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HYDROCARBONS POTINTIALS IN THE EASTERN-MEDITERRANEAN BASIN, AN OVERVEIW

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Abstract: The Levantine Basin has yielded numerous major finds of natural gas since 2009, which have altered the dynamics of the Eastern Mediterranean area. Due to the discovery of the Tamar Field and later the larger Leviathan Field, Israel has the potential to enter the regional natural gas market. Following the first Israeli discoveries, Cyprus and Egypt have also found new gas deposits in the Mediterranean. The massive Zohr Field in Egyptian waters was discovered in 2015 by the Italian firm Eni, while the Aphrodite Field in Cypriot seas was discovered in late 2011 by the American company Noble Energy. Geological data indicates that Syria and Lebanon may contain significant gas resources, even though viable gas reserves have not yet been discovered in these nations. Israel's gas discoveries have been met with opposition by Lebanon, which claims a territory spanning over 300 square miles along the countries' unsettled maritime boundary. This is likewise the case with Greece, Cyprus, and Turkey. The Levantine basin which encompasses Cyprus, Israel, Lebanon, the Palestinian Territories, Syria, and Egypt has the potential to be revolutionary for the Eastern Mediterranean region. The 35 tcf of gas discovered recently may not be the whole supply of hydrocarbons from the Levantine basin. Short- to medium-term obstacles to resource development and monetization arise from the complex political landscape in the region, in addition to technical issues linked to resource development. The hydrocarbon reserves in the Eastern Mediterranean Sea are reviewed and highlighted in this study, along with the possibility of future resource development in light of the region's problems.

Keywords: Eastern-Mediterranean, countries, Levantine basin, hydrocarbon, natural gas, resources.

Introduction

Interest in the Eastern Mediterranean as a possible source of natural gas resources has increased after Israel discovered its first large natural gas reserve in 2009. (Figure 1). Off the coast of Israel, Tamar Field was the first of numerous major discoveries of natural gas in the region. Major discoveries have since been made in Israel (Leviathan), Egypt (Zohr), and Cyprus (Aphrodite), and Lebanon has been making concerted efforts to assess its resources. According to a 2010 United States Geological Survey (USGS) study [1], the Levant Basin, which underlies a significant portion of the Eastern Mediterranean Sea, may hold up to an additional 122 trillion cubic feet of undeveloped natural gas resources. It may be possible to find oil in the Levant Basin in the future; up to 1.7 billion According to the USGS assessment, there might be up to 1.7 billion barrels of recoverable oil in the Levant Basin, making future oil discoveries possible.

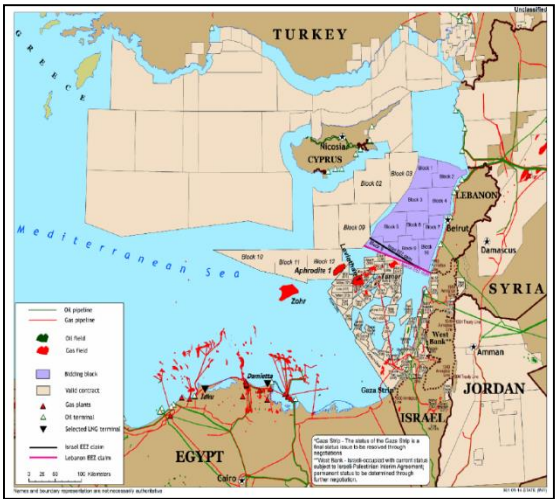

Fig. 1: Eastern Mediterranean Oil and Gas Geography (Source: U.S. Department of State)

Geographically speaking, the Eastern Mediterranean has existed for millennia. But 21st-century changes have made it necessary to conceptualize it as a unique "new" territory with particular traits. The area, which is made up of Cyprus, Egypt, Greece, Israel, Lebanon, Libya, Syria, Turkey, and Italy, is becoming more and more important in international politics. More precisely, because of a multitude of opportunities and difficulties, including migrant flows, energy, security, and sustainability of the region, the Eastern Mediterranean region is today of utmost significance to the European Union. Within Cyprus' exclusive economic zone (EEZ), in the region known as Aphrodite, significant amounts of offshore natural gas have been found. Cyprus drew maritime borders with Israel in 2010, Egypt in 2003, and Lebanon in 2007 [2]. The prospects and difficulties that east Mediterranean gas presents to the nations and investors in the area are discussed in this article.

