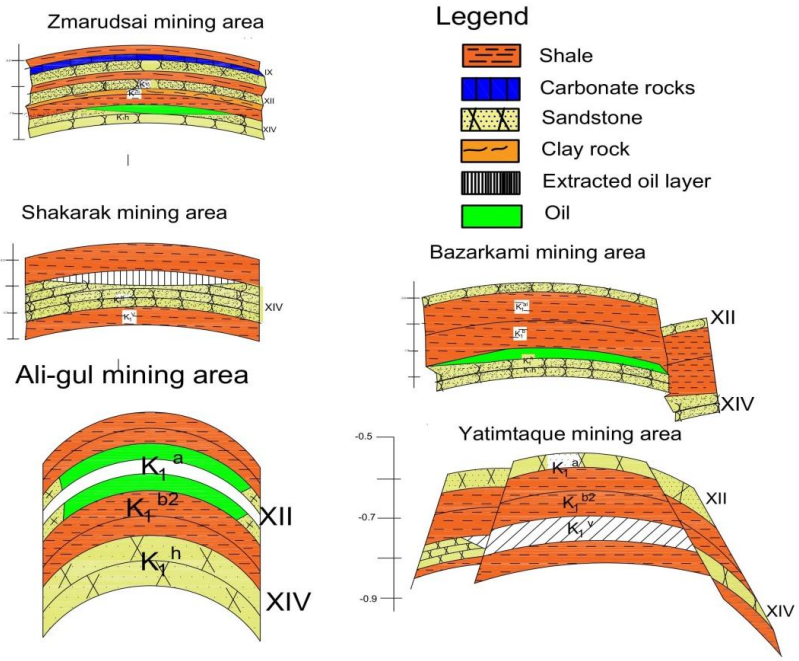

Fig.5: Types of hydrocarbon mines Neocom oil and gas complex(Modified from unpublished reports provided by the Kabul Polytechnic University of Afghanistan)

The natural gas of (XIV) formation is basically sulfur-free, but in some mining areas of Khwaja-Gogerdak block, it has a small amount of hydrogen-sulfide, as it is calculated 0.11 to 0.13% in Yatimtaque, 0.1-0.3% in Jarquduque, and 0.2-0.3% in Khwaja-Bolan. The amount of sulfur in oil wells reaches up to 1.52-1.98% (in Khwaja-Bolan), and more than 2.6% (in Aqderya). The density of oil varies from 0.58 to 0.92 gr/cm3, the amount of paraffin range between 0.3 to 4.0, and asphaltene from 2.0 to 3.0%. In the Wall-e-Andkhoy mining areas, the roof of this complex is located at a depth of 1895 meters (in Jarquduque) and 2316 meters (in Shakarak) and the roof of (XIV) formation is at the dep of 2070 and 2316 meters, respectively in the above-mentioned mining areas. In Dawlatabad depression mining areas, the roof of the complex is 1555-1573 meters deep (roof of XIV formation is 1670-1670 meters deep) and in the Ali-Gul mining area of Maimana high, it is 800 meters deep (roof of XIV formation is 870 meters deep).

The caprocks of the complex belong to Barium Suite (Ekozbolaq suite) and according to Hauteriviansediments, it has a regional development, which in its lower part consists of limestones or mostly gypsum mud with thin layers of whitish-pink stratified limestones along with thin layers of sandstones and anhydride lenses. The upper part of the suit is made of greenish-gray, red and pin muds with mixed limestones, with thin sections of grayish siltstones with mixed lime-stones and anhydrite.

The caprocks are denser (2.5-2.56 gr/cm3), with a porosity of 4-6%, and its filtration properties reach up to 0.03-0.5 mD. So, the caprocks of Neocom have the best resistive properties, which results in the occurrence of multiple hydrocarbons mines in the XIV formation.

