Characterization and Modeling of the Ordovician Tight Reservoir, Djebel Mouima South, Southern Tidikelt Region, Ahnet Basin, Algeria.

Abstract

The first gas discovery in the Algerian Sahara was realized within the Ahnet Basin as of 1953. This basin located in the occidental part is considered as one of the most promising gas basin in Algeria.

The characterization of the Ordovician reservoir was realized using a petrophysical evaluation based on the result obtained from diagraphic analysis of the DMS-1 and DMS-2 wells. The aim of this study is to model comprises a geostatistic approach to determine the follow the lateral evolution of the reservoir properties such as porosity, water saturation, permeability, and shale volume. To build 3D structural models horizons, faults, and well tops were used. The construction of the geological variogram of each property in order to determine the distribution of the petrophysical properties and the best accumulations.

Key-words: Ordovician, Djebel Mouima, model, reservoirs, variogram.

INTRODUCTION

The international agency of energy estimates that the unconventional gas world reserves are of 920 000 106 cubic meters. The Paleozoic formations having the tight gas reserves in the north of Africa are those of the Cambro-Ordovician as well as the lower Devonian reserves, our research study focuses on the Ordovician tight gas reservoirs. The most important basins presenting good tight gas potential within the Saharan platform are: Ahnet-Timimoune basin, Berkine basin and Regganr basin. The Tindouf and Bechar basin seams promising, however, they are still in the exploration stage.

Geological setting of the Ahnet basin:

The Ahnet basin is located in the south western part of the Algerian sahara, it is limited with the meridians 1° and 3° and the parallels 24° and 27°; covering an area of 50 000km². The study area (Djebel Mouima Sud prospect) is located in the Ahnet basin in the southern part of the Tidikelt area, extending over an area of 100 000 km², bloc 338a having a NWN-SES orientation. It is the deepest structure in this perimeter, drilled with two wells DMS-1 & DMS-2; the first reach the depth of 2321m and the second reaches the depth of 2140m (Fig. 01).
The figure above shows the three Tidikelt compartments as well as the position of Tidikelt South where our study area is located. The Tidikelt South is located between the meridian 2°05' and 3°10' and the parallels 25°30' and 26°15' (Fig.01).

**Structural setting of Djebel Mouima South**

Tidikelt structure is oriented NE-SW cut by sub-vertical to vertical NE-SW to N-S oriented faults which were probably generated during the Hercynian orogenesis. The main fault is oriented N-S, the inverse movement of this fault may causes the folding of the Triassic and the Paleozoic series those forming the anticlinal structure N-S.
Stratigraphic setting of the Djebel Mouima South.

Figure 3 shows the stratigraphic column of Tidikelt which is composed essentially of marine clastic sediments of Paleozoic age deposited upon Precambrian basement.

Fig. 03: Paleozoic Stratigraphic column of the Tidikelt region  
(Final report of Sonatrach document Tidikelt project, July 2011)

Reservoir modelization

The main purpose of this study is to generate a 3D geo-model of the Djebel mouima reservoir. Petrel software was used in order to integrate all the structural and sedimentological data, moreover we added resent petrophysical data in order to build 3D property model.
Outline resuming steps to follow in order to realize the « D geological modeling of the Ordovician reservoir in the Djebel Mouima South structure.

**Structural and stratigraphic modeling.**

First of all data are loaded in petrel next step is the structural and stratigraphic modeling with a well correlation.

**Well correlation:**

In order to follow the spatial extension of the different reservoir’s units, correlation profiles were realized.
Fault modeling and pillar gridding:

Using the seismic data (2D faults) as well as the Ordovician reservoir well tops, 3D faults plan that constitute the reservoir architecture were realized. This figure represents the 3D faults which were obtained from polygons. From this fault model we can conclude that we practically have the same faults defined within two levels: top Cambrian and top Dalle de M’ekratta, they are of 7 numbers and their orientation is N-S to NWN-SES. The white colored polygon presents the limits of the Djebel Mouima South structure.

Pillar Gridding

Very important step in the realization of the 3D geological modeling, were the fault model will be used, we build a grid composed of 3 layers (top, middle and base skeleton), forming the skeleton of the model.
Following the faults number as well as their situation, the Djebel Mouima South structure was subdivided into five segments, the next objective is the segment 1.

