

Offshore Exploration of the Levant basin

In the Eastern Mediterranean

particularly with a focus on Lebanon

Seismic Exploration & its Impact

on the surrounding areas

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December, 2019

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1- Introduction:

Levant basin extends across the most eastern section of the Mediterranean, (Fig. 1), with Egypt in the southern margin, Palestine, Israel, Lebanon and Syria in its eastern offshore margins.

The Levant basin is a deep marine basin (Fig. 1) on the right, outlined in dashed white, with water depths of 1,500-2,000m, and an area of 83,000km², The Levant basin is one of the world's significant underexplored regions, especially around Lebanon offshore.



Figure 1: Showing the eastern Mediterranean, far right the outline of Levant basin dashed white with hydrocarbon discoveries in the Eastern Mediterranean, Lebanon offshore blocks are on trend with the major discoveries. After GeoExPro. (modified)



<http://www.tespam.org>

<http://www.energypolicyturkey.com>

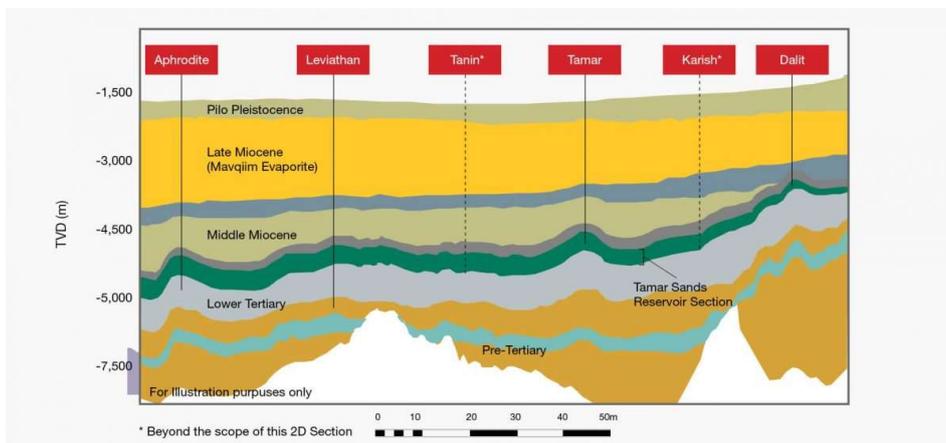
Lebanon (Fig1), middle in red color extends along the eastern coast of the Mediterranean Sea and lies within the same Mesozoic basin in which major oil and gas fields have been found in southern part of Levant Basin.

Lebanon offshore has not yet discovered recoverable gas reserves, but geologic data indicates that there is a potential for Lebanon to possess significant gas resources.

By drilling the first well in offshore Lebanon, the concept of petroleum system will be either proven northward as it has been in the southern part of Levant basin, or it will be limited to the southern part of the basin.

The Southern part of the Levant basin offshore, all the ingredients of petroleum system have been proven, and hydrocarbon has been found, but offshore Lebanon all what it needs is a one well discovery, and this discovery will open a new horizon reaching all the surrounding areas.

A number of significant hydrocarbon discoveries have recently taken place in the Eastern Mediterranean, when Israel made the first find, Tamar, in January 2009. This was followed by Leviathan, another discovery; and Aphrodite (Fig. 2) showing those discoveries just south of Lebanon offshore.



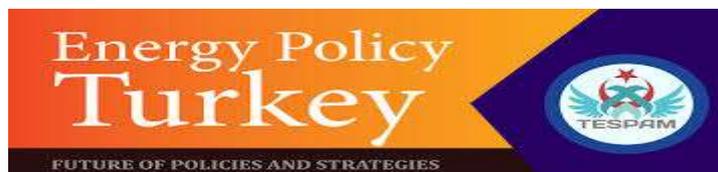


Figure 2; showing the existing discoveries south of Lebanon offshore. The Tamer sands reservoir exhibits high qualities gas recovery in a clean sand with up to 1d permeability and up to 25% porosity, its natural gas > 99% methane. By Delek Group E&P

The latest gas field find was the Zohr field, off Egyptian waters, discovered in 2014. Overall, the region is estimated to hold large amounts of recoverable gas, but the extent to the north of Levant will be proven by Lebanon first exploration well.

