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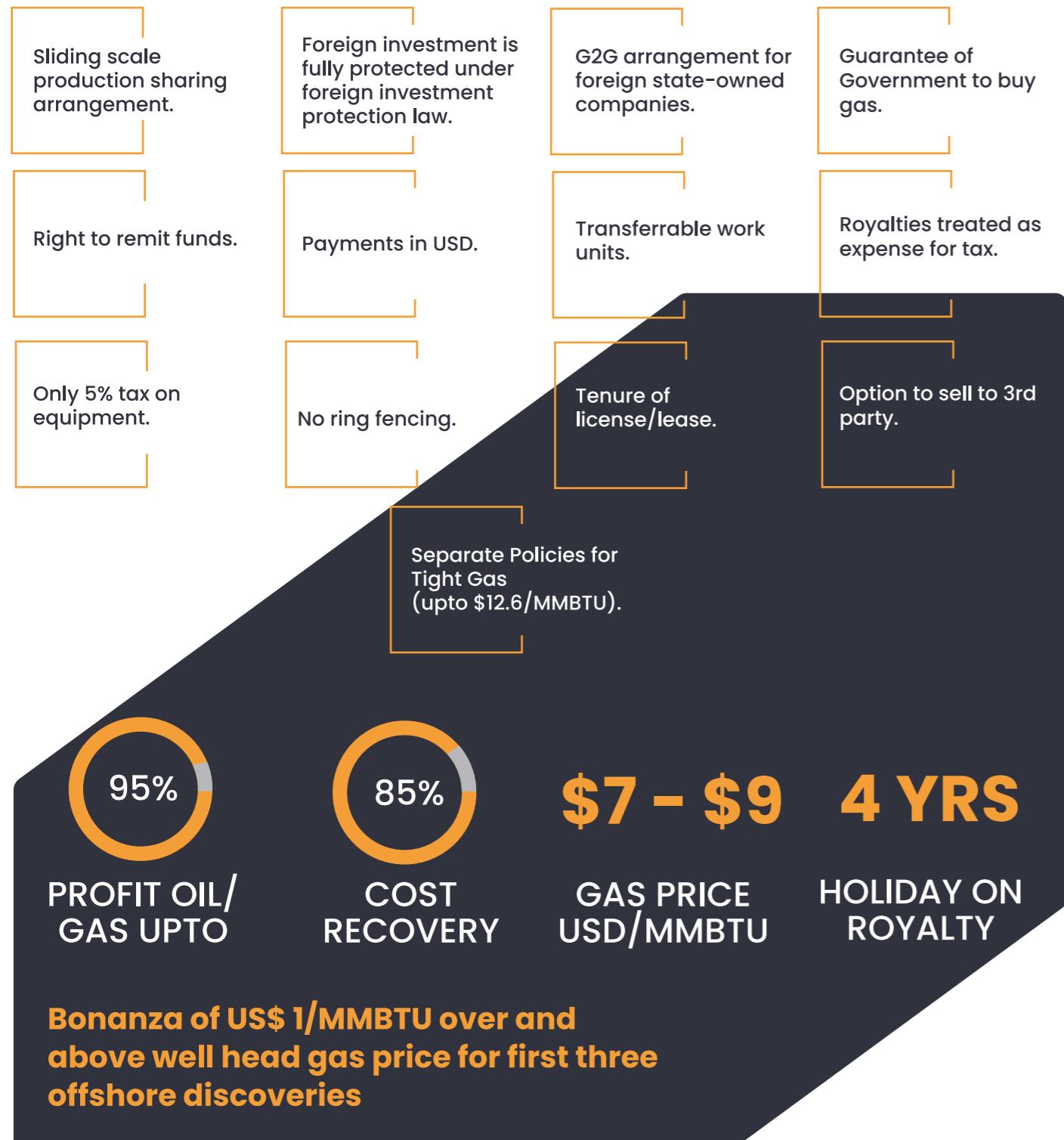
OFFSHORE PAKISTAN

