Reservoir Modeling of Alam El Bueib Formation in the TUT Oil Field, Western Desert, Egypt

Moataz Khairy Barakat
Geology Department, Faculty of Science, Tanta University, Tanta 31527, Egypt
Exploration Geology Department, Institute for Applied Geosciences, Technical University of Berlin, Germany
moatazbarakat@science.tanta.edu.eg

Abstract
The Western Desert is stated one of the best prolific Jurassic and Cretaceous hydrocarbon provinces in the world. The TUT Oil field locates between Latitudes 30° 44' 15'' and 30° 46' 03'' N and Longitudes 26° 57' 18''–27°00' E. Alam El Bueib (AEB) Formation ranges in age from Barremian to Aptian and consists mainly of thick massive, argillaceous and calcareous sandstone with some shale and carbonate interbeds. The Alam El Bueib formation can be considered as an important reservoir rock in the Northern Western Desert. The study area is belongs to the unstable shelf which is a northward-thickening sedimentary section. The major tectonic and structure process occurring during the Cretaceous period is vital factor in imagined the outlining new prospects in the TUT Oil field.
This work is based on 2D seismic lines (TWT) and five wells distributed in the study. Five boundaries members (Alamein dolomite, Alam El-Bueib-1, Alam El-Bueib-3A Alam El-Bueib-3D and Alam El-Bueib-3E) have been identified and correlated on seismic and well log data. The well log analyses are used in determination of lithology and porosity using density-neutron crossplots. The lithology of Alam El-Bueib reservoir is mainly sandstone with some calcareous cement. The hydrocarbon increases mostly at the top and middle parts of the target reservoir in the studied wells. Three types of modeling (structural modeling, facies modeling and petrophysical modeling) have been carried out according to the different results of study parameters. 3D modelling provides a strategy for optimizing exploration in frontier areas and evaluating new plays within well explored basins.

Keywords: 3D structure modeling, properties modeling, Alam El Bueib Formation, TUT Oil Field, Western Desert

1. Introduction
The Western Desert is deliberated the most productive petroleum province in Egypt. Several studies advised that approximately 90 % of oil and 80 % of gas reserves are still undiscovered in the Western Desert (EGPC 1992). The TUT Oil field represented one of the highest oil fields in the north Western Desert region due to its high production from different reservoirs. The study area is sited in Khalada concession about 4-5 km north and northwest of Salam field at the northern of the major Safir-Salam-TUT ridge in Shoushan basin in the northwestern part of the Western Desert (Fig.1).
Alam-El Bueib formation, the main target of this study, is the main reservoir in Shushan Basin due to its highest production. Alam El-Bueib Formation is predominantly white to yellow sandstones with siltstones and few amounts of gray shales (Rebotson, 1982). Its lithology has been subdivided into six units from bottom to the top: AEB-6, AEB-5, AEB-4, AEB-3, AEB-2 and AEB-1, and the AEB-3 unit which was subdivided into six sub units: A, C, D, E, F, and G. In the TUT Oil field the main reservoirs are AEB-1, AEB-3A, AEB-3D, and AEB-3E (Fig.2). The Shoushan Basin, which is extend in the coastal basins, is a half-graben system with a maximum thickness of 7.5 km of Jurassic, Cretaceous and Paleogene sediments (El Shazly 1977 and Hantar, 1990).
This study was based on seismic and borehole data to investigate the subsurface structural settings and the related hydrocarbon potential. The interpretation of the available 2D seismic lines and borehole information was used to identify the stratigraphical and lithological boundaries of the Alam El-Bueib members. The structural setting was deducted from analysis of the seismic sections and depth structure maps followed by structural cross sections and a structural model.

The main objective of this work is to describe the structure pattern by construction a 3D structure modelling of Alam-El Bueib reservoirs (AEB-1, AEB-3A, AEB-3D, and AEB-3E) in North Western Desert, Egypt, where they are important reservoirs in this area.

