[PS]Hydrocarbon Potential in Herodotus Basin, Eastern Mediterranean?*

Xiaobing Liu[1], Zhixin Wen[1], Guangya Zhang[1], Zhaoming Wang[1], and Chengpeng Song[1]

Search and Discovery Article #10617 (2014)**
Posted July 24, 2014

*Adapted from poster presentation given at 2014 AAPG Annual Convention and Exhibition, Houston, Texas, April 6-9, 2014
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[1]Research Institute of Petroleum Exploration & Development, Beijing, China (xiaobing.liu@petrochina.com.cn)

Abstract

Herodotus Basin (HB) is mainly located under the ultra deep-water part of the east Mediterranean, bounded by the leading edge of East Mediterranean Ridge to the north, Nile Data Basin (NDB) to the southeast, Matruh Basin (MB) and Western Desert Basin (WDB) to the southwest. The onshore WDB and the NDB are mature basins, considered as classical petroleum provinces. Numerous deep-water play types, mostly within the NDB, have been identified along the transform margin (separating the MB and HB) of NW Egypt. The offshore MB and HB, extending from the coastline across a relatively narrow shelf into deep water, has a water depth ranging from zero to 3,200 m. Tectonically, HB is the northernmost of the Africa north-facing passive margin, which is the result of the opening of the Neo-Tethys during mid-Jurassic to early Cretaceous times. Structurally, SSW-NNE rifting (mainly along the Matruh trough) evolves from Jurassic to Neocomian / Barremian, covering the MB and southern HB. The offshore MB has prominent thin skin and shale detachment related play types within the Matruh Canyon. Messinian salt plays a significant regional seal in the HB from the seismic illustration. Stratigraphically, in the MSB, late Mesozoic to Cenozoic mudstone and shale, Oligocene to Miocene sandstone and late Miocene salt play as hydrocarbon source, reservoir and seal, respectively, which can be extrapolated to the HB based on the similar geological evolution. From the interpreted play types offshore NW Egypt, three proven plays can be found in the MB, while one potential play can be recognized as Jurassic to Cretaceous sandstone and carbonate sequence-structural-unconformity during the rifting stage in the HB. Mud volcanoes (mainly methane) in the east Mediterranean also play a key role to know the hydrocarbon source potentials. The similar regional geology including tectonics, structure and stratigraphy, together with plays similarity, makes the HB a hydrocarbon potential region, although the ultra-deep water will give rise to more risks.

HYDROCARBON POTENTIAL IN HERODOTUS BASIN, EASTERN MEDITERRANEAN?

Liu Xiaobing, Wen Zhixin, Zhang Guangya, Wang Zhaoming, Song Chengpeng
Research Institute of Petroleum Exploration and Development, CNPC

ABSTRACT

Herodotus Basin (HB) is mainly located under ultradeep-water part of the east Mediterranean, bounded by the leading edge of East Mediterranean Ridge to the north, Nile Data Basin (NDB) to the southeast, Matruh Basin (MB) and Western Desert Basin (WDB) to the southwest. The onshore WDB and the NDB is mature basin, considered as classical petroleum provinces. Numerous deep-water play types, mostly within the NDB, have been identified along the transform margin (separating the MB and HB) of NW Egypt. The offshore MB and HB, extending from the coastline across a relatively narrow shelf into deep water, has a water depth ranging from 0 to 3200 m.

Tectonically, HB is the northernmost of the Africa north-facing passive margin which is the result of the opening of the Neo-Tethys during mid-Jurassic to early Cretaceous times. Structurally, SSW-NNE Rifting (mainly along matruh trough) evolves from Jurassic to Neocomian / Barremian, covering the MB and southern HB. The offshore MB has a prominent thin-skin and shale-detachment-related play types within the Matruch Canyon and Messinian salt plays a significant regional seal in the HB from the seismic illustration. Stratigraphically, in the MSB, late Mesozoic to Cenozoic mudstone and shale, Oligocene to Miocene sandstone and late Miocene salt play as hydrocarbon source, reservoir and seal, respectively, which can be extrapolated to the HB, based on the similar geological evolution. From the interpreted play types offshore NW Egypt, three proven plays can be found in the MB, while one potential play can be recognized as Jurassic to Cretaceous sandstone and carbonate sequence-structural-unconformity during the rifting stage in the HB. Mud volcanos (mainly methane) in the east Mediterranean also play a key role to know the hydrocarbon source potentials. The Similar regional geology including tectonics, structure and stratigraphy, together with plays similarity, makes the HB a hydrocarbon potential region, although the ultra-deep water will give rise to more risks.