The New Exploration Frontier

Bid Round Blocks



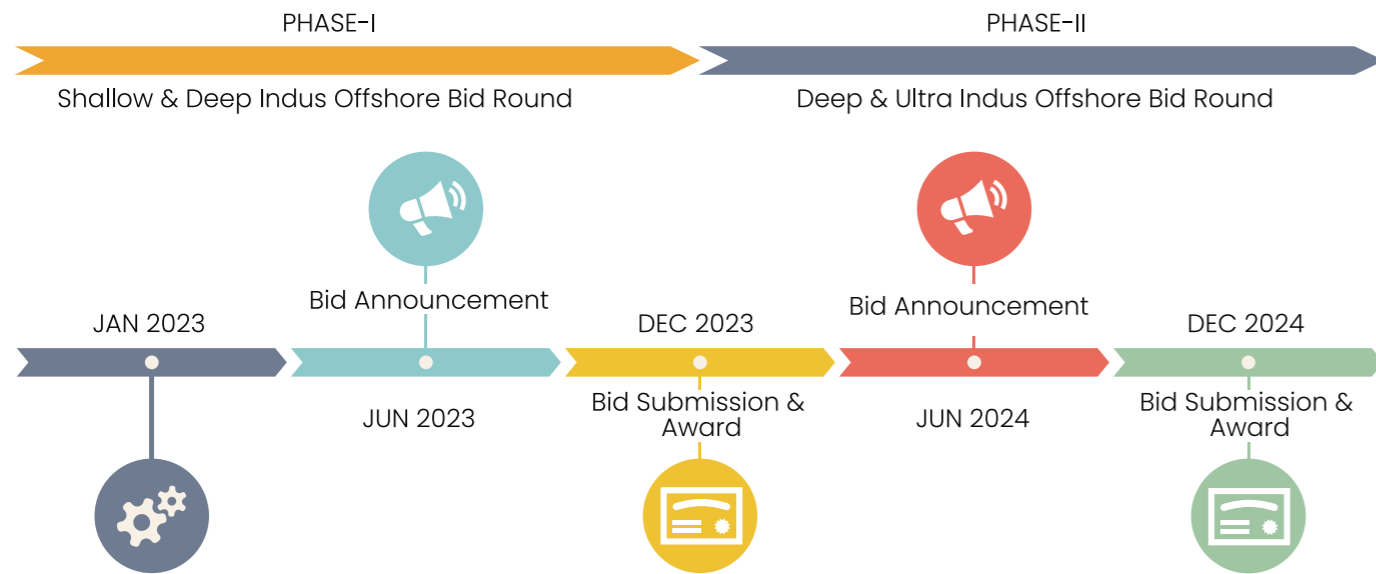
ATTRACTIVE FISCAL AND REGULATORY POLICY FOR PETROLEUM INVESTORS



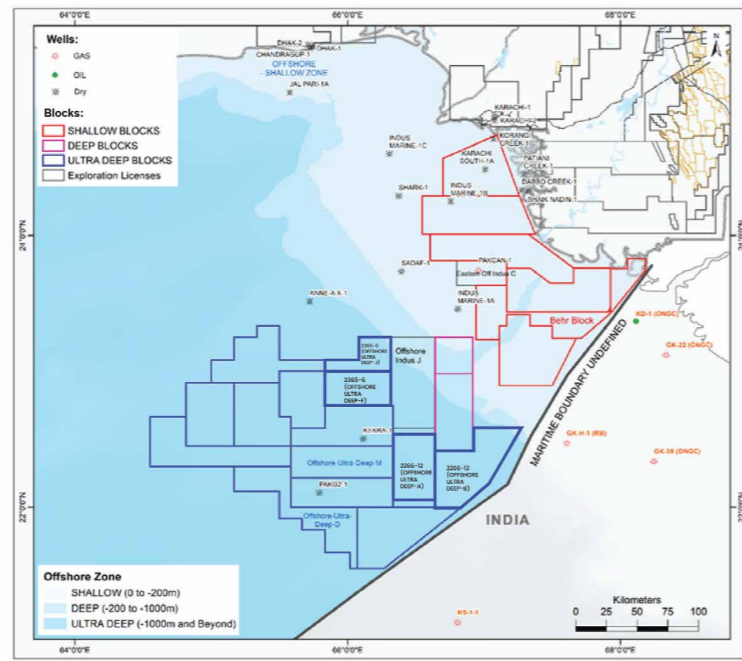
PROCEDURE FOR GRANT OF E&P RIGHTS AND REQUIREMENTS