The formation XIII is separated in the different parts of the lower part of the caprocks, which consist of carbonate-stones and sandstones and their porosity varies from 4.32 %(in Jarquduque) to 20.3% (in Khwaja-Bolan). Basically, in many exploration areas, the permeability of the mentioned rocks varies from 10.3mD (in Khwaja-Bolan) to 1mD or even practically less influential. Gas flow has been obtained from the collector rocks of this formation in Khwaja-Bolan and Khwaja-Gogerdak, gas flow with signs of oil in the Jagdalak and oil (upper part) in the Ali-Gul mining areas.

The thickness of the caprocks increases in the Maimana high from 17-20 meters (in Khwaja-Qul structure), 57 meters (to the southwest), 97 meters (to the north). In the eastern part of the Sar-e-Pul block of northern high of Afghanistan, this thickness increases up to 60-65 meters. Its thickness increases through west and northwest, in Dawlatabad depression from 95-115 meters, in Wall-e-Andkhoy and the neighboring areas of Khwaja- Gogerdak block from 110 to 127 meters, and in the Khamab low up to 155 meters (in Juma area).

The presence of fauna, especially remnants of trace fossils with different colors in the lithological and petrographically composition of the Newcome complex rocks, indicates that the formation of the mentioned rocks started in the continental condition (in the time of Carabil) and its development completed gradually with the transgression and development of the sea in the Jurassic period, and in later suite sedimentation with alternating continental- lagoon and coastal conditions occurred. Thus, in the second half of the Valanzhin period, sea transgression began and gradually developed from north to south, and in the time of Upper Carabil and Al-Murad, sedimentation took place in continental-lagoon conditions, which was accompanied by the wetting of the climate and intensity of alluvial sandstones sedimentation. At the time of Hauterivian, the development of the sea progressed and the sediments are related to the shallow marine conditions. At the time of Barium, the condition of sedimentation has slightly changed and the formation of complex rocks has taken place under lagoon-sea and then lagoon conditions.

The amount of organic matter is reduced in the sediments of the Neocom complex stones compared to the Jurassic stones in the neighboring areas of northern Afghanistan. The amount of organic matter here is around 0.3-0.6%. Most of the researchers suggest that the amount of muddy sediments in the cross-section of the complex has increased and therefore the number of organic materials should also be more in them, in the study area. All the above statements confirm that the Neocom complex is the mother rocks of oil and gas and with the help of thermo-loading conditions, it has been able to generate hydrocarbons.

The study and evaluation of the distribution of hydrocarbons accumulation in the Neocom complex, the relative development of the upper Jurassic evaporate caprocks and the spread of a large number of faults in the study area indicate the flow of hydrocarbons occurred from Jurassic rocks to the Lower Cretaceous sediments, especially to Neocom. Therefore, we consider the oil and gas accumulation in the sediments of the Neocom, which is the most confirmed idea by all geologists who did research in this area. Therefore, we confirm that the oil and gas accumulation in the Neocom complex is epi-syngenetic, which are generated from both Jurassic hydrocarbons and the Lower Cretaceous sediments (Neocom).