2. Natural Gas Situation in the East-Mediterranean Basin

Eight major basins are found in the Eastern Mediterranean region: The basins of the Nile Delta, the Judea Basin, and the Levant basin (Figure 2), the Eratosthenes High, the Western Arabian Province, the Zagros Province, the Cyprus Basin, and the Latakia Basin. The Nile Delta Basin has produced the majority of the hydrocarbons produced historically. The majority of the Nile Delta Basin is located under Egyptian territorial waters, with the exception of a little portion that is governed by Cyprus. Despite the fact that Cyprus accounts for a large portion of Egypt's offshore oil and gas output, no noteworthy discoveries have been made there as of yet. Large portions of Jordan, Syria, Iraq, Saudi Arabia, and Turkey are included in the Western Arabian province basin. The Western Arabian Province has the majority of Syria's and Jordan's agricultural land. The Zagros Province begins in Turkey and finishes at the Gulf of Oman in the south, after passing through Iraq and Iran. The Zagros Province has some of Syria's greatest oilfield; however the great bulk of these fields are located in neighbouring nations, such as Saudi Arabia, Iraq, and Iran. Although the majority of the region's historical hydrocarbon production has come from the Western Arabian and Zagros Provinces, the Levant Basin is currently receiving much of the attention. The nations of Cyprus, Egypt, Greece, Israel, Lebanon, Libya, Syria, and Turkey make up the Eastern Mediterranean region. To overcome a variety of obstacles, the current political climate in these nations calls for a great deal of work and goodwill. Mostly political difficulties extending the Eastern Mediterranean has the potential to foster more regional collaboration, but it also carries the risk of escalating violence. The East-Mediterranean Basin has seen significant petroleum reserves identified, mostly in the previous 10 years, which would make the area a major player in the natural gas export market. Because of their advantageous position, these finds are substantial enough to meet the

region's increasing need for gas while also exporting excess gas to the European and Asian markets, although with a shift in the energy landscape. By 2030, the nations in the East Mediterranean might serve as a "fourth energy route to Europe," as noted by Natali [3].

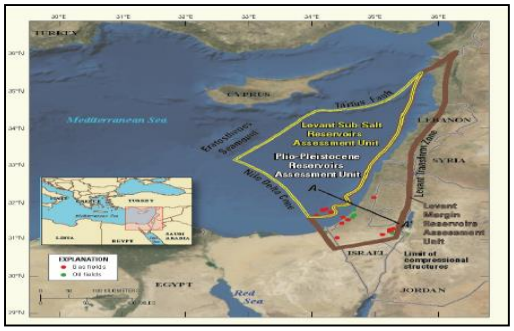

Fig. 2: The Levant Basin [6]

The subject of whether or not the Eastern Mediterranean's hydrocarbon resource finds will shift the game in the area has been raised. The United States Geological Survey (USGS) estimates that the area may contain up to 122 tcf of natural gas in total [4]. Global proven gas reserves are estimated by BP to be at 186.9 Tcm [5]. On the one hand, it is evident from global comparisons that the area has little influence worldwide. The proven natural gas reserves in the East Mediterranean basin could eventually reach 8 Tcm due to increased exploration efforts; this would put it on par with the proven reserves in Saudi Arabia, the United States, Algeria, Nigeria, and Iraq, and roughly one-third of Qatar's 24 Tcm, the third-largest natural gas reserve in the world after the Russian Federation and Iran. In all the eastern Mediterranean countries, particularly Lebanon and Cyprus, where the Italian company ENI announced the discovery of a major gas formation, "Calypso," in Block 6 (Figure 3), in February 2018, those figures are indicative, as there are numerous exploration campaigns with significant potential for new discoveries 200 BCM or more, as reported by the Nicosia-based Middle East Economic Survey [7].

