Subsurface Interpretation Applying Seismic Attributes Technique at Misaada and Rabwa Fields, East Bahariya, Western Desert, Egypt

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Abstract: Most of the drilling activities in oil fields either in exploration or development phases are depending on structural interpretation of 3D seismic data y, which leads to good results in some areas and bad in others, so the demand to apply new methods, which were uncommon in the area of study, resulted in extracting more information from seismic data rather than using structural interpretation method. One of these methods is seismic attributes where we can extract information beyond the seismic reflectors that could lead to a better geological interpretation of the data, hence; seismic attributes have been used as interpretation tool for seismic Geomorphology in order to enhance imaging the subsurface structures, identify new prospects and reducing the development risk. It also can be used to indicate the presence or absence of hydrocarbons by predicting its effect on the amplitude away of the drilled wells.

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1. Introduction:

The Study area Misada-Rabwa is located in the Northern Western Desert of Egypt, Northeast Abu Gharadig basin, south of East Bahariya Concession and West of Qarun Oil Field. It is a transitional area between two main ridges in East Bahariya, Samra-Asala ridge from West and Heba ridge from East. It was discovered in 2003 when the first well Misada-1x drilled. The study applied in an area of about 43Km2 including two fields Misada and Rabwa of about 15and 12Km2 respectively (Figure1).

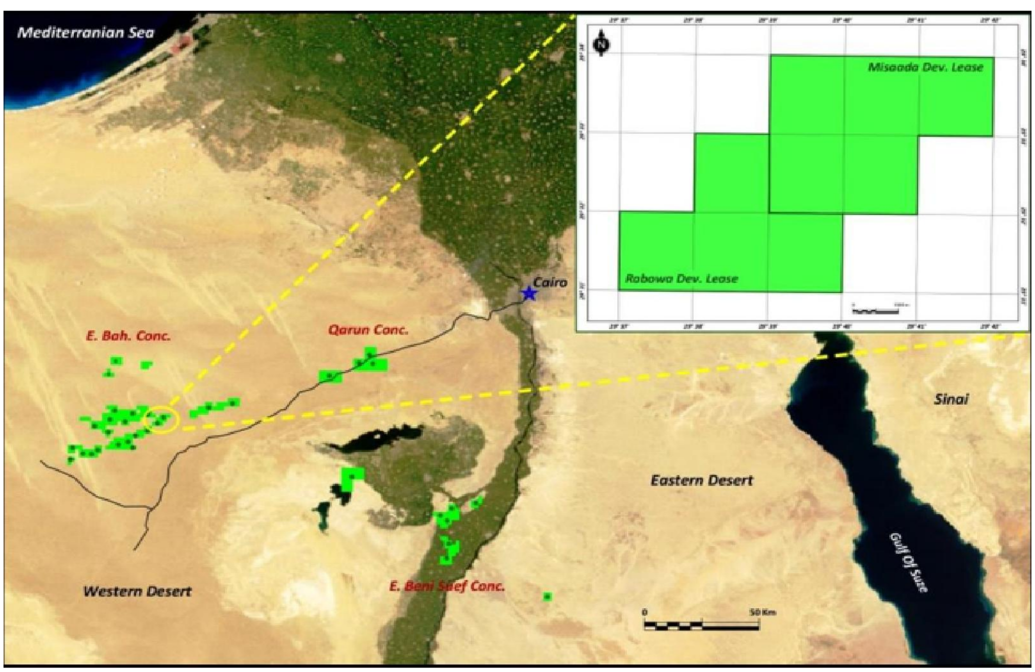


Figure 1 Location Map of Misada and Rabwa Fields in East Baharya Concession.

It is noted that the basin is subdivided into three structural units (Bayoumi, 1996); from east to west:

• Mubarak sub-basin, Abu Gharadig basin and, Qattara Depression. These low lands including Mubarak High, Abu Gharadig Anticline, and mid-basin Arch, as shown below, (Figure 2).

The most important tectonic event occurred during the Late Cretaceous and Early Tertiary and was probably related to the movement of the North African plate toward Europe. It resulted in the elevation and folding of major portions of the North Western Desert along an east-northeast, West - Southwest trend (Syrian Arc system) and in the development of faults of considerable displacements.

Oil potentialities of the study area can be evaluated by the presence and absence of the petroleum system elements.