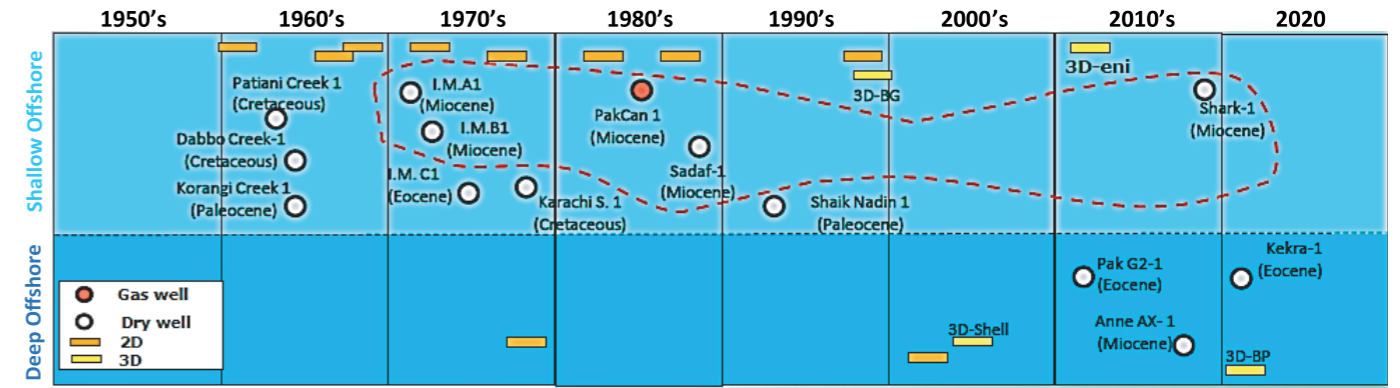
Road Map BID AWARD PROCESS



	S.NO.	BLOCK NAME	AREA (Sq.Kms)	WATER DEPTH
Phase 1	1	BEHR (2366-9)	2481.44	0-200m
	2	BIN QASIM SOUTH (2466-10)	2021.69	0-200m
	3	GHARO CREEK (2466-9)	2453.05	0-200m
	4	KETI BANDAR (2367-6)	2464.75	0-200m
	5	KOCHI CREEK (2366-8)	2450.14	0-200m
	6	ZARRAR(2267-3)	2424.8	0-200m
	7	OFFSHORE DEEP-A (2266-14)	1774.2	200-1000m
	8	OFFSHORE DEEP-B (2266-10)	833.78	200-1000m
	9	OFFSHORE ULTRA DEEP-A (2266-12)	1774.2	>1000m
	10	OFFSHORE ULTRA DEEP-B (2266-13)	833.78	>1000m
	11	OFFSHORE ULTRA DEEP-F (2265-6)	1373.56	>1000m
	12	OFFSHORE ULTRA DEEP-J (2365-5)	900.36	>1000m
Phase 2	13	SAPAT BANDAR (2465-5)	1894.66	0-200m
	14	OFFSHORE DEEP-C (2366-10)	2482.83	200-1000m
	15	OFFSHORE DEEP-K (2465-6)	2482.33	200-1000m
	16	OFFSHORE ULTRA DEEP-C (2166-1)	2475.04	>1000m
	17	OFFSHORE ULTRA DEEP-D (2165-3)	2444.86	>1000m
	18	OFFSHORE ULTRA DEEP-E (2264-3)	2429.76	>1000m
	19	OFFSHORE ULTRA DEEP-G (2265-7)	2048.36	>1000m
	20	OFFSHORE ULTRA DEEP-H (2265-8)	1976.92	>1000m
	21	OFFSHORE ULTRA DEEP-I (2264-4)	1859.69	>1000m
	22	OFFSHORE ULTRA DEEP-L (2265-9)	2482.33	>1000m
	23	OFFSHORE ULTRA DEEP-M (2265-10)	1999.1	>1000m
	24	OFFSHORE ULTRA DEEP-N (2265-11)	1860.21	>1000m