3. Turkey's position

Turkey has its own problems in addition to endorsing the stance of Turkish Cypriots. It is essentially fallout from the Kastelorizo/Meis dispute with Greece. Turkey's objection to the RoC's 2003 EEZ delimitation agreement with Egypt included the following points: the area in question also concerned Turkey's sovereign rights; all affected states should have been consulted under international laws and norms; and Turkey was not consulted. As a result, Turkey rejects the RoC-Egypt EEZ delimitation deal. Naturally, the RoC rejects this Turkish reasoning [9].

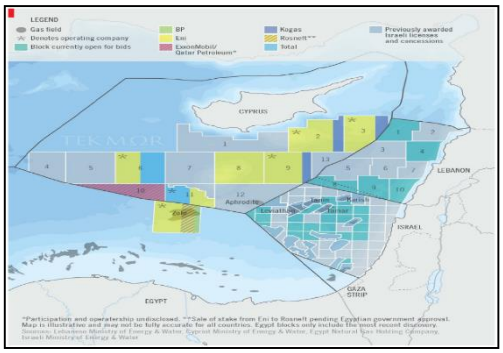

Fig. 3: Energy blocks in the East-Mediterranean [8]

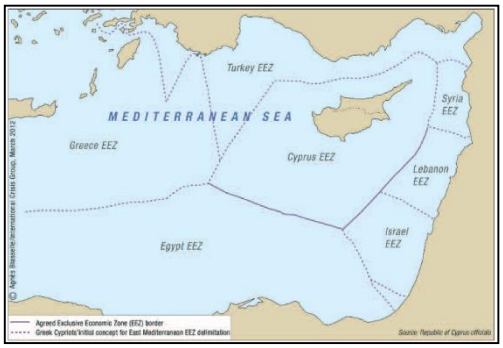

Fig. 4: "Turkish continental shelf and EEZ [source and copyright: international Crisis Group]."

As previously said, this is a by-product of the Greece problem, which is better illustrated by a map (Figure 4). Turkey claims that it would only have very limited access to the sea if Greece wins its case for maritime demarcation. Both Greece and Cyprus would have substantial access. Turkey claims it should have a higher

claim to a larger share of the marine regions as it is the state with a longer coastline. Its borders should thus be lowered to the median line with Egypt (Figure 5).

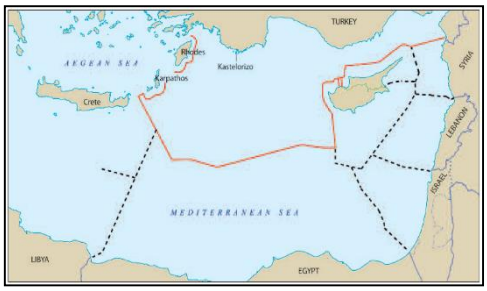

Fig. 5: "potential Turkish continental shelf/ EEZ in the Eastern Mediterranean sea [Source: Turkish marine research Foundation at ttp://www.tudav.org/]."

The median line (Figure 6) is crucial since it passes across Blocks 1, 4, 5, 6, and 7 of the RoC EEZ. Furthermore, Turkey speaks strongly on these western blocks. When discussing the interests of the Turkish Cypriots, it adopts terminology that is very different.

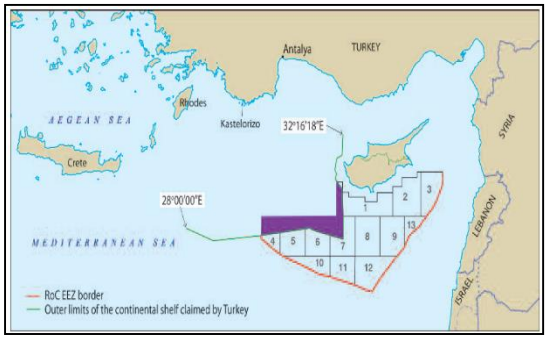

Fig. 6: "The overlap between the continental shelf claimed by Turkey and the RoC concession blocks in the south-west of the island. [Source: erciyes (2012)]."

However, Figure 7 depicts the positions of Libya's Sirte and Pelagian Basin Provinces, which are regarded as a contentious zone for hydrocarbons despite efforts to coordinate with Turkey about boundary delimitations by formal agreement.