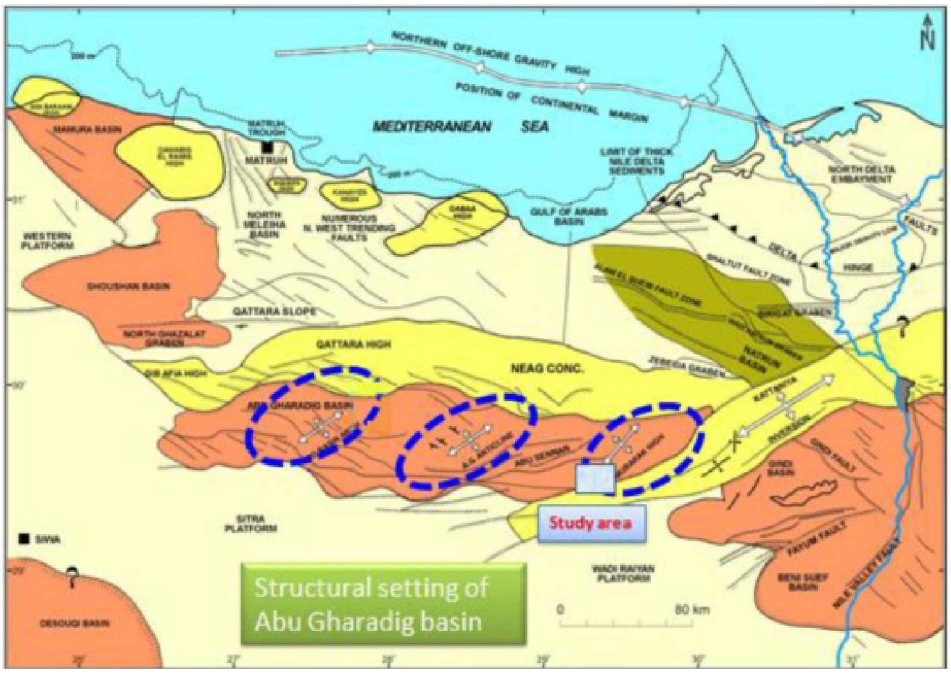


Figure 2 Structural divisions of Abu Gharadig basin, (Bayoumi, 1996)

Using the available 3D seismic data, helped in the evaluation of the prospects and hydrocarbon potentialities to the deep Jurassic zones of the Misada and Rabwa area. Also, the results of the 3D seismic data interpretation contributed to the understanding of the tectonic history of the study area.

Most fields in the northern Western Desert are related to structures formed in Late Cretaceous-Eocene and are placed in or at the edge of early depo-centers that later became kitchen areas (Abu El Naga, 1984).

The main productive reservoirs of the study area are Abo Roash "G" Member and Upper part of Bahariya Formation. So, this study concentrates on them in addition to the deeper Formations from Early Cretaceous and Late Jurassic reservoir's which failed to produce tell now and from which, we aim to add new undiscovered zones. (Figure 3).

All the drilling activity in this area were drilled according to conventional work which based on choosing the highest structural traps. Some of them succeed and others failed to achieve good results. The use of unconventional methods could lead to achieving significant results which reduce both exploration and development risk.

In this study, in addition to structure interpretation, Seismic Attributes were applied in order to find if there is a relation between the presences of hydrocarbon and the acoustic impedance or Seismic data amplitude, hence; can detect the areas of the same effect away of drilled wells.

The achieved results in this research suggest that the application of seismic attributes methodology integrated with structure interpretation leads to quite good predictions of prospects and leads, enhancing the development plan within fields and reducing the drilling risk.

2. Methodology:

The available dataset for this study were Post-stack seismic data, well logs data, VSPs, and formation tops. The seismic volumes were Full-stack seismic reflectivity volume and Inverted P- impedance volumes which created using colored inversion. On the other side, the well logs data comprising P-wave Velocity and Density.

In (Figure 4), the workflow composed of four main steps. The first step is loading and QC for the input seismic data and wells data. The second step is to tie wells to seismic data using VSP and creating synthetic Seismogram from density and sonic logs. The third step is interpreting seismic data, in order to create structure contour maps for the reservoir surfaces which used in the Fourth step to extract seismic attributes on these surfaces.