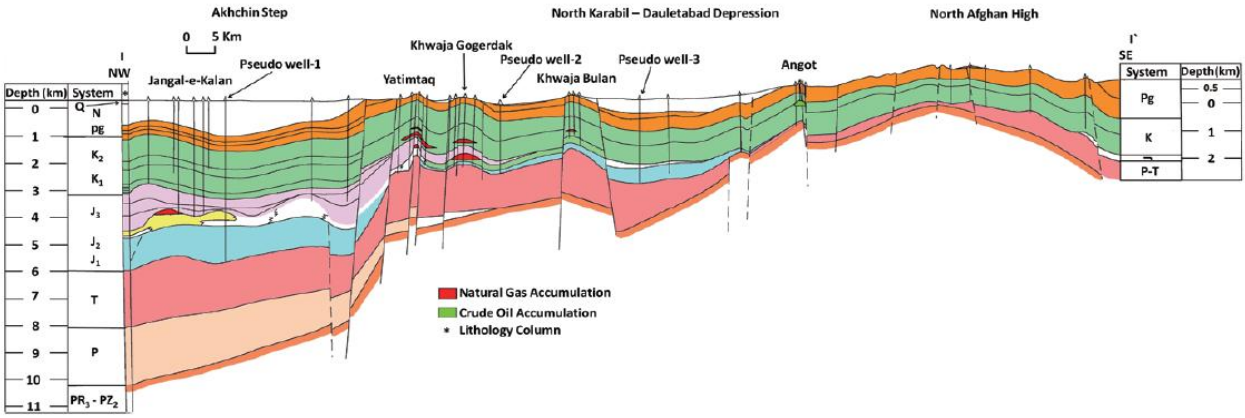

Fig.6.Geological cross section II` in the Amu Darya Basin, northern Afghanistan[5]

3. Aptian-Lower Albian oil and gas productive complex

The rocks of this complex have a widespread in the study area and are composed of mud, gray, and dark gray sandstones with thin layers of siltstone, sandstones, anhydrides, and limestones. Red stones have been observed in the cross-section of the complex in the eastern parts of the region, which is more common in the central parts of the northern high of Afghanistan and the Turkestan dam.

In the cross-section of the complex, two natural-stratified reservoirs have been discovered, in which XII (Aptian Suite) and XIa (sub-Suite of the lower Albian) formations are collector parts.

On the floor of the stratified complex, mud- evaporate stones of the Aptian Suite (Calgric Suite) with a thickness of zero to 75 m is located, which is composed of thin layers of pebbles, siltstone, and sandstones. The collector part of the Aptian Reservoir (XII formation) consists of reddish, small-grained quartz-feldspar, pebbles, and siltstones with thin layers of mud and limestones. The cement of the sandstones is composed of carbonates and mud, in which the sand fraction is 42.6% in the sandstones, 23-33%, and in the Siltstone, 3-4%, and in the mud. In the Siltstone, the gravel fraction is 11-26 %, the mud is 2.5-7.3%.

Carbonatite makes 4.7-22.0% of the stones and their density is 2.01-2.36 gram/cm3. In many areas, in the roof of the formation, a layer of limestone with a thickness of 0.5-4.0 meters can be seen.

The thickness of XII formation varies in different areas as follow:
The maximum thickness of this layer is confirmed (60-94 m) in the exploration wells in the Khwaja-Gogerdak block of the northern high of Afghanistan, and its minimum thickness is measured (10-25 m) in the Sar-e-Pol block, and also in the Maimana high and wall- Andkhoy (Qartamash area). The effective (oil and gas productive) thickness of XII formation varies both in one building (Qashqari mining area 5.8-15.6 meters), or around the study area (in Yatim-taque area -7 meters, Ali Gul-5.7 meters, Aqderia-5.8 meters and Khwaja-Bolan 13 meters.