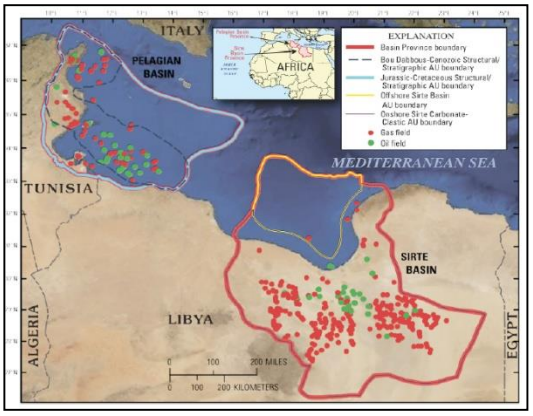

Fig. 7: Locations of the Sirte and Pelagian Basin Provinces [10]

4. Levantine Basin

Currently, a significant geological revaluation of the eastern Mediterranean region's oil and gas potential is under place. The region has the potential to develop into a premier hydrocarbon province if the predictions come true. Recent exploration efforts in the offshore region bounded by Israel and Cyprus, for example, have identified significant natural gas resources that have the potential to significantly alter the region's energy future. According to Israel's Natural Gas Authority, these offshore gas reserves may eventually exceed 1.3 trillion standard cubic meters [11] (Figure 8).

5. Gas discoveries

Since 2009, when Israel produced the first of many significant offshore natural gas discoveries, the outlook for gas production in the East Mediterranean area has undergone significant change. While Lebanon and Syria started focusing on the investigation of their own possible resources in 2011, Cyrus did the same (Figure 9).

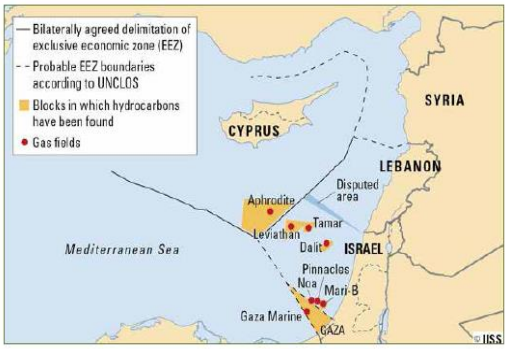

Fig. 8: Gas discoveries in the Levant Basin [Source: IISS]

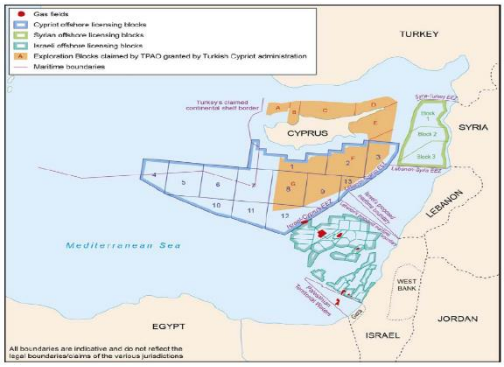

Fig. 9: Indicative map of maritime boundaries and exploration blocks in the East Mediterranean [Source: Oxford Institute for Energy Studies]

Turkey may see the East Mediterranean gas finds as a chance to both cement its position as a transit nation for Europe and meet its expanding domestic gas needs. However, Turkey's poor relations with Israel have so far tainted any possible advantages it may have reaped from these new findings as a transit nation; the only outcome has been heightened tensions over the outstanding Northern Cyprus is a problem. Turkey's dispute of Cyprus offshore blocks is shown in Figure 10.

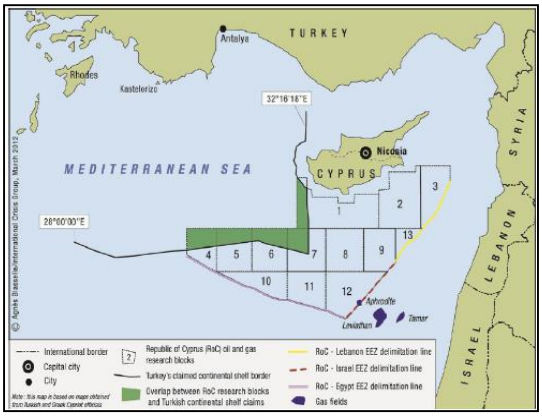

Fig. 10: Turkey contest of Cyprus offshore blocks [Source: International Crisis Group, March 2012]