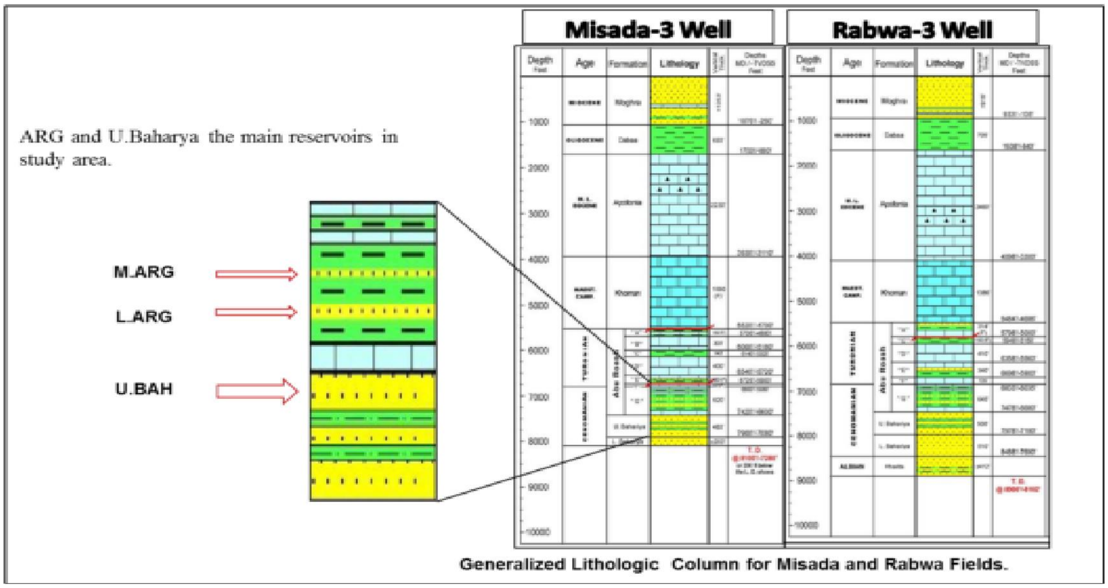


Figure 3 Lithological Section of both Misadaand and Rabwa Fields Represented by Misada-3 and Rabwa-3 Wells.

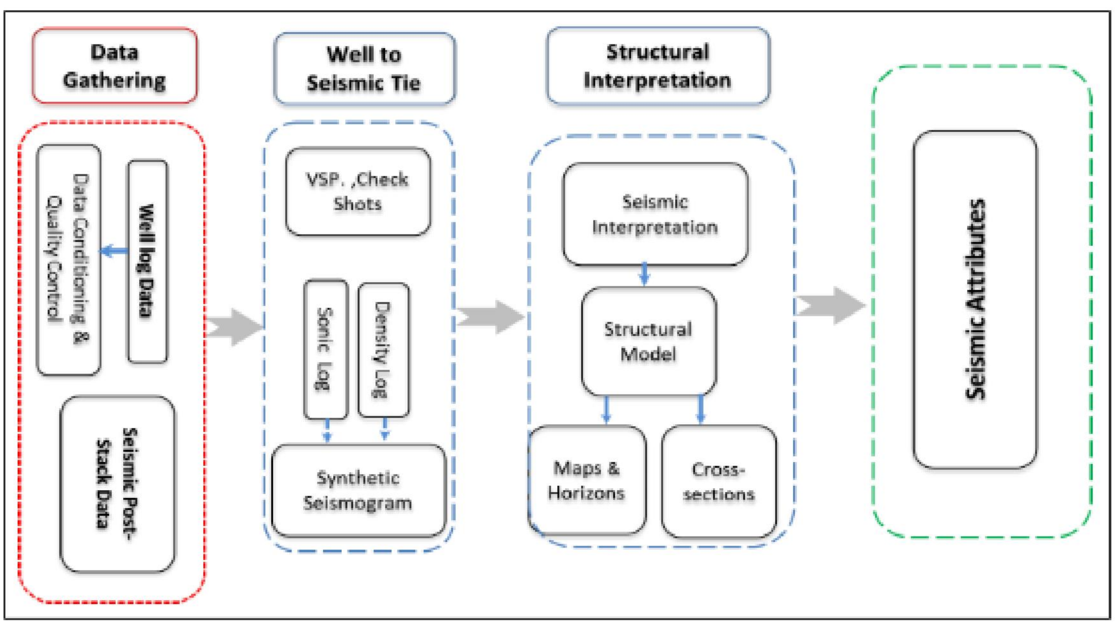


Figure 4 Work flow applied on the study area.

3. Results:

Based on seismic interpretation ten horizons were picked, (Figure 5) two seismic cross sections showing the ten picked horizons from basement to Apollonia formation.

Structure contour maps of the main reservoirs in the area were constructed. M.ARG Structure contour map (Figure 6) showing the structure of both fields where all wells targeted this reservoir is producing from this thin sand bed. While U.BAH Structure contour map (Figure 6B) showing some problems which cannot be understood from structure interpretation individually, these problems summarized in the following:

• M2 Well is a dry hole targeted U.Bahariya Reservoir.

• Despite the good and high structure closure, all Rabwa Wells are producing from ARG Sand Reservoir and dry on U.Bahariya Sand Reservoir.

• All Misada Wells producing from U.Bahariya Sand Reservoir with a large difference in net pay Sand thickness especially between M1and M7 wells.

The conventional Seismic structural interpretation is limited and cannot individually solve the previous question marks. So additional techniques like Seismic attributes used in this study.

In most exploration and reservoir seismic surveys, the main objectives are, first, to correctly image the structure in time and depth and, second, to correctly characterize the amplitudes of the reflections. Assuming that the amplitudes are accurately rendered, a host of additional features can be derived and used in interpretation. Collectively, these feature sarereferred to asseismic attributes. (Taner et al, 1979).

The stacked seismic data volume is commonly used for interpretation of geologic structure and seismic attributes. The most common attribute is simply amplitude, although its interpretation in thin-layered beds is not necessarily straightforward. (Robertson, J.D. and Nogami, H.H. 1984.