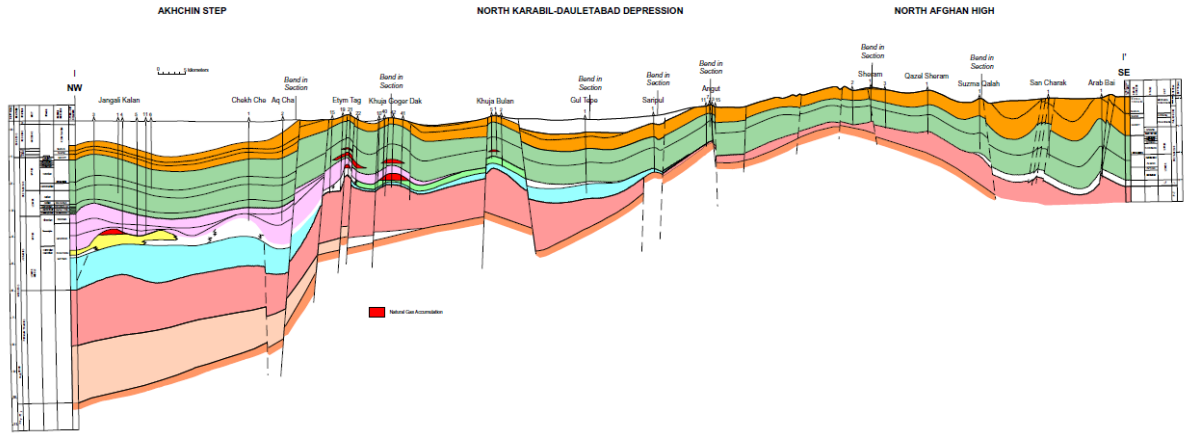

Fig.7.Geologic cross section from Andkhoy step to the North Afghan High. Modified from unpublished cross section provided by the Afghanistan Ministry of Mines and Industry

This mentioned formation does not have stable collector properties due to large lithological changes. Thus, the general porosity of its collector rocks varies averagely from 10 to 27.7 % (its effective porosity varies from 11-17% in the Aqdaria and Qashqari), permeability from 2.5-5.0 and even sometimes it changes from 350 to 395 m.D, averagely 50-100 mD (millidarcy).

In the XII productive formation, gas accumulates in Khwaja-Gogerdak block (Yatimtaque, Khwaja-Gogerdak, and Khwaja-Bolan mining areas), oil accumulates in Sar-e-pol block (Qashqari mining area, 2 mines) of the western part of the northern high of Afghanistan and also in Maimana high(Ali-Gul mining area, 2 mines) has been confirmed. It is found that these mines are dome-shaped-stratified, rarely floating above water in the Qashqari mining area (XIIb formation) **(**Fig.9**).**

Gas saturation of collector rocks in the Khwaja-Gogerdak mining areas varies from 50% (in Khwaja-Bolan) to 64% (in Yatim-Taque), oil saturation ranges from 65% in the Ali-Gul mining area of Maimana high to 69-74% in the Qashqari mining area of Sar-e-Pol block of the northern high of Afghanistan.

Formation pressure in mines reaches up to 12.4-13.4 MPa, formation temperature reaches 49.0-53.0 degrees Celsius (in Qashqari mining area). Gas production from the collector rocks of XII formation in the Yatim-Taque mining area reach up to 114.5-118.0 thousand cubic meters per day, in Khwaja-Gogerdak mining area 28-391 thousand cubic meters per day and oil 2.0 (in Ali-Gul mining area) to 20.0-34.5 cubic meters per day (in Qashqari mining area). In some wells of the recently mentioned mine, the production reached up to 95.5 cubic meters per day.

In the Jagdalak area, from XII formation, a sample of oil-saturated sa

At the base of the lower Albian, in many exploratory wells, XIa formation is separated, which is distinguishing from XII by a mud layer with 15-25 m thickness.

Around the Khwaja-Gogerdak Block, this formation consists of alternating layers of sandy lime-stones and muds. In the depressive areas of the study region (wall- Andkhoy and Khamab depression) pebbles are replaced by sandy muds with thin layers of siltstone. In Maimana high, the above-mentioned formation is made of alternating organic sandy limestones pebbles, and muds. The thickness of XIa formation varies from 10-21 m in Sar-e-pol and Khwaja-Gogerdak blocks to 20-25 m in Wall - Andkhoy and in Khamab depression. The thickness of the oil and gas saturated formation varies from 3.0-4.2 meters in Angut and Qashqari mining areas to 12.6-13.8 meters in Aqderya mining area. The properties of the collector rocks of the formation are completely variable, as its porosity reaches up to10.0-14.4% in the Yatim-Taque and Aqderia, 21.0-23.8 % in the Angut and Qashqari mine areas. The permeability is 3.9-8.5 mD (millidarcy) in the Aqderia to 120 to 236 mD (in the mining area of Qashqari and Angut)