6. Geology of the Eastern Mediterranean

Since the Permo-Triassic, the African, Arabian, and Eurasian plates have interacted to form the Eastern Mediterranean region. Numerous processes, including rifting, seafloor spreading, subduction, strike-slip fault subduction, and continental collision, have an impact on it. Its research has established itself as a true geological laboratory and continues to spark a great deal of controversy. In response to the Late Triassic opening of the central Atlantic, Neotethys evolved near the northern end of Gondwanaland, is linked to the genesis of the Eastern Mediterranean Basin. Though several theories have been put up concerning Neotethys' creation, only three will be covered in this article [12-13].

A thorough understanding of geology, particularly the geological history and evolution of the Eastern Mediterranean, as well as the significance of the Eratosthenes Sea Mount, are prerequisites for comprehending the presence of the Zohr gas field. Figure 11 illustrates the seismic characterizations of Zohr gas field which formed of reef rocks of Oligo-Miocene.

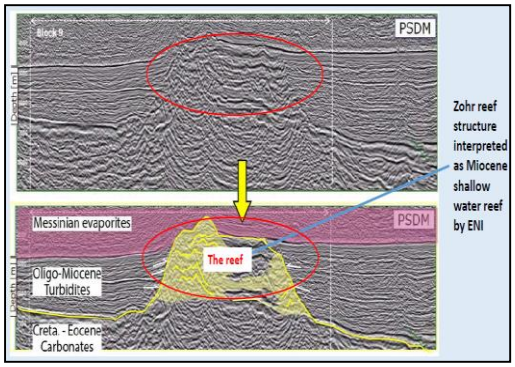

Fig. 11: Seismic characterizations of Zohr gas field [14]

7. Mediterranean Region Hydrocarbon Reserves

Saturating much of the eastern Mediterranean's offshore areas, the Levant Basin is the focal point of contemporary energy exploration operations in the area. According to an assessment conducted in 2010 by the U.S. Geological Survey (USGS), the Levant Basin is estimated to have mean likely undiscovered natural gas resources of 122 trillion cubic feet (Tcf) and mean probably undiscovered oil resources of 1.7 billion barrels. To put things into perspective, the countries that were part of this research had proven natural gas reserves of 18.2 trillion standard cubic feet as of January 2013, and total proven oil reserves of little over 2.5 billion barrels, of which 99.5 percent came from Syria.

The USGS evaluated the average likely undiscovered resources of natural gas liquids (NGL). The USGS estimated that there were 3.1 billion barrels of natural gas liquids (NGL) in the mean likely undiscovered reserve. The Levant Basin's resources undoubtedly comprise a substantial amount of the entire resource base; however the USGS estimates do not accurately reflect the potential energy resources in the eastern Mediterranean region.

8.1. Israel's Offshore Natural Gas Deposits

Following a 3D seismic investigation offshore their coast, the Lebanese government has questioned the belief that Israel holds a bigger part of the Levantine deposits (Figure 12), estimated to be over 40%. Tamar and Leviathan, two gas fields, were reported to possess 246 bcm and 509.4 bcm (18Tcf), respectively [11]. Although Leviathan seems to have been underestimated, the magnitude of the Tamar gas field was first overestimated. As of April 2013, Noble Energy's led consortium had already completed four appraisal wells in Leviathan, increasing its estimate to 520 bcm. It had also completed six appraisal wells and a 3D seismic analysis in 2011 in Tamar [15].