The attributes can be derived from the seismic volume itself, such as the amplitudes of the seismic traces or the instantaneous phase, instantaneous frequency, and derivatives of seismic trace. Attributes also can be inversion- derived such as P-impedance, S-impedance, and density (Russell, 2006).

In this example, as an input, we used the internal attributes of the seismic itself the output surface attributes especially on U.Bahariya reservoir surface were effective and useful as well illustrated in the following:

The first attribute extracted was Coherence attribute, Coherence is an attribute of similarity among neighboring traces. And is often used to identify fracture sorfaults that tend to disrupt reflectionslocally, it is a post- stack attribute that measures the continuity between seismic traces in a specified window along a picked horizon. It can be used to map the lateral extent of a formation. It can also be used to see faults, channels or other discontinuous features. (Figure 7) showing the Coherence attribute maps for some surfaces and over laid by the fault polygons from the conventional structure interpretation to show that this attribute is very useful in fault detection and structural adjustment.

- The second attribute was RMS (Root Mean Square) attribute. This attribute extracted on U. Bahariya surface and shows great results. Figure 8 shows features notrelated to structure eflected as a contras tin Color from cold (Blue) to hot (Red). Understanding these features will solve many problems in the area which were not solved in terms of structure interpretation. After applying these attributes, we noticed the following: Many wells drilled in a three-way deep closure of Rabwa field which highlighted with red polygon and named RW in the southwestern part of the area (Figure 8) all these wells showing a dry U. Bahariya sand and low RMS amplitude (Blue Color).

- In Misada Field, many wells show a good sand and pay zones but still have an abrupt change in Pay sand thickness, the wells of good pay sand located in high RMS amplitude and the color gradient is very combined with net pay sand map (Figure8).

- The M1and M7wellsin (Figure8) are close to each other (about270m distance) but they have a major variation in pay sand (6 ftpay sand in M1well, and 46ft in M7well) as calculated from well log data (Figure9). This figure showing that the RMS amplitude map reflects the net pay map in Misada field calculated from the results of all drilled wells. It is clear that the well M7inhigh amplitude area (hot color) while M1 in lower amplitude area.

- The Well M2 shows a high closed Structure but it is dry on U. Bahariya sand which reflected as a low RMS amplitude (blue color), So the field which highlighted with red polygon and named RW in the south western part of the area (Figure 8) all these wells showing a dry U.Bahariya sand and low RMS amplitude (Blue Color). Recommendation is to Side track this well to the closest location of high Amplitude (highlighted with a red polygon (Figure8).

- According to the above mentioned, RMS is a very useful attribute on U.Bahariya reservoir in the study area which was used to detect hydrocarbon occurrences. As a result, new locations of high amplitude suggested to be tested by new wells as highlighted on (Figure 8).

The third post-stack attribute computed on U. Bahariya Surface is the Maximum Amplitudes Attribute. (Figure10) shows Maximum amplitude attribute map extracted on top U. Bahariya surface the map shows a clear feature which not related to structure. This feature makes a separation between M1and M7 wells, which explain the variation in pay sand thickness between these two wells. This feature may be related to abrupt facies change which is geologically accepted because the U. Bahariya sand deposited in a tidal environment. Figure 11, demonstrates an E-Wseismic line perpendicular to this feature shows that it is not related to structure.

