# PETROLEUM SYSTEMS OF LEBANON: AN UPDATE AND REVIEW

Presented By: Grace Comer

Authors: R. Ghalayini, F. H. Nader, S. Bou Daher, N. Hawie, and W. E. Chbat

### Abstract

- → New interpretation of the Levant margin (offshore Lebanon)
- → New evaluation of the petroleum systems of the Eastern Mediterranean
- Lebanon onshore and offshore split into 4 domains:
  - Distal Levant Basin
  - Latakia Ridge
  - Levant Margin
  - Onshore
- Domains characterised by a particular structural style and stratigraphic architecture
  - Different source reservoir trap configurations
- New division draws attention to specific areas of exploration interest
  - There are distinct petroleum systems
- New interpretation of the Levant margin
  - Focused on the carbonate dominated stratigraphy and petroleum potential of area
  - Attracted major attention after recent Zohr discovery in offshore Egypt

#### Introduction

- Part of the greater Levant region
- Located on active NW margin of the Arabian plate
  - Mostly by the left-lateral Levant Fracture System
- To the East:
  - Petroliferous Palmyride fold and thrust belt and
- To the West:
  - Stable foreland of the Levant Basin
- Considered to have significant exploration potential
  - 2006-2015: Discovery of more than 70 TCF (trillion cubic feet) of proven natural gas reserves
  - Gas fields include:
    - Tamar
    - Leviathan
    - Aphrodite
    - Zohr



Main structural elements of Lebanon, the Levant Basin and part of Syria.

# Map showing the geological domains of Lebanon as discussed in this study, together with hydrocarbon discoveries in nearby countries.



#### Methods and Data

• Five Seismic Lines Along North and South Offshore Margin

#### <u>North</u>



<u>South</u>



# Petroleum Systems Charts

140 130	120 110 1	00 90	80 70	60	50 40	) 30	20	10 0	DEEP BASIN	
	Mesozo	Dic		Γ.	c	enoz	oic		Geologic	1
Cretaceous						Tertion		c	timescale	
						renary		uaten	Datralaum	
loocomian	Early	L	Late	Palao	Paleogen	Oligo	Nec	gene a	Petroleum	
veocomian			Senonian	Paleo.	Eocene	Oligo.	MICC	aue r	System	
						В	oge	nic	Source Rock (SR)	1
									Reservoir Rock	]
			_	_	_		_		Seal Rock	
						_		_	Overburden Normal faulte	
						- 1	_	_	Anticlines	Trap Formation
								-	Generation Migration Accumulation	
									Miocene biogenic SR	1
								Gas	Oligocene biogenic SR	
									Oligocene SR	lic.
TOC - <<1	0 % docroa	coc woet	ward			0	il	Wet Gas	Camp - Cenom - Paleo SB	ogei
TOC = < 2	6 %	ses west	Oil			0 ii		Gas	Kimmerid Neocomian SR	Ĕ
TOC = < 0.	5 - 1.5 %	0	il			Gas			Triassic SR	Ť
						1 1		•	Critical moment	
SR TOCs are distal basin. th	speculative and	d are based	i on values r ease away f	ecorded or	onshore. In nargin.	n the			Notes	1
-										]
280 260	240 220	200 18	0 160 1	40 120	100	80 60	40 Con	20		
aleozoic		IVI	esozoic			$\rightarrow$	Cen	02010	Geologic	
Permian	Triassic	Ju	irassic	Cre	taceous		Te	tiary	timescale	
Early M L	E M Late	E	ML	Early	L	ate l	aleogen	e Neog.	Petroleum	
				eoc.		ienon. Pa	L Eoc.	O. Mio.	system	
								Biogenie	Source Rock (SR)	
_		_					<u>.</u>		Reservoir Rock	
	_			-	-				Overburden	
									Trap Formation	
									Generation Migration Accumulation	
FOC = 2 - 3	%						0	Ga	Soligo-Miocene biogenic SR Kimmerid - Neocomian SB	
TOC = 0.5 - 1.5 %									Triassic SR	Thermogenic
								₩	<ul> <li>Critical moment</li> </ul>	
urassic TOCs a ifferent in the m	are from sampling nargin. The Triass	onshore an ic TOC is fr	d may be om Syria.	Oligo-Mio. may latera	biogenic se Illy charge t	burce rock	s in the oirs along	deep basin the margin	n Notes	
140 120	100 110 1	00 00	80 70	60	F0 4	20	00	10 0	LATTAKIA BIDGE	1
140 130	Mesoz	nic	00 70	T	<u>, i i i i i i i i i i i i i i i i i i i</u>	enoz	nic	10 0		1
Westzoic						CIIOZ			Geologic	
				Tertiary	(	Qua	timescale			
	Early		Late	<u> </u>	Paleogen	)	Neo	igene	Petroleum	
eocomian			Senonian	Paleo.	Eocene	Oligo.	Mioc	ene P	system	
						В	o g e	nic	Source Rock (SR)	1
									Reservoir Rock	]
									Seal Rock	-
									Overburden	-
									Trap Formation	1
									Migration Accumulation	1
								Gas	Oligocene biogenic SR	1
TOC = << 5 %, decreases westward									Camp Cenom Paleo SR	ale.
TOC = < 2.6 %									Kimmerid Neocomian SR	moger

TOC = << 5 %, decreases westward TOC = < 2.6 % TOC = < 0.5 - 1.5 % Oil 

SR TOCs are speculative and are based on values recorded onshore. In the distal basin, the TOC is believed to decrease away from the margin.

280 260	0 240 220 200	180 160	140 120 100 80	60 40 20 0	ONSHORE DOMAIN	
Paleozoic		Mesozoi	c	Cenozoic	Geologic	
Permian	Triassic	Jurassic	Cretaceous	Tertiary	timescale	
Early M L	E M Late	E M L	Early Late Neoc. Senon.	Paleogene Neog. Pal. Eoc. O. Mio. P	Petroleum system	
					Source Rock (SR)	
					Reservoir Rock	
					Seal Rock	
				Bekaa Valley	Overburden	
					Trap Formation	
					Generation Migration Accumulation	
TOC = 2.6 %	6	Kimmerid Neocomian SR	Thermogenic			
TOC = 0.5 -	1.5 %	Permo - Triassic SR				
				<u> </u>	Critical moment	
These are the onl	Lebanon	Notes				

Triassic SR

Critical moment Notes

## Conclusions

- Distal Levant Basin
  - Oligocene-Miocene siliciclastic units have reservoir potential
  - Sandstones are proven reservoir rocks
  - Dominated by Oligo-Miocene biogenic source rocks
  - Potential structural traps include:
    - Upper Miocene four way dip closures
    - Lower Miocene tilted fault blocks
- Latakia Ridge
  - Potential reservoir rocks are mainly Oligo-Miocene siliciclastics
  - Mixed biogenic thermogenic source rock potential
  - Potential traps are Upper Cretaceous four way dip closures
- Levant Margin
  - Potential reservoirs include Mesozoic carbonates together with Lower Cretaceous and Oligocene-Miocene siliciclastics
  - Possibility of lateral migration from kitchens in the deep offshore
  - Potential traps are in general stratigraphic
- Onshore
  - Triassic dolomites and Jurassic and Cretaceous carbonates have reservoir potential
  - Potential traps include four way dip closures

Takeaways from Article

- Working petroleum systems likely present
  - Encourage further exploration in 4 domains outlined
- Use countries close by as good analogues prospects and to reduce exploration uncertainty
  - The study of potential analogues in the Palmyrides could have a positive impact on future exploration