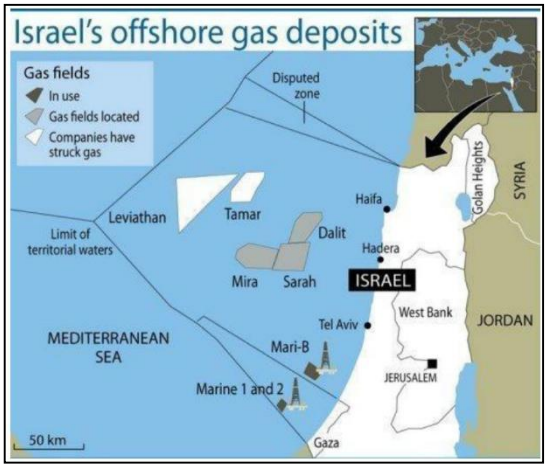

Fig. 12: Israel offshore gas fields [Source: Delek Energy quoted in AFP]

Table 1: Israel's natural gas reserves [16]

Reserve	Size of resources*
Leviathan	480-509.4 bcm 425-594 bcm
Tama	246 bcm
Mari B	31 bcm
Shimshon	30 bcm
Dalit	15.6 bcm
Dolphin	14 bcm
Noa	2.3 bcm
Pinnacles	1.3 bcm
Prospective resources known today	Approx. 680 bcm
Reserves and contingent resources	Approx. 800 bcm
Total natural gas supply (reserves, contingent resources and prospective resources	Approx. 1,480 bcm

*There are three types of resources: prospective, likely, and confirmed. Not all fields have a known recovery factor as of yet.

8.2. Cyprus Offshore Natural Gas Deposits

The USGS reports that Cyprus has less reserve than Israel (Figure 13). Since the discovery of Aphrodite, the government has estimated reserves up to 1.132Tcm; once further appraisal wells are sunk, estimates are expected to rise to 1.7Tcm (i.e. roughly 40-60Tcf). There is more work to be done to determine the reserves' commercial feasibility. The government anticipates producing gas for the Cyprus market starting in 2017 and for export in 2019. The Aphrodite Field was found offshore of Cyprus in 2011 by Noble Energy. The natural gas reserves in the field were estimated to be between 5 and 8 trillion cubic feet (tcf) [14]. By 2019, Cyprus intends to start developing the field and exporting gas. There isn't any natural gas infrastructure in Cyprus right now. The Gas from the Aphrodite Field can be difficult and expensive for Cyprus to use domestically due to a lack of natural gas infrastructure on the island. To do this, it would be necessary to build both the industrial facilities and power plants that could consume the gas, as well as the overland pipelines in Cyprus. Cyprus has two options for exporting gas to Europe: it either construct an LNG export terminal or use LNG terminals in nearby nations. It would be significantly less expensive to build a pipeline from Aphrodite to the LNG export terminals in Egypt than it would be to build an LNG facility in Cyprus.

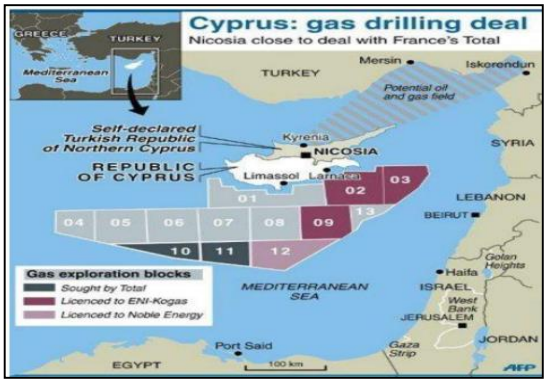

Fig. 13: Cyprus Gas Drilling Deals

The conflict over the Exclusive Economic Zones that exists between Turkey and the Turkish Republic of Northern Cyprus (TRNC) is the primary obstacle to the development of offshore gas in Cyprus. Turkey fully supports the TRNC's stance that any development must take Turkey's regional interests into account as well as the welfare of the TRNC's people.

ENI wants to repeat its accomplishments in block 3. Nonetheless, Ankara argues that Block 3, located southeast of the island, ought to be governed by Turkish Cyprus instead of the Republic of Cyprus, which granted Turkey's national oil company, Turkish Petroleum (TPAO), the rights to a block that overlaps Block 3 in 2011 (Figure 14). Additionally, Ankara restated its opposition to all maritime accords pertaining to Cyprus, including those with Egypt and Israel.