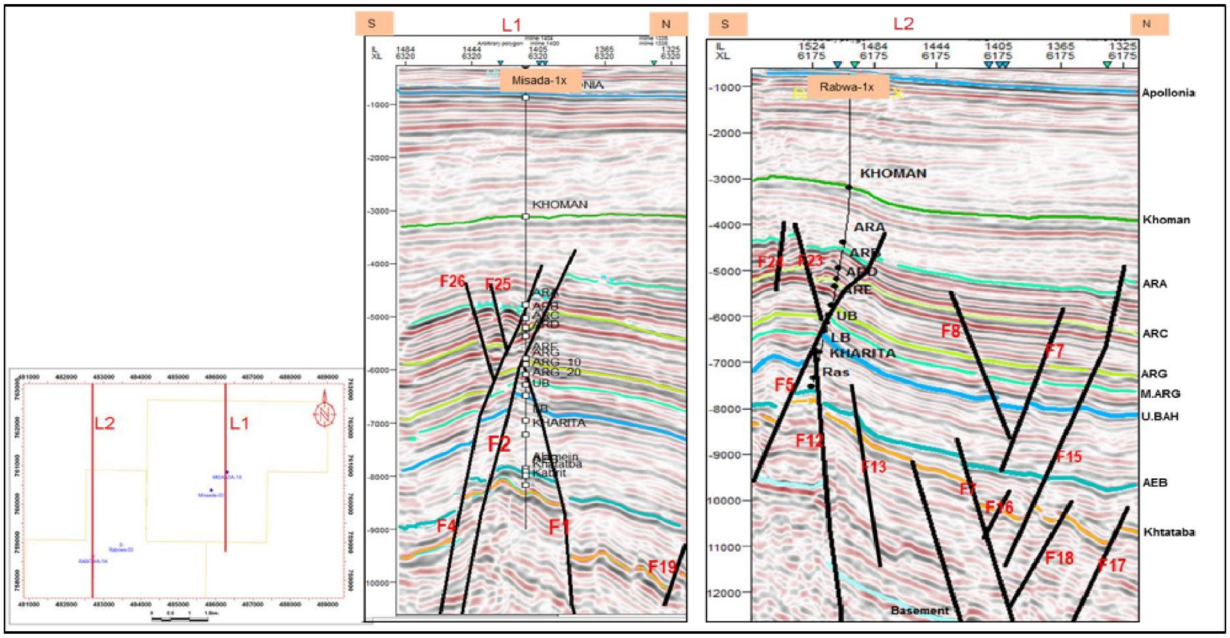


Figure 5Two seismic cross sections showing the picked horizons and fault interpretation.

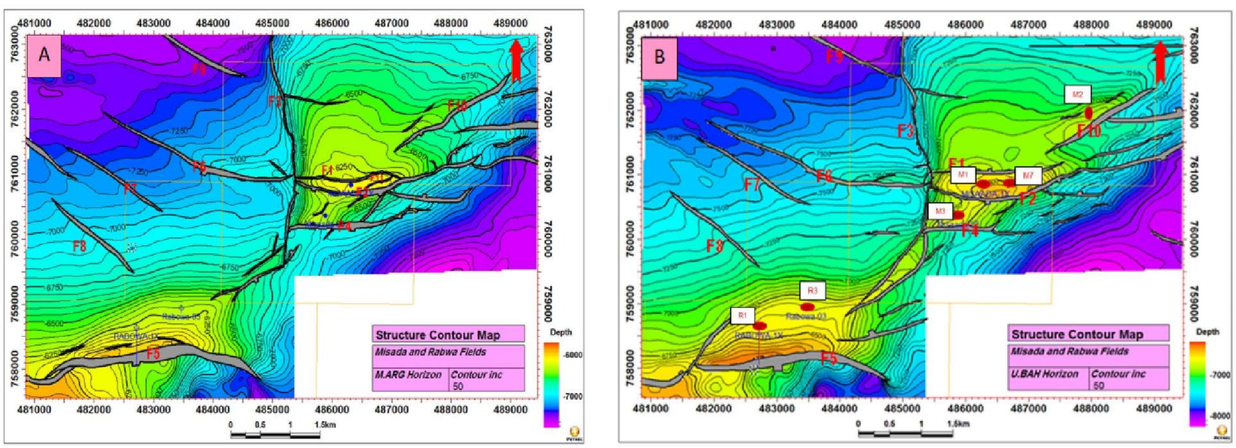
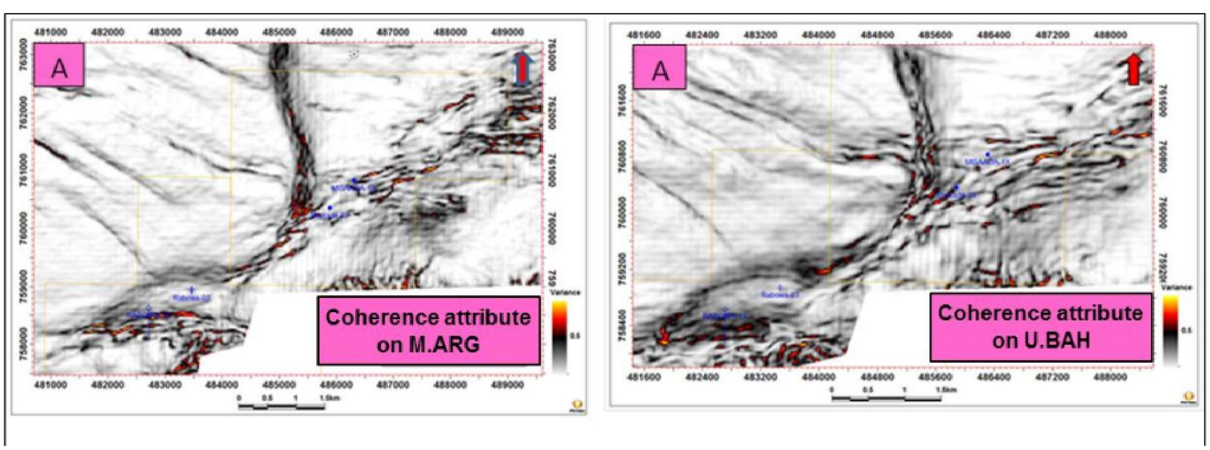


Figure 6 A) Structure Contour Map on M.ARG Member **B)** Structure Contour Map on U.Bah Formation



