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Lebanon – The Next Frontier in the Eastern Mediterranean

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Summary

Located in the easternmost part of the Mediterranean Sea, offshore Lebanon remains a frontier, untested basin surrounded by many discoveries and proven working petroleum systems. Large gas fields have been discovered in clastic reservoirs within the southern portion of the Levantine Basin, these sediments are derived from the Nile Delta cone to the south, proving the existence of good quality pre-salt clastic reservoirs. These Nile Delta derived sediments are predicted to extend into the northern sector of the Levantine Basin, thus depositing offshore Lebanon. The 10,000 sqkm 3D dataset helps to reduce the geological uncertainty and helps identify the presence of channels and fan systems across the Levantine Basin. Biogenic gas is now proven in many clastic and carbonate discoveries in close proximity to this region. In addition, the narrow margin and deeper sections of the basin are believed to have the potential for additional thermogenic oil prone source rocks charging both deeper basin clastics and rifted Mesozoic carbonates units along the Levant Margin. With the opening of the 2nd Licensing Round imminent and the first wells offshore Lebanon scheduled for 2019 the industries attention remains focused offshore Lebanon and the general Eastern Mediterranean province.

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Lebanon – The next frontier in the Eastern Mediterranean.

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The Eastern Mediterranean has attracted much industry attention in recent years, mainly due to a number of large gas discoveries. The largest ever gas discovery in the Eastern Mediterranean, offshore Egypt was drilled in 2015, targeting a new carbonates play type rather than the already established clastic system. The discovery known as Zohr, has over 30 tcf of gas in place within a carbonate reservoir (Miocene to Cretaceous in age), sealed by the Messinian evaporites and biogenically charged. A second discovery in a carbonate build up, known as Calypso, has subsequently been drilled offshore Cyprus. Additional carbonate structures in the region have also been identified. Additional carbonates are now targets for future exploration drilling campaigns.

This is a welcomed addition to the known clastic petroleum system in the region which is in predominantly Cenozoic aged strata (Pliocene, Miocene & Oligocene) across the prolific Nile Delta; a well-documented petroleum system that has been producing for many years.

Additional large gas fields have been discovered in clastic reservoirs in both Israel (Tamar and Leviathan) and Cyprus (Aphrodite) within the southern portion of the Levantine Basin, these sediments are also derived from the Nile Delta area to the south, proving the existence of good quality pre-salt clastic reservoirs within Miocene strata. These Nile Delta derived sediments are predicted to also extend beyond Israel towards the northern sector of the Levantine Basin, offshore Lebanon (Figure 1).