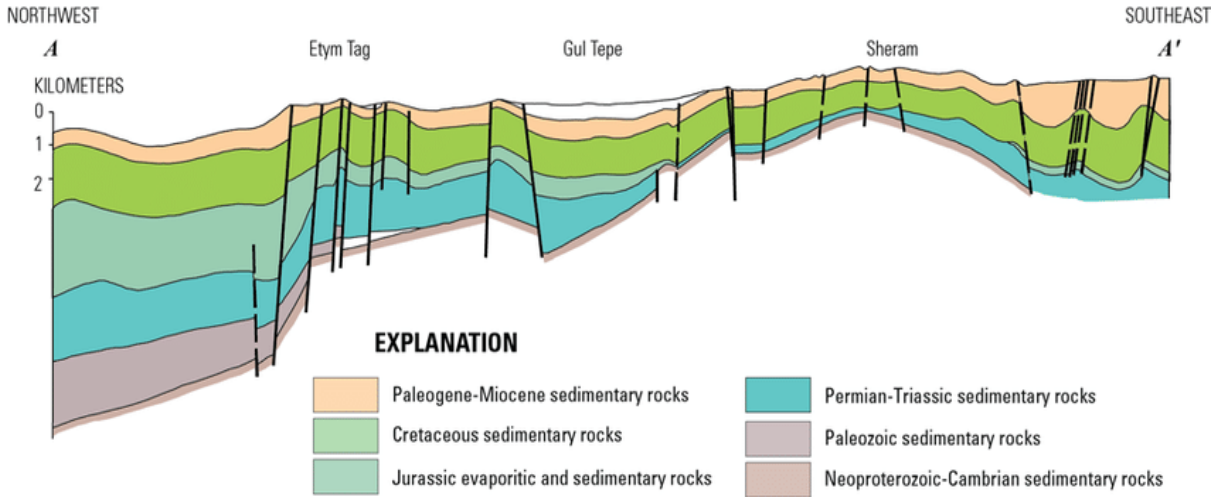

Fig.8.Geologic cross section from Andkhoy step to the North Afghan High[6]