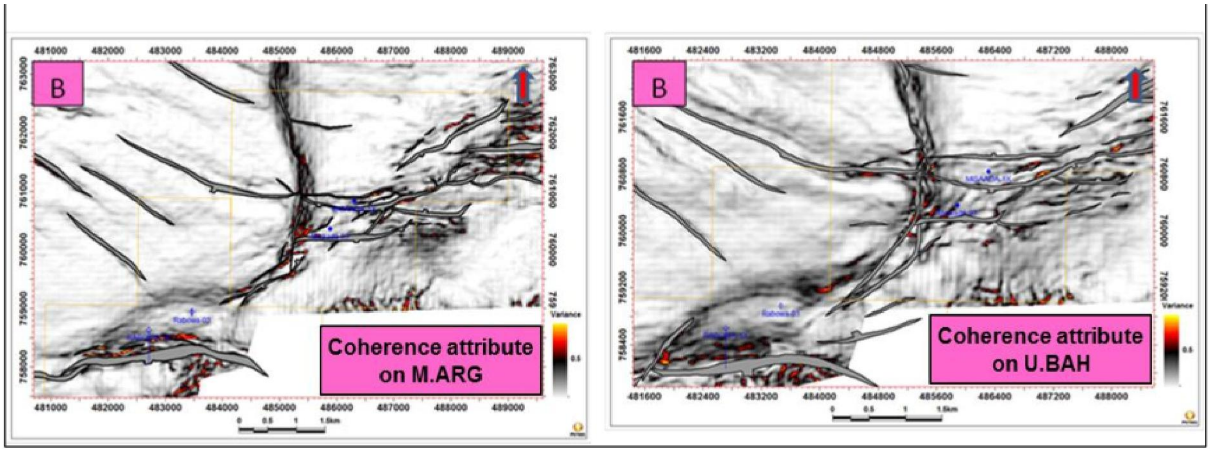


Figure 7 Coherence Attribute Maps for both M.ARG and U.BAH Horizons A) Coherence Attribute B) Coherence Attribute overlaid with fault polygons.