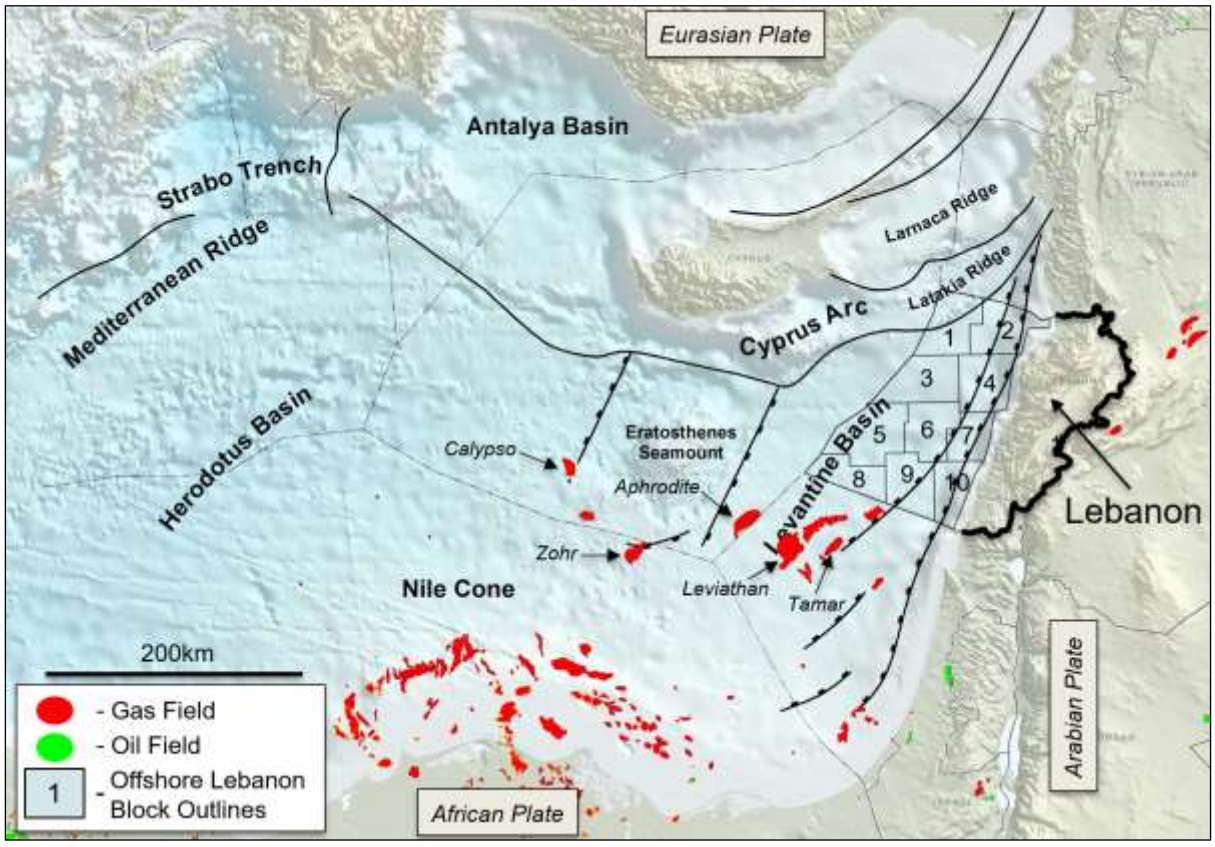

Figure 1. Location map of the Eastern Mediterranean highlighting the main structural elements, offshore basins, key discoveries and the offshore Lebanon block outlines.

The Levantine Basin is located in the easternmost part of the Mediterranean Sea, bounded by the Cyprus Arc/Latakia Ridge to the north, the Eratosthenes Continental Block (ECB) to the west, the Levant Margin and the Dead Sea Transform Fault system to the east and the Nile Delta Cone to the south. The tectonic evolution of the basin is complex undergoing repeated periods of extension, inversion and transpression. This has occurred due to the interaction of several continental plates boundaries which include the Eurasian, Arabian and African plates (Figure 1).

The Levantine Basin can be subdivided into two main geological settings (Levantine/Levant Basin and the Levant Margin). The main basin fill is likely to consist of shallow marine deposits (Gardosh et al, 2008) charged by the same biogenic gas system that has charged a large proportion of the Eastern Mediterranean discoveries. Biogenic gas is now proven to have charged both clastic and carbonate reservoirs to the south and west, as confirmed by the most recent discoveries. In addition, the narrow margin and deeper sections of the basin are believed to have the potential for thermogenic source rocks (Nader, 2011).

Carbonates exist along this shelf edge margin and may have developed as local build ups, these may provide attractive targets if capped by the evaporites (Nader, 2011). The basin is overlain by a very clear package of Messinian evaporites and this is likely to be the main regional seal across the basin where thicknesses reach up to 1900m in the basin and subsequently pinch out towards the Levant Margin to the east. Additional minor seals consisting of hemipelagic to pelagic shales are anticipated throughout the basin (Hawie et al, 2013), these are proven in the western Levant Basin.

The overall thickness of post salt deposition is significantly thinner offshore Lebanon based on seismic interpretation, thus the Pliocene in the northern part of the Levant Basin is not considered a prospective zone compared to the Nile which has significantly thicker sedimentary sequence within the Pliocene,

Even though offshore Lebanon potentially has all the elements in place for a working petroleum system it is still classified as frontier, this is due to lack of exploration drilling. This is hopefully due to change towards the latter half of 2019, planned exploration drilling is anticipated for a single well in block 4 and block 9 (awarded blocks in Q1 2018 as part of the 1st License Round Offshore Lebanon). Fortunately there is significant seismic data coverage offshore Lebanon to help de-risk future exploration.

PGS currently has ~10,000 sqkm of modern 3D data, acquired between 2006-2013 (Figure 2) that has been pre stacked merged creating a contiguous dataset (MegaSurveyPlus) which aids the regional understanding and mapping of multiple leads. In addition to this, there is also ~4900 line km of broadband GeoStreamer 2D data that was acquired in two phases during 2008 and 2011, this was subsequently reprocessed during 2017. Water depths range from ~50-2000m across the seismic database.