**Make Horizons**

**Layering.** Layering: where the creation of the stratigraphic horizons is the last step in the structural modeling. However, before the realization of the layers, we need first to have the limits of the parts that should be subdivided; they are the top of the horizons DMK and the Cambrian top that limits the Ordovician reservoir. The making horizon process consists on inserting horizons of top and bottom of the Ordovician reservoir into the 3D grid.

The result of the previous step is the formation of zone constituting the Ordovician reservoir of the Djebel Mouima South structure that should be divided into zones where the number is limited upon the number of unites constituting the Ordovician reservoir.

**Zoning:**

We will have as result the subdivision of the zone between the top of the Dalle of M’ekratta and the top of the Cambrian into three zones.

**Layering:**

The result of this process is to subdivide the studied reservoir into drains those thicknesses is of 10m.
Fig. 09: Creation of layers within each zone of the Djebel Mouima South (Petrel)

Fig. 10: Thickness model below the GDT contact of the Djebel Mouima South structure
Cellular thickness above the contact would range between 250-300m.

In order to follow the distribution of properties, we need to filter following the direction I, we will have a 3D cross section oriented N-S and showing cellular above the contact WUT below the GDT.

![Fig. 11: N-S 3D cross section in the thickness model below the GDT contact Djebel Mouima South structure](image)

**Upscaling:**

Within the well DMS-1 the best petrophysical properties are within the Hamra Quartzite, however in the well DMS-2 they are in the Hamra Quartzite and the El Golea sandstone which has the best properties.
Net to Gross model:

The net to gross values are low in the model where we have used the data of the well DMS-1.
**Petrophysical Modeling**

During this estimation phase, we will choose the stochastic method as a modeling method.

Porosity values are generally low within the Ordovician reservoir. The best porosity value is of 4% which was reached within the North-Ouest side of the Dalle of M’ekratta.

![Effective porosity model distribution of the Djebel Mouima South structure (Petrel)](image1)

**Fig. 14 : Effective porosity model distribution of the Djebel Mouima South structure (Petrel)**

![Water saturation distribution model of the Djebel Mouima South structure (Petrel)](image2)

**Fig. 15 : Water saturation distribution model of the Djebel Mouima South structure (Petrel)**
Fig. 16: Clay volume distribution model of the Djebel Mouima South structure (Petrel)

Fig. 17: Permeability distribution model of the Djebel Mouima South structure (Petrel)
The distribution is more homogeneous within the Hamra Quartzite and El Golea sandstone than the Dalle of M’ekratta were we can observe a fast change from the S-E toward the N-O. The Ordovician reservoir is also characterized by a low permeability excepting the DMS-2 well where some good values were observed. Very good value of water saturation specially within the Hamra Quartzite in the North-West of the Dalle of M’ekratta. The distribution is more homogeneous in the Hamra Quartzite and the El Golea sandstone than the Dalle of M’ekratta where we observe a fast change from the S-E toward the N-O. Shale volume values in the Dalle of M’ekratta are almost similar in the Hamra Quartzite and lower, less than 10%.

General Conclusion

Djebel Mouima South positive structure oriented NWN-SES affected by normal faults oriented N-S to NWN-SES. The highest part of the structure is delimited by two major faults. The Djebel Mouima structure is a good structural trap. DST results indicate three intervals producing gas: Emsien, Silurien and Ordovician. The Ordovician reservoir of the Djebel Mouima South is represented from base to bottom by the following formations: Hamra Quartzite, El Golea sandstones, and the Dalle de M’ekratta. The post-fracturation results in the Ordovician reservoir indicate an important gas debit. Important number of natural fractures was interpreted within the Ordovician reservoir. Presenting a possibility to improve the permeability,
- Within the DMS-1 well the upper part of the El Golea sandstone is characterized by intensive fractures.
- Within the DMS-2 well, fractures are encountered at the base of the El Golea and within the Hamra Quartzite. The intensity of fractures is more important within this well.

Stratigraphic correlation shows the vertical variation of the thickness is evaluated at 134.625m in the Hamra Quartzite, 141.4m within the El Golea sandstone and 12.375m in the Dalle of M’ekratta formation. The interpretation of iso-value maps characterizing the Ordovician reservoir shows that Ordovician reservoir of the Djebel Mouima South presents low values of porosity, water saturation and clay volume and very low value of permeability.

Best properties are encountered in the North-West showing a decrease toward the Sud-East, the best reservoir from a petrophysical characterization point of view is the Hamra Quartzite formation.

As modeling result, we obtained a best visualization of the properties distribution.

Bibliography