2. Geological setting
The Western Desert is essentially a plateau desert with vast flat expanses of rocky ground and numerous extensive and deep closed-in depressions, (Said, 1962). It has been recognized as a region of simple geological structure, covered by the northerly dipping Tertiary rocks of regional extent and reasonably lithologic uniformity. The greater part of the North Western Desert formed a platform characterized by relatively basins or depocenters. Figure 3 shows the main sedimentary basins and major structural elements in the North Western Desert, Egypt (Bayoumi, 1996). Shushan Basin is located within the so-called “Unstable Shelf” which occupies almost all of the northern parts of Egypt. The Unstable Shelf characterized by a northward thickening sedimentary section underlain by high basement relief due to block faulting.
Fig. 2 Generalized litho-stratigraphic column of Western Desert, Egypt (modified from EGPC 1992)
In the Western Desert the basic structural elements are oriented NE to ENE, EW and WNW to NW, to some extent reflecting the two dominant WNW-ESE, ENE-WSW trends in the basement, where ENE-WSW depressions and ridges alternate (Meshref 1990).

The stratigraphic sequence that rests over the basement complex in the North Western Desert consists of alternating depositional cycles of clastics and carbonates (EGPC, 1992). The Lithostratigraphic units in these basins have been studied by many authors who have discussed the stratigraphy, facies and tectonic framework of the region (Meshref et al., 1980; Barakat et al., 1987; Berglund et al., 1994 and Zein El-Din et al., 2001). The stratigraphy succession can be divided into four unconformity-bound cycles each terminated by a marine transgression (Sultan and Halim 1988). The earliest cycle consists of Lower Jurassic non-marine clastics (Ras Qattara Formation) which rest unconformably on the Paleozoic Nubian sandstone. These non-marine clastics are overlain by marine Jurassic clastics Khatahba Formation. In the Upper Jurassic, the maximum extent of the Jurassic transgression, shallow-marine carbonates of the Masajid Formation were deposited. A major unconformity separates the Masajid Formation from the overlaying Alam El Bueib Formation. The second cycle began in the Early Cretaceous with the deposition of the shallow marine clastics and carbonates of Alam El Bueib (Units 6 and 5). These are followed by marine shale (Unit 4) and a succession of massive fluvial sandstones (Units 3; Neocomian). Individual sand bodies are separated by marine shale. The sands are
overlain by the alternating sands, shales and shelf carbonates of Units 2 and 1, culminating in the Alamein dolomite associated with the Aptian transgression (Fig. 2). Aptian Alamein dolomite consist mainly of vuggy carbonate and fractured and crystalline dolomite, and the depositional environment is restricted marine (Moretti et al. 2010). Another unconformity separated the Dahab Shale from the Kharita Formation.

The third cycle extended from the Middle Albian to the Early Tertiary. Kharita Formation are overlain by the shallow-marine and nearshore deposits of the Bahariya Formation (Lower Cenomanian). A marked deepening of depositional conditions is indicated by the deposition of the Abu Roash (G) (Upper Cenomanian). General transgression occurred during the Senonian with deposition of the Abu Roash (F) to (A) (predominantly carbonates). The unconformably overlying Khoman Chalk Formation was deposited only in the northern Western Desert. The last cycle The Dabaa and Moghra Formations (marine clastics) is terminated by an unconformity, above which the Eocene Apollonia Formation was deposited. These were capped by the flat-lying Marmarica Limestone outcropping in many parts of the northern Western Desert (Zein El-Din et al., 2001).

3. Exploration history

The first hydrocarbon Exploration work began in the Western Desert in 1940 and the first oil discovery was carried out in the mid-1950 by Sahara Petroleum Company (SAPETCO) (Abdine, 1974). After that, a lot of discoveries have been stated commercial in the Western Desert. The TUT Oil field was discovered in 1986 by Khalda petroleum company. This is producing from four horizons; AEB-1, AEB-3A, AEB-3D, and AEB-3E, production was commenced in October 1987 through the well TUT-1. AEB-1 reservoir started production in October 1989 by the well TUT-2. AEB-3A reservoir started production in October 1987 with TUT-1, TUT-3 in March 1988, well-9 in August 1991 and well TUT-12 in September 1991. AEB-3D reservoir was initially produced through the TUT-2 in February 1988 and TUT-7 in August 1990. AEB-3E reservoir started production in March 1988 through the well-3 this reservoir is producing from five wells TUT-3, 6, 8,11 and 14. Several oil fields in the northern part of the Western Desert are currently producing from thin and separated intervals within the Alam El-Bueib thick section (Hagras, et al., 1992).