Exploration HISTORY



Acquired Data

2D Seismic	75,000 L. Kms
3D Seismic	~11,000Sq. Kms

Drilled Wells

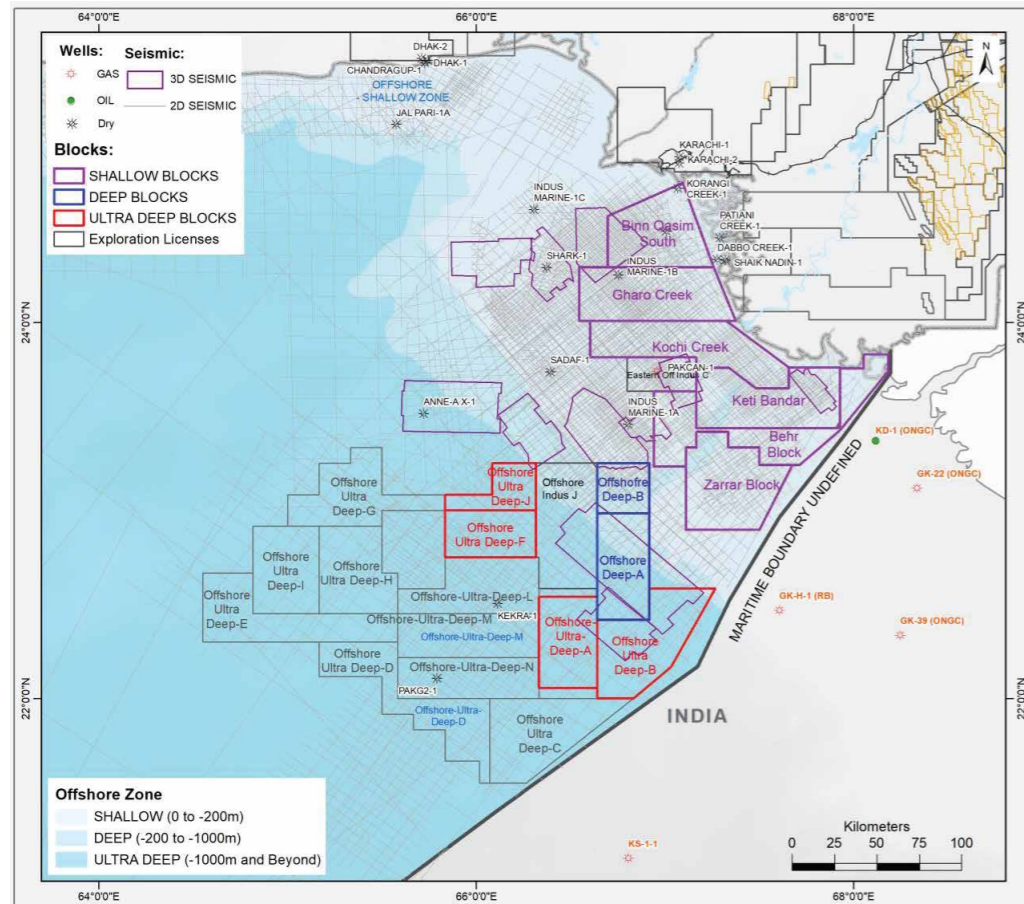
Sr.	Well Name	Well Results	Operator	Year	TD (meters)
1	Pak Can-1	Discovery, drilled probably at edge of sand body	OGDCL	1985	3702
2	Dabbo Creek-1	Drilled off structure	Sun	1963	4354
3	Patiani Creek-1	Drilled off structure	Sun	1964	2659
4	Indus Marine 1C	High formation pressure	Wintershall	1975	1942
5	Sadaf-1	Lack of charge	Occidental	1989	3980
6	Pak G2-1	Lack of charge	Total	2004	4700
7	Kekra-1	Lack of charge	Eni	2019	5693
8	Indus Marine 1A	Poor reservoir quality	Wintershall	1972	2481
9	Shaikh Nadin-1	Poor reservoir quality	Canterbury	1992	1679
10	Anne-Ax-1	Reservoir not encountered	Shell	2007	3257
11	Shark-1	Reservoir not encountered	Eni	2010	3500
12	Karachi South-1	Trap integrity	Husky	1978	3353
13	Indus Marine 1B	Mechanical failure	Wintershall	1972	3804
14	Korangi Creek-1	Possible seal failure	Sun	1964	4140