According to the United States Geological Survey (USGS), in 2010, the region could hold up to a total of 122 TCF natural gas, which underlays a large portion of the eastern Mediterranean Sea. The USGS report also indicated that there could be up to 1.7 billion barrels of recoverable oil in the Levant Basin, making future oil discovery possible.

2- Levant basin Petroleum System:

The seismic interpretation of available 2D & 3D data have provided good results of mapping the subsurface, a framework for the Levant Basin and margin based on the seismic data interpretation and analogue modelling, and a thorough geochemical assessment of source rock potential supported by extensive sampling onshore, and regional basin modelling, providing an updated evaluation of offshore Lebanon hydrocarbon potential.

These studies suggest different zones contain gas reservoirs at different depth: biogenic gas is formed at shallow depths and low temperatures by bacterial decomposition of organic matter, suggesting lower costs in drilling and extraction. Thermogenic gas, in contrast, is formed at greater depths through thermal cracking of decomposed organic matter or oil into gas where molecular bonds are broken due to high heat and temperature suggesting higher costs in drilling and extraction.

3- Seismic Surveys (database)

Data availabilities of high quality 2D & 3D seismic dataset that have been acquired in the last decade covering the entire Lebanese **exclusive economic zone (EEZ)**, (Fig. 3), showing 2D & 3D Seismic



Surveys offshore Lebanon. These seismic dataset made a major breakthrough in understanding the Lebanese petroleum potential.

All this available data provided by the **Lebanese Petroleum Administration (LPA)** got a significant information, and helped in the exploration of the northern Levant Basin, also attracted major international oil companies interest in exploration of Lebanon offshore.

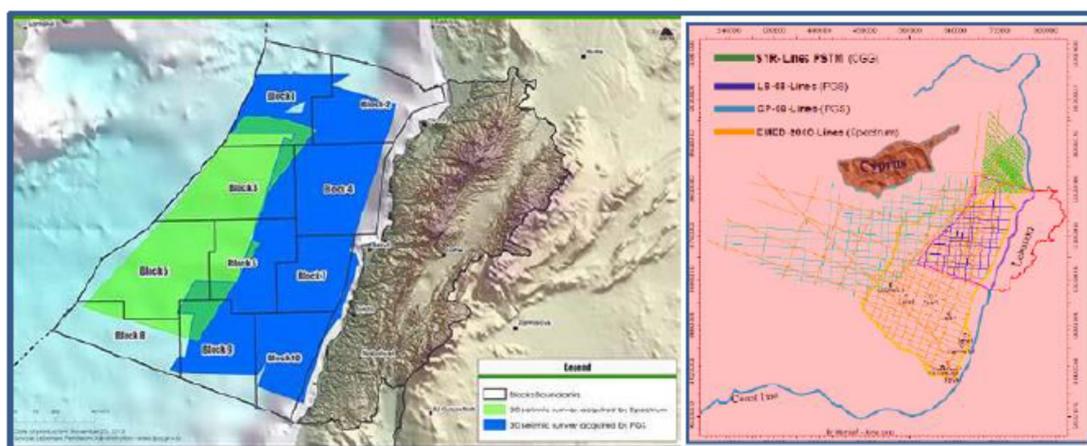


Figure 3: LPA's offshore showing 2D & 3D Seismic Surveys maps.

4- Offshore Lebanon Seismic interpretation

As a result of seismic interpretation offshore Lebanon, promising prospects and leads have been identified over the whole area, (Fig. 4A) showing several structures features, these traps are structural such as symmetrical anticlines, three way dip closures with fault control on the fourth direction, and stratigraphic traps such as pinch-outs. (Fig. 4B) is an overview of a regional seismic line running from the southern part of Levant basin toward the northern part of the basin, showing a clear structural difference from south to north by thickening of Cretaceous to Miocene units, also highly faulted interval Oligocene to Miocene levels, with obvious difference by thickening of the deeper formations to north. (Fig. 4C) a seismic section showing an anticline structure, with possible flattish contact indication below the structure.