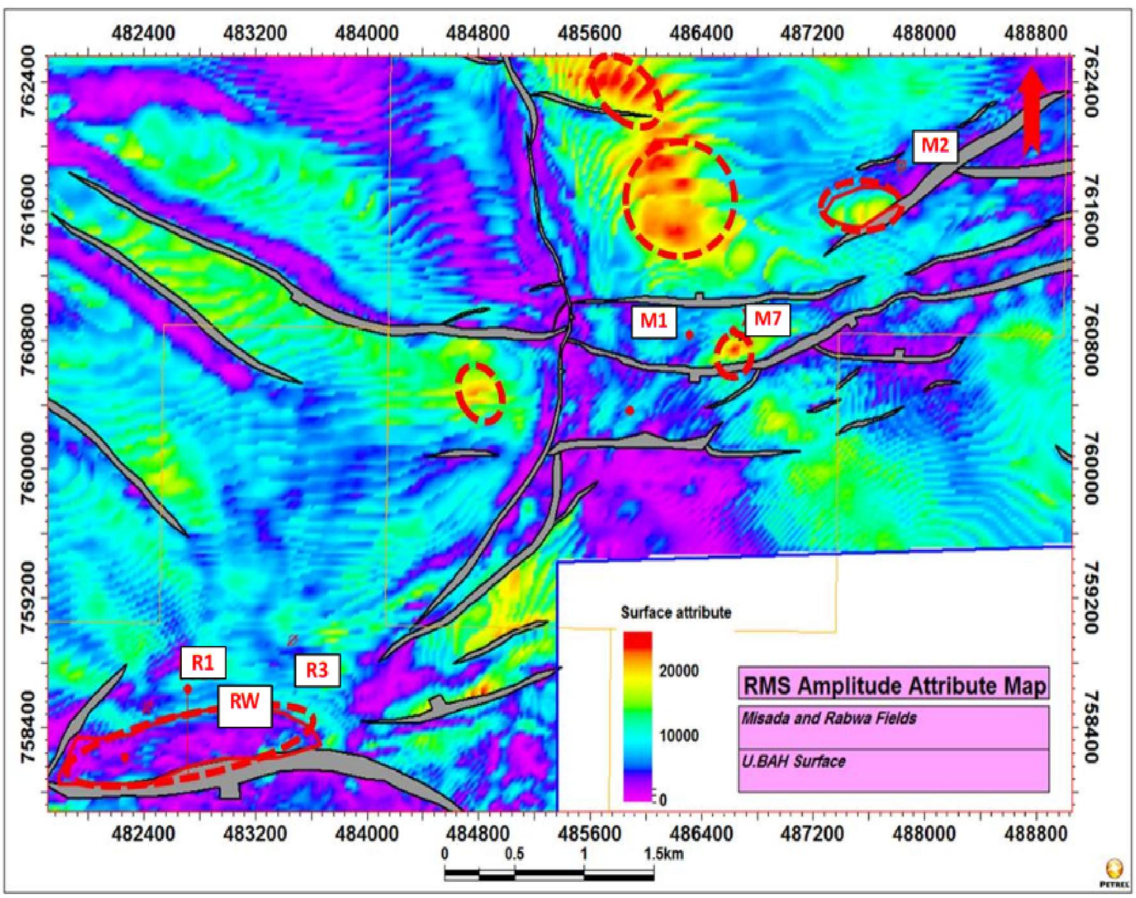


Figure 8 RMS. Amplitude Attribute Map overlaid by structure fault polygons

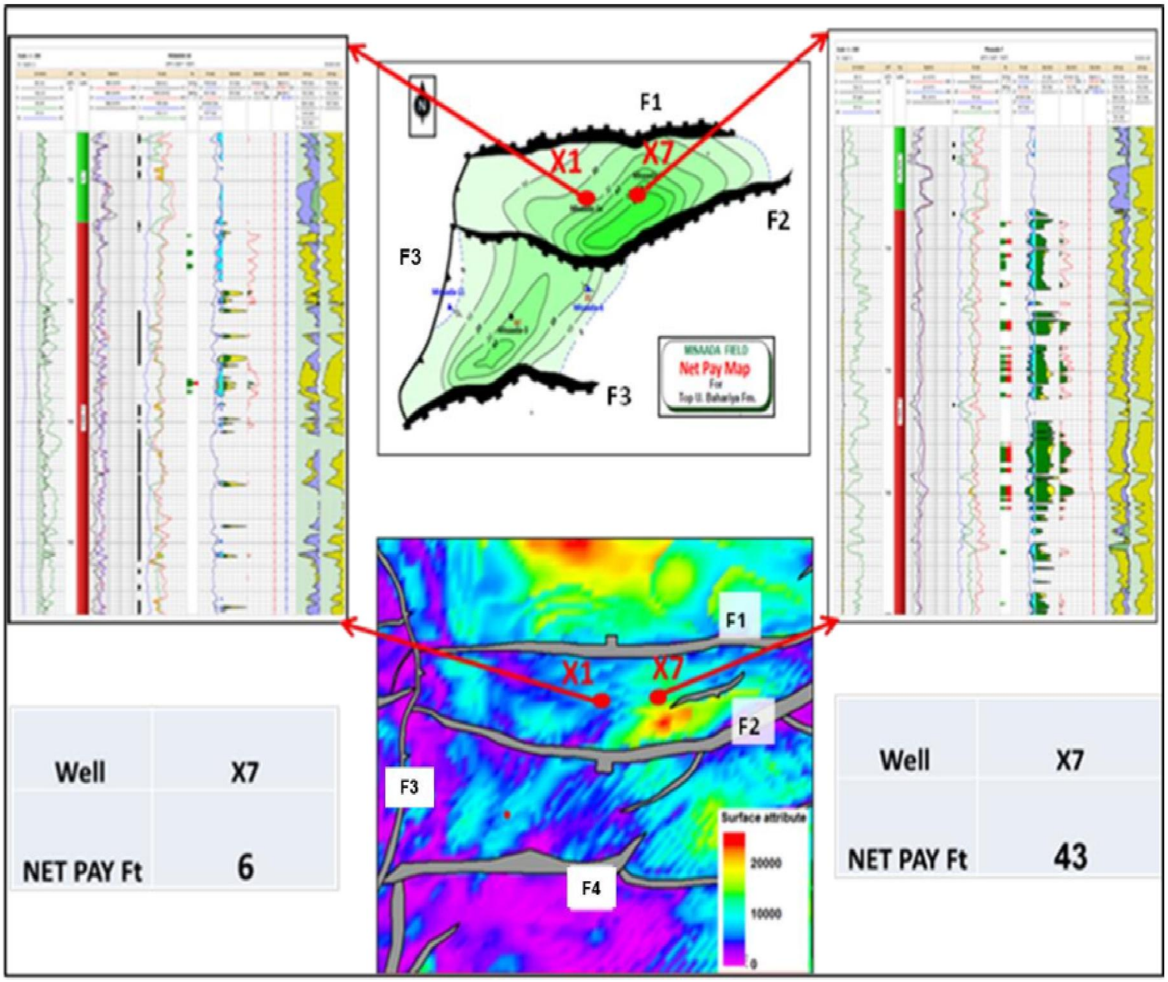


Figure 9 showing the similarity between RMS. Attribute Map and Net pay Map in Misada field