BASIN LOCATION AND ITS NEARBY GIANT FIELDS

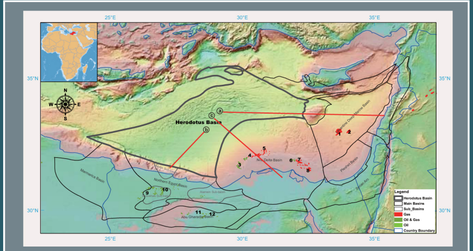

Figure.1 Location map including basin boundary, giant fields and cross sections of eastern mediterranean. The number of giant fields conrresond to the table 1.The topographic base map is taken from http://b-gi.obs-mip.fr/, the Herodotus basin is in thick gray irregular polygon.

Basin Name	Field Number	Field Name	Year of Discovery	Water Depth(m)	Reservoir Depth(m)	Reservoir Age	REC_PP (mmboe)
Levantine Deep marine	1	Leviathan	2010	1634	5170	Miocene	3363
	2	Tamar	2009	1677	4890	Miocene	1769
Nile Delta	3	North Alexandria	2000	650	3405	Pliocene, Miocene	935
	4	West Delta Deep-Domestic	1998	600	2056	Pliocene	894
	5	West Delta Deep-ELNG	1999	790	2577	Pliocene	1362
	6	Ha'py Development Area	1995	80	2574	Pliocene, Miocene	858
	7	Temsah	1977	85	2638	Miocene	813
	8	Port Fouad	1982	28	2519	Pliocene, Miocene,Oligocene	703
Northern Egypt	9	Khalda Offset	1991	0	4107	Cretaceous,Middle Jurassic	757
	10	Khalda	1969	0	3066	Upper Cretaceous, Middle Jurassic	604
	11	Badr El Din	1982	0	3113	Upper Cretaceous	624
Abu Gharadig	12	Apache Merged Area	1969	0	2509	Upper Cretaceous	592

Table.1 Giant oil and / or gas fields of the eastern mediterranean and its surroundings, for locations see Figure.1.

The Herodotus Basin is located in the ultradeep-water part of eastern Mediterranean with the area more than 130, 000 square kilometer, bounded by northern Egypt basin and Nile delta basin to the south and Leveantine Deep Marine basin to the east. Giant fields in the northern Egypt basin are mainly oils with a discovery date from 1960s to1990s within the Mesozoic reservoirs. Those in the Nile delta basin are mainly oil or gas with a discovery date from 1970s to 2000s within the Cenozoic reservoirs. Recently, two giant gas discoveries from the Levant Deep Marine basin within the sub-salt Miocene reservoirs make the eastern Mediterranean be a hot area. As the thick Messinian salt has a wide distribution in the eastern Mediterranean and many fields have been discovered from the nearby basins, whether the Herodotus ultradeep-water basin have the hydrocarbon potential under the sub-salt reservoirs need to be examined.

GEOLOGICAL SETTINGS, PALEOPLATE RE-CONSTRUCTIONS AND MAIN STRUCTURES

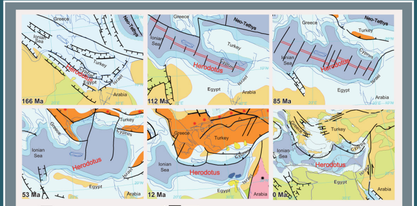

Figure. 2 Paleocontinental-paleographic map of africa and euroasia and north africa with an approximate basin location (Modified from Tellus and scotese et al. (1994))

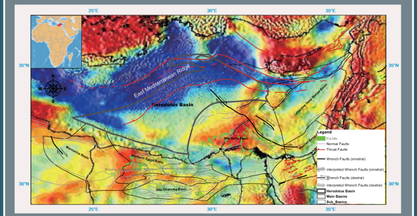

Figure. 3. Major structures and oil and/gas fields of the eastern Mediterranean, Structural elements are based on Chamot-Rooke et al. (2005), Longacre et al. (2007), Bevan & Moustafa (2012) and Skiple et al.(2012). The base map is isostatic gravity anomaly taken from http://b-gi.obs-mip.fr/.

The Herodotus basin (HB) is the northernmost of the Africa north-facing passive margin which is the result of the opening of the Neo-Tethys during mid-Jurassic to early Cretaceous times. During the mid-Juraasic, the HB has a continental shelf deposit. From early-Cretaceous to mid-Miocene, nohrtern part of the HB has an oceanic deposit.