8.3. Lebanon's Offshore Natural Gas Deposits

Lebanon may contain up to 15 tcf of exploitable offshore gas resources, according to one industry assessment [17]. Lebanon has not yet proven potential gas reserves or allowed any businesses to start exploratory work to find potential resources. Lebanon started pre-qualifying businesses to submit bids for Mediterranean exploration licenses in 2013. Although 46 businesses met the qualifying requirements, Lebanon was unable to grant exploration licenses due to political impasse. Deeds specifying which blocks are to be allowed

for exploration as well as a taxation policy are still required of Lebanon.

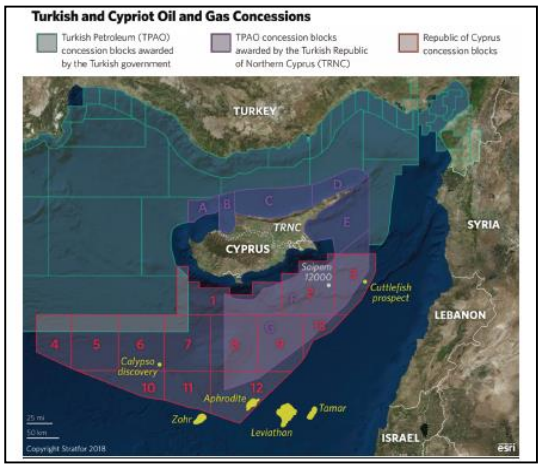

Fig. 14: Turkish and Cypriot Oil and Gas Concession [16]

As to the August 2012 3D seismic survey research, Lebanon's oil and gas reserves offshore are projected to be 25.4 Tcf or 720 Bcm. According to Fattouh [18], Lebanon's seafloor may have a large hydrocarbon potential an early estimate of 660 million barrels of oil and up to 30 trillion cubic feet (Tcf) of natural gas (around 850 billion cubic meters) (Figure 15). Lebanon intends to carry out more exploration. The Lebanese Petroleum Administration's (LPA) suggestion to be ready for Lebanon's Second Offshore Licensing Round, which is set to begin in earnest by the end of 2018 [19], was accepted by the Council of Ministers in May 2018 (Figure 16).

8.4. Syria's Offshore Natural Gas Deposits

The Energy Information Agency estimates that proven natural gas reserves in Syria's eastern and central regions are around 28 billion cubic meters (1 trillion cubic feet). Although Syria's natural gas production decreased to 8 billion cubic meters in 2011 from 9.5 billion in 2010 (Figure 17). Due to the present political and military strife, as well as international sanctions imposed on the regime, exploration efforts in Syria have been suspended, making the country's energy potential even less clear. The proved reserves (on-shore) produced around 400,000 barrels of oil and gas per day (bpd), of which 260,000 bpd were for export in 2011. The estimated reserves in 2011 were 241 Bcm of natural gas and 2.5 billion barrels of oil [3]. CCG Veritas did a 2D seismic survey in 2005 in sea depths ranging from 500 to 1,700 meters (Figure 17). Three offshore blocks were the subject of an announced bidding round in March 2011, but the conflict has entirely stopped it [20]. As a result, the potential of the Syrian underground is not well known to the general population.

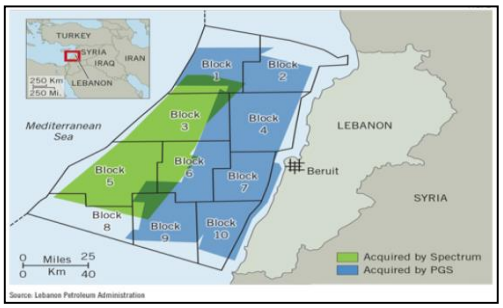

Fig. 15: Offshore Seismic 3D Surveys in Lebanon [21]

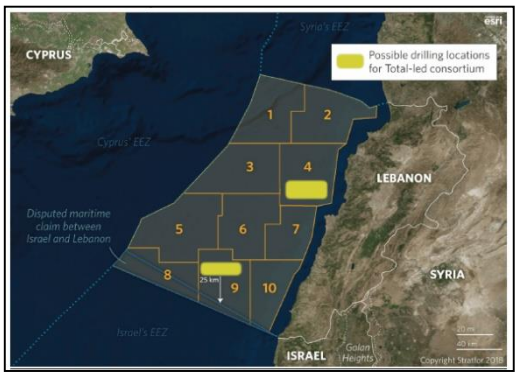

Fig. 16: Lebanese Offshore Exploration Blocks [22]

Fig. 17: Syria Off-Shore Blocks – CCG Veritas [23]

8.5. Palestinian Territories' Offshore Natural Gas Deposits

Offshore the Gaza Strip, there is gas as well. British Gas, the business that was first granted the Tamar license in 1999, made investments in Gaza as well [14].