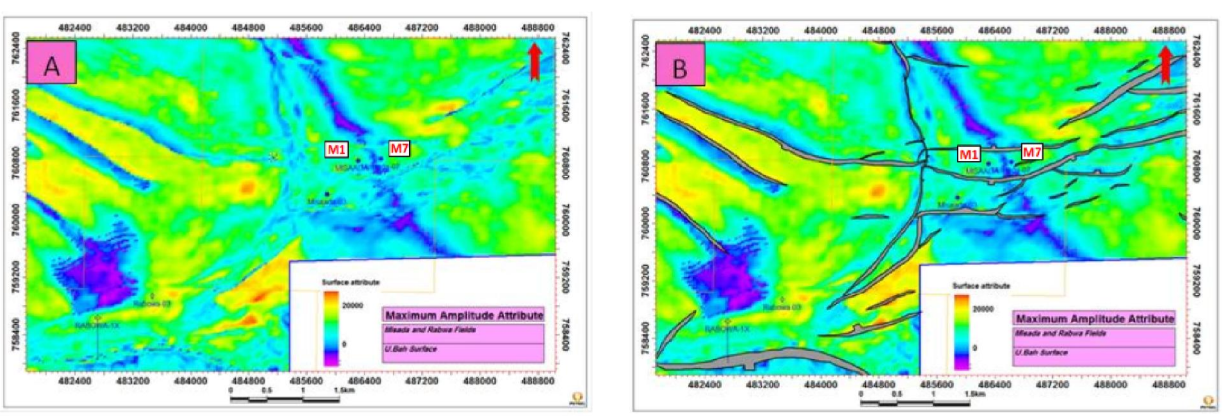


Figure 10 A) Maximum Amplitude Attribute Map On top U.BAH. **B)** Maximum Amplitude overlaid by interpreted Fault Polygons.

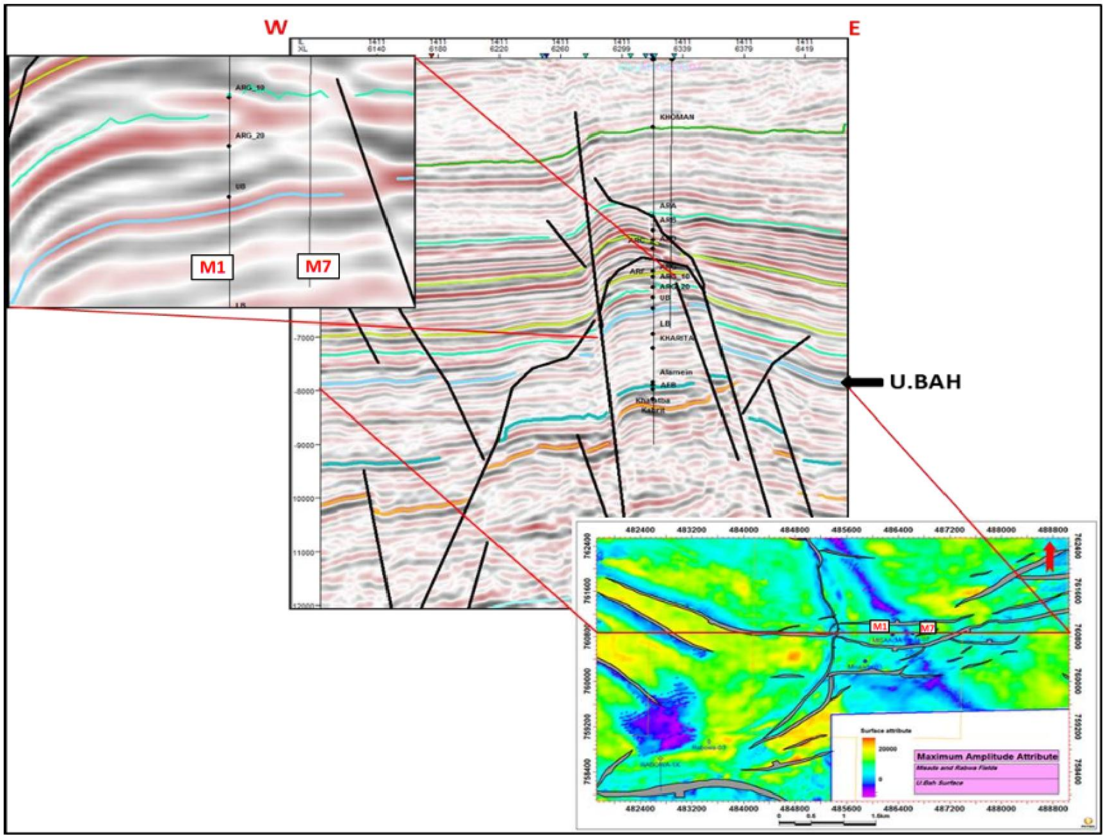


Figure 11 E-W seismic line shows that the barrier between the wells M1and M7 is not related to structure.

4. Conclusion:

From the previous work on Seismic Attributes some notes can be summarized as follows:

- Seismic attributes enable interpreters to extract more information from the seismic data such as facies change, reservoir thickness and Lithology.
- Seismic Attributes can be used in some applications include hydrocarbon play evaluation, prospect identification, risk reduction, reservoir characterization, well planning and field development.
- Integration between Structure and Stratigraphic interpretation is important in prospect identification, well planning and field development.
- Choosing the suitable attribute with both the available data and reservoir thickness is a very important matter to achieve good results.

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