(Fig. 4D) a structure depth map showing a closure oriented NNE- SSW at B.M. Miocene level, showing a four way dip closure with smaller culminations within the main closure, this is only one example of many other structures within the northern part of Lebanese part of Levant basin.

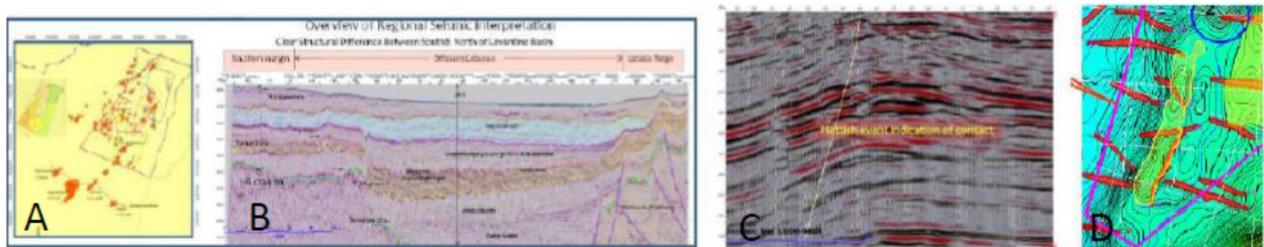


Figure 4: A structures features identified within offshore Lebanon, B regional seismic line from south to north in the Levant basin, C: seismic section showing an anticline feature, D: depth structure map showing an elongated closure.

Several potential play types have been defined in the area, including four ways dip closures, elongated three ways dip closures with fault control on the four direction within the Miocene sandstone level.

The seismic quality data provide a good clarity data in this frontier area of offshore Lebanon, but the lack of well data means a number of unknown remain uncertain, because up to-date not a single exploration well has been drilled within offshore Lebanon.

5- Lebanon & its first exploration well:

The first exploration well offshore Lebanon was planned to be drilled by the end of December 2019, but due to time constrain it might be drilled in early January 2020, with more wells to follow in year 2020. Total, as part of a consortium comprised of ENI and Novatek, is operating in Block 4 & block 9, offshore Lebanon, which were part of the petroleum licensees awarded during the 1st Lebanese offshore licensing round.

Total, ENI and NOVATEC consortium, presented the technical information related to the drilling of the first exploration well, in Block4 (Fig.3), in accordance with the approved exploration plan. According to Total, the exploration well location will be west of the area off Safra Kesrouaniya, north



of Beirut, 30 km from the beach, this the first step forward, the next step is to drill the second exploratory well in Block 9.

Conclusions

The eastern Mediterranean region in general has recently become known for its hydrocarbon discoveries success, in the Nile Delta and southern parts of Levant basin offshore Palestine, Israel and Cyprus, including fields like Tamer, Leviathan, Aphrodite (Fig. 2) , Zohr and others, but offshore Lebanon is considered to be the last undrilled acreage in the Levant basin, with the expected near future drilling the area will be integrated into the exploration cycle of the eastern Mediterranean, but the area is surrounded by many hydrocarbon discoveries and proven petroleum system. Large gas discoveries in clastic reservoirs in the southern part of Levant basin, these sediments is believed to be derived from the Nile Delta cone, extended and deposited into the northern part of Levant basin.

Biogenic gas is proven, many clastic and carbonate discoveries in the nearby region, and in addition to that, the deeper section of the basin is believed to have the potential of thermogenic oil prone source rocks charging the deeper clastic.

The first exploration well offshore Lebanon in the end of December or early January 2020 will answer all the remaining equations concerning the northern part of Levant basin.

Total mentioned that there is a 20% to 25% chance of hitting a commercially natural gas discovery in Block 4. The drilling results will make the difference, a positive result will bring more attention and focus to offshore Lebanon, and to the eastern Mediterranean province in general.