8.6. Egypt Offshore Natural Gas Deposits

The Italian corporation Eni SPA made the discovery of the supergiant Zohr Field in August 2015. The greatest find in the Eastern Mediterranean to date is the Zohr Field, valued at over 100$ billion and holding up to 30 tcf [25]. It is also among the biggest finds of natural gas made in the globe in recent times. Egypt has started working to bring the Zohr Field online as soon as possible due to the increasing domestic demand for natural gas. The country hopes that by developing the field, it will be able to import less gas. Top Features of Zohr are displayed in Table 2.

Table 2: Zohr main Characteristics

Parameters	Characteristics
Country	Egypt, Area: east Mediterranean, Company: ENI
Block	Shorouk , 3765 τ.χλμ
Sea depths	1400-1800 m. Total Depth of the first well 4131 m.
Distance from Egypt	180-190 km
Structure	100 sq km
Gas Column	630 m, Net pay: 410 m.
Reservoir	Miocene carbonates (reef- built up)
Gas in place	30 tcf or 840 BCM (or 5,5 bil. boe). (biggest in the Mediterranean Sea).
Distance from block 11 of Cyprus	4-6 km.
Distance from Aphrodite gas field	40 km

9. Eastern Mediterranean Hydrocarbon Potential

As of April 2017, Israel and Syria possessed the only known reserves in the Eastern Mediterranean. Syria possesses confirmed onshore natural gas reserves of 8.5 Tcf and 2.5 billion barrels of oil [26]. Conversely, Israel has achieved notable breakthroughs in its offshore space since 2009. It has 10.1 trillion cubic feet of proven natural gas reserves and 11.5 million barrels of proved oil reserves.

According to Table 3, the projected total recoverable reserves for the nine offshore fields found by Israel are around 30 trillion standard cubic feet.

Table 3: Offshore Natural Gas Discoveries in the Eastern Mediterranean [27]

Country	Discovery date	Field name	Estimated reserves (tcf)	First volumes
Cyprus	2011	Aphrodite	4.5	2017
Israel	1999	Noa	0.04	2012
	2000	Mari-B	1.5	2004
	2009	Dalit	0.5	2013
	2009	Tamar	10.0	2013
	2010	Leviathan	18.0	2016
	2011	Dolphin	0.08	Unknown
	2012	Shimshon	0.3	Unknown
	2012	Tanin	1.2	Unknown
	2013	Karish	1.8	Unknown
Palestinian Territories	2000	Gaza Marine	1.0	Unknown

On the other hand, Table 4 gives the Major gas discoveries in the Eastern Mediterranean.

Table 4: Major gas discoveries in the Eastern Mediterranean [28]

Gas field	Probable reserve (bcm)	Discovery date	Status
Tamar-Israel	280	2009	Producing
Leviathan-Israel	620	2010	Pursuing gas sales
Aphrodite-Cyprus	128	2011	Pursuing gas sales
Zohr-Egypt	845	2015	Being developed

10. Conclusion

This article provides an overview of the hydrocarbon resources that are now in the Eastern Mediterranean and the Levantine basin exploration efforts. Opportunities for additional exploration and production may arise in the offshore regions that connect Cyprus to Israel, Lebanon, Syria, Egypt, Libya, and Crete. Considered an appealing region for exploring is the Eastern Mediterranean. For the hydrocarbon potential to be adequately assessed, at least 10 more years of vigorous exploration are required. It is regarded as an intriguing exploration location with untapped potential based on geological evidence. Amid recent massive discoveries of around 3 trillion standard cubic meters of natural gas, the Eastern Mediterranean is drawing attention from throughout the world for hydrocarbon production and exploration initiatives.

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