The main structures include east Mediterranean Ridge and Cyprus Arc within the subduction zone to the north, conjugate strike-slip faults to the southeast and series of normal faults to the southwest.

REGIONAL CROSS SECTIONS, PLAYS AND BURIAL HISTORY FROM THE NEARBY BASINS

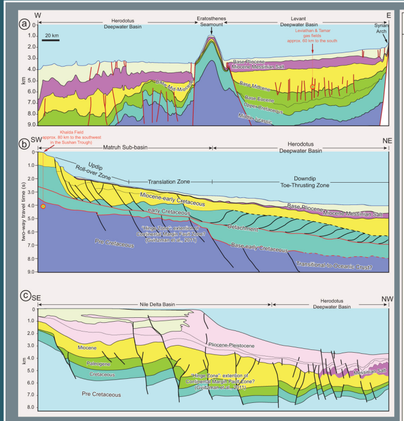

Figure.4 Simplified regional cross sections, for locations see Fig. 1(a: Modified from Skiple et al., 2012; b: Modified from Tari et al., 2012, Gvirtzman et al., 2011 and Dolson et al., 2006; c: Modified from Aal et al., 2001)

Recent giant gas discovery, such as Leviathan & Tamar in the Levant Deepwater basin within the sub-salt Miocene sand reservoirs. W-E cross section show the similar sequences to the west of Eratosthenes Seamount, Herodotus Deepwater basin.

Giant oil discovery, such as Khalda field in the Northern Egypt basin, is mainly Cretaceous or mid-Jurassic reservoirs. SW-NE cross section show a lateral continuous deposit till to the Herodotus basin with a confirmation of mid-Jurrasic continental shelf deposit from the paleoplate reconstruction.

Many giant oil / gas discoveries in the Nile Delta basin, are mainly from Pliocene to Oligocene reservoirs. SE-NW cross section show a Miocene depositional continuation and the Messinian salt in the HB will be a ideal seal.

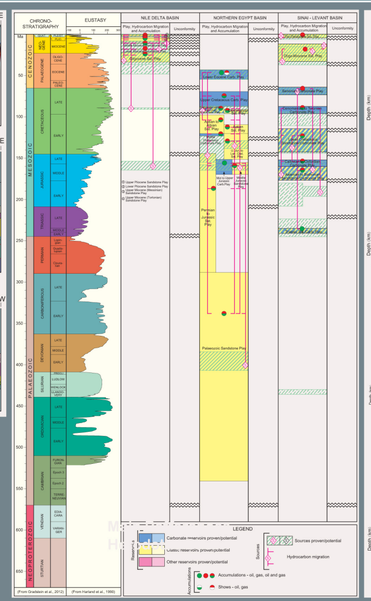

Figure. 5 Summary of regional play concepts in the eastern mediterranean (Modified from Tellus, Sultan and Halim, 1988, Wever, 2000, EGPC, 1994).

In Nile Delta basin, Mesozoic sources migrate upward to the Oligocene-Pliocene reservoirs. In Northern Egypt basin, Silurian - Devonian sources migrate upward to the Carboniferous and Jurassic reservoirs while Mesozoic sources migrate upward and / or downward. In Sinai - Levant basin, Mesozoic sources migrate upward and / or downward within the Mesozoic reservoirs while Cenozoic sources migrate upward within the Oligocene-Pleistocene reservoirs. Unconformities are located mainly after Triassic Period which make the long-distance lateral migration to be possible.

Figure. 6 Burial history from four (sub- or main)basins along the coast of the eastern Mediterranea. Matruh-Shushan Graben (well Shushan-1 in razzak field, Younes, 2006); Alamein sub-basin (Shahawky Abdine, 1993); Nile Delta Basin and Pleshet Graben (Robertson Research International Limited, 1993) .

They have a similar burial history from mid-Jurassic to late-Cretaceous with a deposition rate of 30 - 35 m/Ma. From Cenozoic, the Nile Delta basin and Pleshet Graben have a relatively rapid depositing than those from Northern Egypt basin.

SUMMARY AND CONCLUSIONS

Paleoplate reconstructions indicate that the Herodotus basin has a continental shelf deposit during mid-Jurassic and slope apron deposit since mid-Miocene.

Giant oil / gas discoveries located nearby the Herodotus basin, mainly Cretaceous, mid-Jurassic and Oligocene - Pliocene reservoirs.

Unconformities make the long-distance lateral migration to be possible.

It is interpreted the possible mid-Jurassic and Miocene reservoirs from the regional cross sections.

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