4. Materials and methods

The present research is based on the data supplied by Khalda Petroleum Company (KPC) upon the approval of the Egyptian General Petroleum Corporation (EGPC). The data used in the present study includes the following: - (1) Reflection 2D seismic profile of (twenty lines, Fig.4) in dip and strike direction, which were used to map the Alam El-Bueib reservoir in the TUT Oil field. Seismic interpretation was achieved on PetrelTM (version 2014.1) of Schlumberger Inc. (2) Well-log data of five wells distributed in the study area (Fig.4). These wells are (TUT-01X, TUT-03, TUT-11, TUT-21 X and TUT-79). The well logs include (gamma ray, caliper, resistivity, neutron, density, and sonic; plus pressure data). The logs were used for the lithological interpretation of the formations. The well log evaluation has been achieved using Interactive Petrophysics software (IP) version 4.2.
Fig. 4 Base map of seismic lines and boreholes in the study area
The interpretation of seismic data include: identification reflectors boundaries, picking horizons and correlation of boundaries, structural features, establishment structure maps and making a 3D modeling then creating cross sections in any direction.

4. Results and Discussion

4.1. Seismic Interpretation

4.1.1 Identification of reflectors boundaries

To recognize the geology and subsurface structure of the study area, a complete interpretation of twenty seismic lines would be completed. According to the reflectivity of the sediment layers and subsurface pulses can be divided into different groups according the variations of their characters (Barakat, 2010).

Reflectors boundaries of different zones are recognized by tying the available borehole data and 2D seismic lines. Synthetic seismogram gives the interpreter confidence in horizon picking, correlation, and time-depth relationship and allows interpreter to identify multiples in the seismic data. By using Petrel™ (version 2014.1) synthetic seismograms were accomplished from Convolving reflection coefficient log with a defined wavelet. Figure 5 shows a synthetic seismogram for TUT-1X well addressing the tops of the Alam EL-Bueib Formation and the AEB-Members.

Fig.5 Synthetic Seismogram for TUT–1X well (in reverse standard polarity), sonic and density, reflection coefficient
4.1.2 Picking horizons and correlation of boundaries

The Alamein Dolomite horizon is the easily reflection picked along the TUT Oil field. This horizon was picked across seismic lines after reflector identification. The horizon is picked along all seismic grids by correlating the seismic events and tying their times (Fig.6). This boundary forms a major unconformity. Furthermore, this boundary is mostly affected by the ENE Syrian arc system. This reflector has a strong to medium appearance and high frequency. It is characterized by its continuity, which is obscured by faulting to form broken discontinuous reflectors.

In seismic data interpretation, horizon picking is important for structural analysis. Horizons are often interrupted by faults which are usually vertical fractures which cause displacement of the horizons. By using 3-D workstation interpretation, horizon picks are marked by digitizing with a pointing device (usually a mouse) on a screen display of a section. This can be done using displays in any orientation. In the following, the seismic boundaries are described. In this work, five boundaries have been identified (Fig.6). They are listed from below from the youngest to the oldest as follows: Alamein Dolomite, AEB-1, AEB-3A, AEB-3D, and AEB-3E.

Once a horizon pick has been made on any particular trace of the seismic section, it is an available for display on any other section that includes that trace.

Fig.6 Interpreted seismic line number North to South through TUT-11, TUT-1X, TUT-3 and TUT-21X wells

4.1.3 Structural features
Structural features determination is an important step in seismic interpretation. The subsurface structural setting of the study area was analyzed by the available 2D seismic section (TWT). The structural framework of the TUT Oil field, was represents the overall geometry of the Alam El-Bueib reservoir and all reflectors are affected by normal faults. The N-S seismic section view reveals a system of fault-bounded blocks, and the bounding faults are all normal slip faults as shown in Figure 6. The main faults affect the Lower cretaceous and Jurassic sequences with two sets of normal faults, the first have downthrown side towards the south. In addition, the second set has downthrown sides towards the north. Between Fault 2 and Fault 3 are forming small horst producing traps. The majority of the normal faults formed in Jurassic due to Early Jurassic plate movement including opening of the Neotethys. Some of these faults were reversed in Late Cretaceous due to strike slip movement caused by compressional forces of the Syrian Arc movement (Abd El-Motaal and Kusky, 2003).

4.1.4 Construction structure maps

The next step after completing the interpretation of the seismic sections is to construct structure contour maps for each of the selected stratigraphic boundaries. To illustrate the subsurface structural configuration of the study area, five structure contour maps are constructed on top of five horizons which are (Alamein Dolomite, AEB-1, AEB-3A, AEB-3D, and AEB-3E).