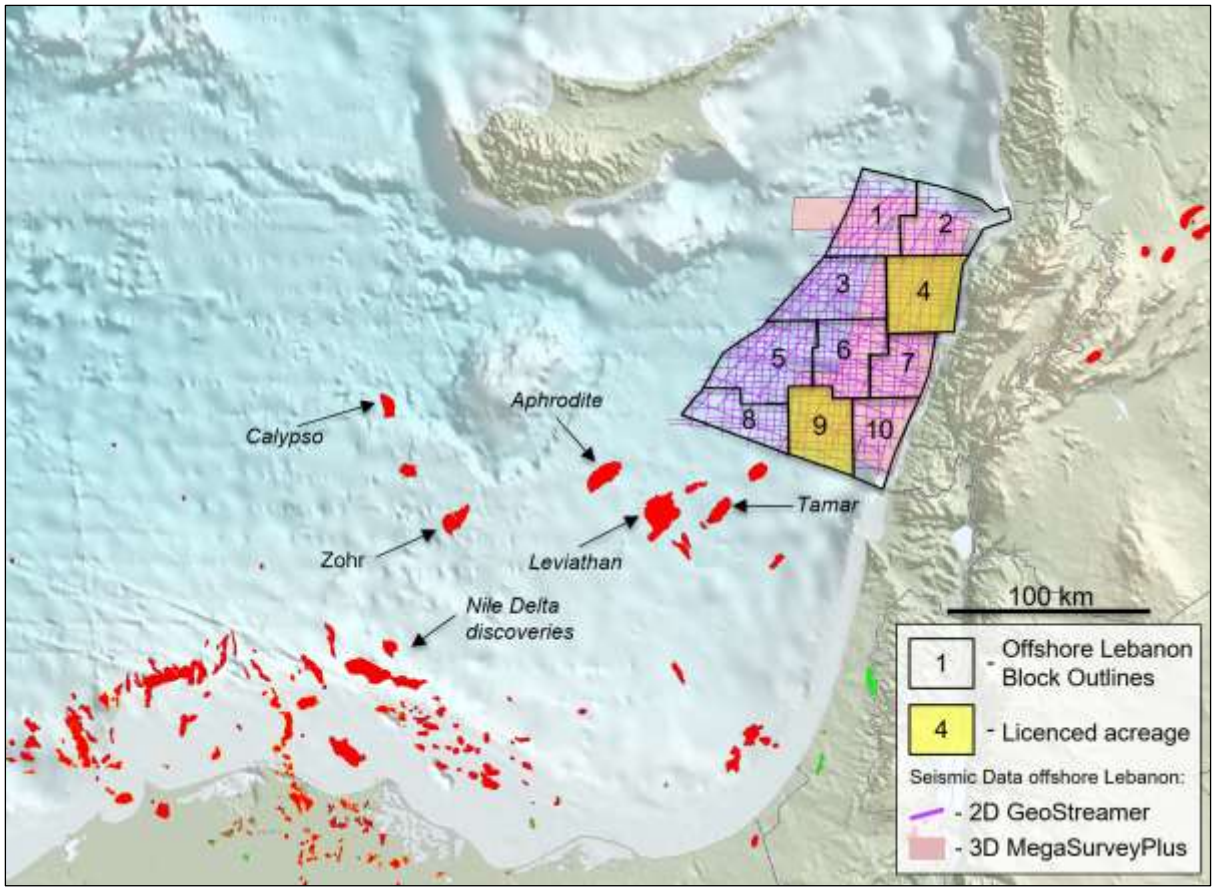

Figure 2. Seismic Database (2D & 3D) Offshore Lebanon with a selection of key gas discoveries highlighted, both within clastic and carbonate reservoirs.

The seismic database indicates the presence of turbidites and fan systems across the Levantine Basin (clearly identifiable on amplitude extractions from the 3D dataset) and also highlights the additional opportunity of carbonate packages along the narrow Levant margin potentially Jurassic – Late Cretaceous rifted Mesozoic platforms (Nader, 2011).

The data helps with the identification of multiple leads at various intervals across the basin and highlights additional potential elements required for a working petroleum system such as potential source rock intervals, migration pathways and sealing units based on seismic interpretation. However, the maturation of any potentially deeper thermogenic source rock will only be de-risked once drilled.

With a 2nd Licence Round announcement imminent and the first wells offshore Lebanon scheduled for 2019 the industry attention remains focused offshore Lebanon and the whole general Eastern Mediterranean province. The opportunity to discover additional reserves in a frontier basin in close proximity to proven and producing assets, together with a significant export market creates a very attractive opportunity.