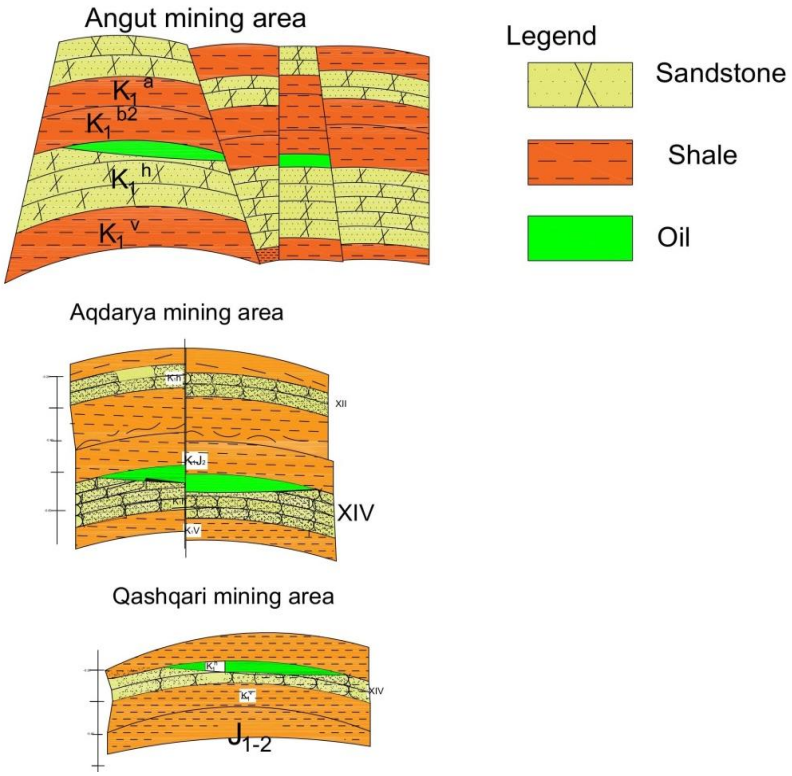

Fig.9: Types of hydrocarbon mines Aptian- lower Albian oil and gas complex (Modified from unpublished reports provided by the Kabul Polytechnic University of Afghanistan)

The difference in the collector properties of the formation rocks is related to the change in the lithological composition and presence of muds in the collector rocks according to the area. The sediments of XIa formation have non-industrial oil reservoirs up to 8.21-23 % in the mining areas of Angut, Aqderya, and Qashqari of Sar-e-Pol block, gas has taken place in the mining area of Khwaja-Gogerdak block. Oil debit of Angut mine area is up to 1.5 cubic meters per day and night, in Aqderya 2.6-3.3 cubic meters per day and night, and gas debit from Yatim-Taque mining area has increased from 3.0-65.0 and even 129.0 thousand cubic meters per day and night and also a small amount of condensate has been obtained as a result of the experiment.

The oil saturation of collector rocks ranges from 61.0-64.0 % (in Aqderya and Qashqari mining areas) to 74.0 % (in Angut mining area) and its gas saturation reaches up to 64 % (in Yatim-Taque mining area). Formation pressure in the mines of this layer ranges between 8.5-10.9 MPa(Mega Pascals) and its temperature reaches up to 47.5-51.0 C◦.

The regional caprocks of the complex consist of sub-suite of the Lower Albian dark-gray and sometimes dark, rich in organic mudstones. The thickness of the caprocks is fixed in most of the study areas (115-120 m), except in Ali-Gul and Jagdalak structures of Maimana high which reach up to 150-210 m.

As previously mentioned, it is possible that in the sediments of the complex, oil and gas formation process has been developed in the depressed parts of the study area (Khamab, Dolatabad and Wall Andkhoy depressions), that is why oil and gas accumulations in the collector rocks of the complex can be considered as syngenetic. Also, the vertical migration of oil and gas from the old sediments has been done through the faults and fractures in the caprocks, because the evaporite stones have decreased in thickness here. [2, 3.4].

4. Conclusions and Recommendations

1. With increasing the number of muddy sediments, the amount of organic materials is increased in the depressed parts of the study area in the cross-section of the Neocom complex. Therefore, the Neocom complex rocks are the mother rocks of oil and gas, which with the help of thermo-loading conditions have been able to generate a certain volume of hydrocarbons.
2. In areas where the Upper Jurassic evaporitecaprock is less developed and the faults and fractures are more, it is possible that the hydrocarbons may migrate from Jurassic to the Lower Cretaceous sediments, including Neocom. This issue has been confirmed by many researchers.
3. In our opinion, oil and gas accumulation in the complex of Neocom sediments are epi-cigenetic, which are generated from both, the hydrocarbons of Jurassic and Lower Cretaceous (Neocom)
4. The muddy layer of Lower Albian sub-suite has a higher amount of organic matter comparing to the Neocom complex, which in our opinion is the basic oil and gas generator formation for the Lower Cretaceous sediments.
5. The possibility of oil and gas formation processes in the Aptian- Lower Albian complex seems to be higher in the depressedparts of the study area (Khamab, Dawlatabad depressions and Wall-Andkhoy), and it is also possible that the hydrocarbons migrated vertically

at places where the thickness of the evaporate rocks is decreased.

6. In our opinion, it is better to continue explorational works for discovering industrial oil and gas reservoirs in the depressions of Khamab, Dawlatabad and Wall-Andkhoy, as well as in the northwestern areas of the northern high of Afghanistan.

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