4.1.5 3D modeling

3D modeling has been carried out to enable the building of a permanent geo-database of the subsurface structural geology and changes in Alam EL-Bueib thickness. There are three steps required to perform the structural modeling (fault modeling, pillar gridding and creating zones). Structural modeling is performed in three steps. The first step is to define the faults in the geological model, which is termed “Fault modeling”. These faults will form the basis for creating the 3D grid, into which the horizons, zones and layers can then be inserted. Pillar Gridding is the second step in seismic modeling. In this step, the skeleton framework or 2D Grid is created using Petrel™ (version 2014.1) and is based on the faults rather than the surfaces themselves. Making zones is the last step in seismic modeling. Additional horizons below Alam EL-Bueib-1 are included in the 3D grid by isochrones down from the previously input horizon. The make zones process is calculated one stratigraphic interval at a time. Each horizon delimits a stratigraphic interval. From the make zones process five horizons (Alamein Dolomite, AEB-1, AEB-3A, AEB-3D, and AEB-3E) were initiated in time. These horizons were calculated conforming to the master horizon (Alamein Dolomite) and were controlled by the well picks. These horizons were converted to depth for each level using velocity maps, followed by correlation of the result of converted horizons with well picks at each well location to be checked (Figs 7-11).

All these maps achieve their maximum value toward the middle portion of the study area. The western and northern parts of the study area characterized by low-relief areas. All the horizons of AEB (1, 3A, 3D, and 3E) are similar and generally dip to the north and gently dip to the west direction. The highest relief is found in the middle portion of the field due to compressional force by Syrian arc movement in the Late Cretaceous. The benefit of 3D modeling is the ability to present a structural pattern by showing a cross section in different directions (Fig 12).
Fig. 7 Depth structure map of the Alamein Dolomite horizon

Fig. 8 Depth structure map of the Alam EL-Bueib-1 horizon

Fig. 9 Depth structure map of the Alam EL-Bueib-3A horizon

Fig. 10 Depth structure map of the Alam EL-Bueib-3D horizon
Fig.11 Depth structure map of the Alam EL-Bueib-3E horizon

Fig.12 Structural model top Alamein horizon, location of geological cross-sections N-S
4.1.6 Cross sections

After the 3D structural model completed many cross sections, it can easily be formed in different directions to show the (lateral and vertical) display of the AEB reservoirs and their thickness variations including the faults. The N-S cross section direction passing through TUT-11, TUT-1X, TUT-3 and TUT-21X wells (Fig. 13) illustrate that the area is affected by five faults. Two graben structures were forming between F1, F2 in south part and F4, F5 north part of the area, while the horst structure forming in the middle portion of the study area between F2 and F3 which would be an excellent place for hydrocarbon accumulations in the study area.

All Alam EL-Bueib horizons (AEB-1, AEB-2, AEB-3A, AEB-3C, AEB-3D, and AEB-3E) show the same structural elements. This means that the horizons of Alam EL-Bueib were formed in the same depositional condition.

Fig.13 Geological cross section North to South on the Alamein and Alam EL-Bueib-1, 2, 3A, 3C, 3D and 3E, 3F 3G horizons through TUT-11, TUT-1X, TUT-3 and TUT-21X wells

4.2. Petrophysical Evaluation
4.2.1 Neutron-density crossplots

Identification of lithology is of a particular importance in petrophysical evaluation. The Neutron-density crossplots were performed for Alam EL-Bueib horizons (AEB-1, AEB-3A, AEB-3D, and AEB-3E) are described in the studied wells as follow:

Figure (14) illustrates the neutron-density crossplots of Alam EL-Bueib-1, it is noticed that, the points are between sandstone and limestone and the porosity ranged from 15% to 25%. This indicates the presence of sandstone and limestone matrix lithology. The shifting of some points towards the dolomite line may be due to shale effect.

The neutron-density crossplots of Alam EL-Bueib-3A (Fig.15) reflect that the porosity ranges from 10 to 25%, where the most points are scattered on and very close to sandstone line especially TUT-11 well, while the rest points are plotted between sandstone and limestone. This indicates the presence of sandstone reservoir with some limestone streaks. Some points scattered toward dolomite line are attributed to dolomitic cement.

From the density-neutron crossplot of the Alam EL–Bueib – 3D reservoir of the study area (Fig. 16), it is observed that, the majority of plotted points are scattered between limestone and dolomite line (TUT-11, TUT-21 wells) due to the effect of shale. The other points scattered between sandstone and limestone lines with porosity ranging from 10 to 22%. This indicates the presence of shale lithology mixed with sandstone and limestone streaks limestone.

Figure (17) shows the neutron-density crossplots of Alam EL-Bueib-3E reservoir, the majority of plotted points aligned on sandstone line and in between sandstone and limestone lines, with porosity ranging from 15 to 22%. It indicates that the lithology is mainly sandstone with some calcareous cement.

![Fig.14 Density-neutron crossplot of the Alam El-Bueib-1 reservoir](image1)

![Fig.15 Density-neutron crossplot of the Alam El-Bueib-3A reservoir](image2)
4.2.2 Vertical distribution of petrophysical parameters

The vertical distribution of petrophysical parameters achieved by construction the litho-saturation crossplots in the study area to illustrate the distribution of porosity, shale volume, water saturation and hydrocarbon saturation. The litho-saturation crossplots are a representation, zone wise, for the rock component and its fluid content with depth of the wells. The rock components include the clay, quartz, dolomite and calcite, while the fluids content involve the water and hydrocarbon saturations. However, the following is a brief about the reservoir lithology and its fluid content in the studied wells.

Figure (18) represents the Litho-saturation crossplot of Alam EL-Bueib-1 at TUT-11 well which indicates the rock unit is composed of sandstone intercalated with shale streaks and layers of carbonate and siltstone. The hydrocarbon saturation shows an increase in middle part of the reservoir in some wells. Whereas, Alam EL-Bueib-3A reservoir in TUT Oil field (Fig.19) displays that the rock unit is composed of sandstone as a major lithological constituent with appearing layers of carbonate and siltstone. The hydrocarbon saturation shows an increase in the top most part of the reservoir in some wells.

In Alam EL-Bueib – 3E reservoir at TUT-21 well shows that the rock unit is composed of shale as a major lithological constituent with appearing layers of sandstone and limestone. The hydrocarbon saturation shows an increase in middle part of the reservoir (Fig.20). While, The litho-saturation crossplot of Alam EL-Bueib – 3E reservoir in TUT Oil field reveals that the rock unit is composed of sandstone as a major lithological constituent with appearing layers of siltstone and shale. The hydrocarbon saturation shows an increase in the top most part of the reservoir in all wells.
4.3 Property Modeling

Property modeling is the process of filling the cells of the grid with petrophysical properties. Property modeling used for modeling in Petrel™ (version 2014.1) is split into two separate processes:

4.3.1 Facies modeling

A facies model can be defined as a general summary of a specific depositional environment and well logging interpretation distributed throughout the model grid. Two fundamental facies are defined in the (fluvio-marine) environments which characterize the depositional mode of Alam EL-Bueib reservoir at TUT Oil field (Fig.21). The sand is considered to have the best reservoir quality due to the relatively high energy and consequent coarse grain size and shale is the impermeable part of the reservoir. The described facies are coded and loaded in Petrel™ (Schlumberger 3-D modelling software) to build a 3D facies model in the area of interest.
Fig. 19 Litho-saturation crossplot of Alam EL–Bueib -3A member in TUT–11 well
The shallow marine clastics and carbonates of Alam El Bueib (Units 6 and 5) were deposited in the Early Cretaceous. These are followed by marine shale (Unit 4) and a succession of massive fluvial sandstones (Units 3; Neocomian). Individual sand bodies are separated by marine shale. The sands are overlain by the alternating sands, shales and shelf carbonates of Units 2 and 1, culminating in the Alamein dolomite associated with the Aptian transgression.
4.3.2 Petrophysical modeling

Porosity

The porosity is determined stochastically within each lithological facies (backbone for calculating petrophysical parameters) (Fig.22). As porosity modeling is concerned, no seismic attributes that may be used as a predictor have been identified. Therefore, the 3D distribution of the porosity is based on the vertical well profiles. The well data are transformed (normal score) so they are approximately Gaussian distributed. The Gaussian model is characterized by various statistical parameters, which reflect the spatial variability of the porosity. A standard deviation, to specify the local scale spatial variability and a variogram, to specify the local scale variability, are defined. The variogram parameters indicate to what degree the measured porosity values in a position can impact the unobserved porosity values in a position nearby.

In the current study: the effective porosity of Alam El Bueib-1 reservoir ranging from 13.2 in TUT-21 well to 19.2 in TUT-3 well with the mean value is 15.3 %, and for Alam El Bueib-3A ranging from 10.9 in TUT-21 well to 15.1 in TUT-03 well with the mean value is 13.8%. Whereas the effective porosity of Alam El Bueib-3D reservoir ranging from 8.6 in TUT-11 well to 13.3 in TUT-03 well with the mean value is 10.7 % and for Alam El Bueib-3E reservoir ranging from 12.5 in TUT-11 well to 16.2 in TUT-03 well with the mean value is 14.3%.
Water saturation

Water Saturation is calculated based on distributions related to porosity ranges. The full range of porosity has been divided in five arbitrary classes in which associated Water Saturation values from logs were statistically analyzed. It turned out that within each porosity class, related Water Saturation data fit a log normal distribution. These distributions condition perfectly the modeling of the Water Saturation for each porosity class. This fast and simple method allows the generation of a consistent water saturation distribution that respects a realistic degree of correlation between porosity and saturation (Fig.23).

In the current study: the water saturation of Alam El Bueib-1 reservoir ranging from 32.5 in TUT-79 well to 42.2 in TUT-21 well with the mean value is 38.7 %, and for Alam El Bueib-3A ranging from 30.2 in TUT-11 well to 48.9 in TUT-79 well with the mean value is 38.6%. Whereas the water saturation of Alam El Bueib-3D reservoir ranging from 23.3 in TUT-03 well to 36.3 in TUT-11 well with the mean value is 30.3 % and for Alam El Bueib-3E reservoir ranging from 22.4 in TUT-21 well to 98.3 in TUT-79 well with the mean value is 45.95%. With this simple technique, the distribution of the saturation is performed in one step for all the Alam EL-Bueib reservoir cells that are located above the Oil-Water Contact in Alam El Bueib-3E (Fig.24).
Fig. 23 3D water saturation modeling of Alam EL-Bueib-1, 2, 3A, 3C, 3D and 3E, 3F, 3G horizons at TUT Oil field

Fig. 24 3D Oil-Water Contact of Alam EL-Bueib at TUT Oil field
5. Conclusions

The TUT field is located in a cluster of oil fields of Cretaceous age in the northern part of the Western Desert which were mainly discovered in the late 80ies and early 90ies. The twenty seismic lines and five wells distributed in TUT Oil field were carefully analyzed to identify the most important seismic reflectors. The top of Alamein Dolomite was the first boundary picked and used as a marker bed then AEB-1, AEB-3A, AEB-3D, and AEB-3E. The analyzed of petrophysical parameters indicate that out of four units of the Alam EL-Bueib Formation in TUT Oil field, the AEB-1, AEB-3A, AEB-3D and AEB-3E are hydrocarbon-bearing. The Alamein Dolomite bed is considered as an excellent seal for Alam EL–Bueib reservoirs. The density-neutron cross-plots of the Alam EL–Bueib Formation show the presence of sandstone with some calcareous cement and the porosity mean value is 15.3 % in AEB-1, 13.8% in AEB-3A, 10.7 % in AEB-3D and 14.3%in AEB-3E. The hydrocarbon increases mostly at the top and middle parts of the target reservoir in the studied wells.

Data integration and modeling were facilitated by the PetrelTM, Schlumberger’s reservoir modeling software. The integrated model has been used to support key operational and future field development decisions. To summarize and visualize the pervious results, three types of 3D models have been realized:

1. Structural modeling: The 3D structure model explains the effect of the main structural features on AEB-1, AEB-3A, AEB-3D, and AEB-3E reservoirs. The main geologic structure can be observed in the middle part of TUT Oil field consists of horst block forming by two sets of normal faults (F2 and F3).
2. Facies modeling: The facies distribution in TUT Oil field showed the lateral continuity of reservoir sandstone among the area without any stratigraphic barrier.
3. Petrophysical modeling: the petrophysical model is to provide a complete set of continuous reservoir parameters (i.e. porosity and water saturation) for each cell of the 3D grid.

Finally, the southern and central portions are considered the best location for drilling new development wells in this area due to the fact they contain the highest relief.

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References