14 wells have been drilled, 11 in shallow water and 3 in ultra-deep.

5 wells in shallow water and one in deep water was drilled for Miocene clastic play

2 wells in deep water target Paleogene carbonates buildups

OFFSHORE DATA SET



No. of 3D Seismic

11 surveys

3D Coverage

11950.5 Sq. Kms

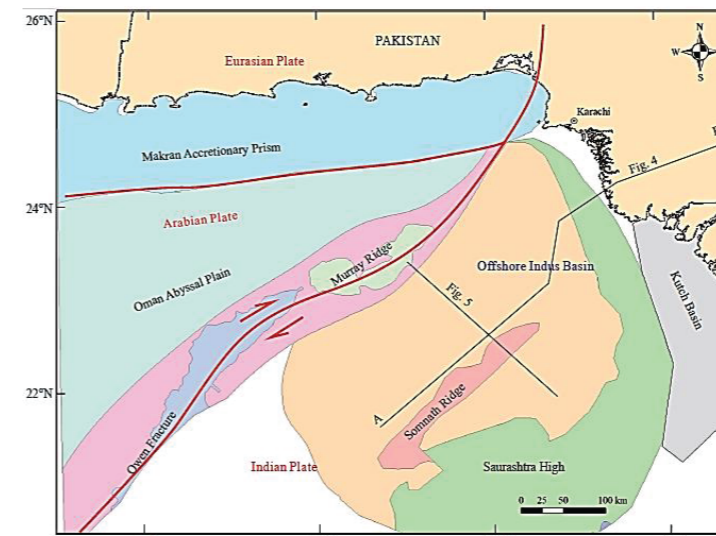
No. of 2D Lines

1172

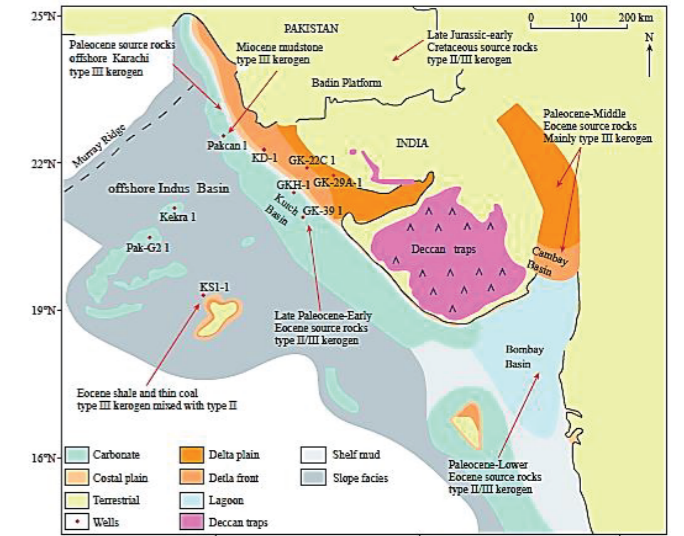
2D Coverage

63913.60 L. Kms

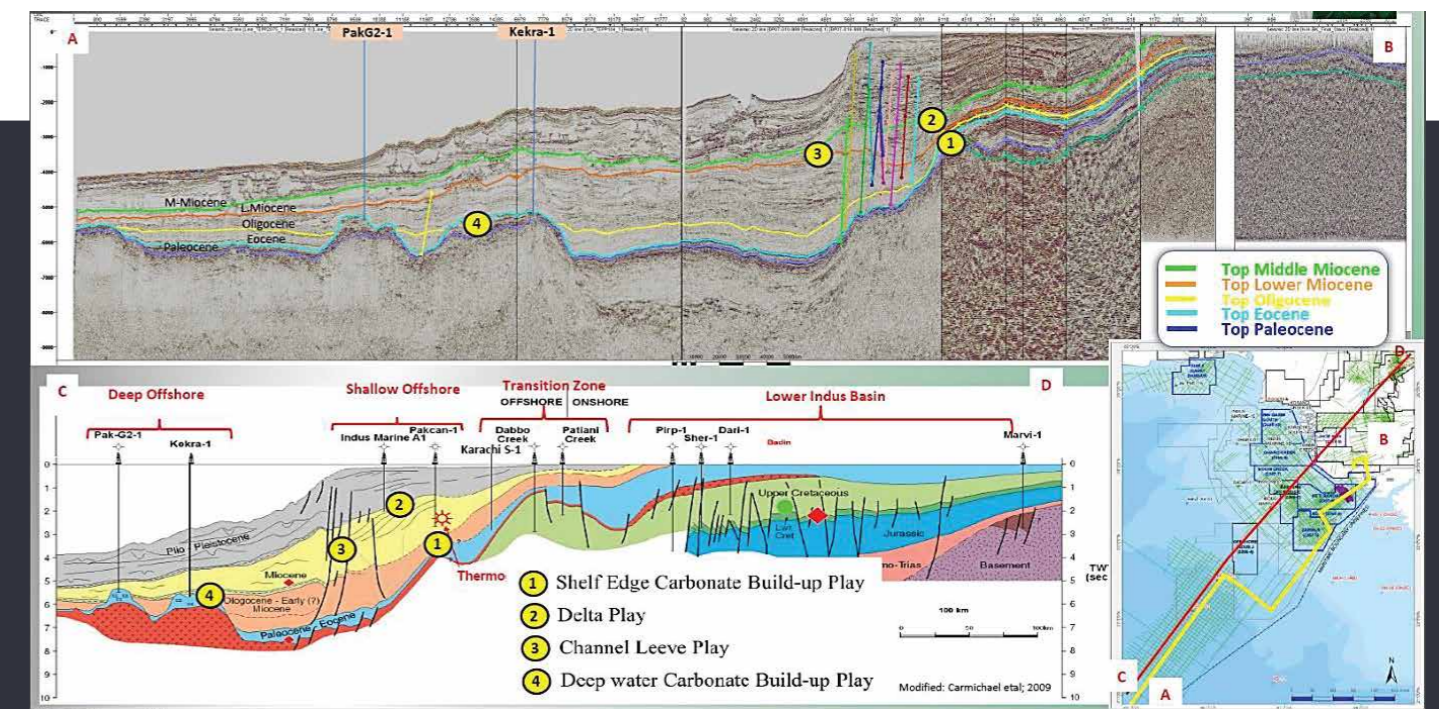
GEOLOGICAL PERSPECTIVE



A - Geotectonic location of Pakistan offshore (modified from Smith GL, 2013).

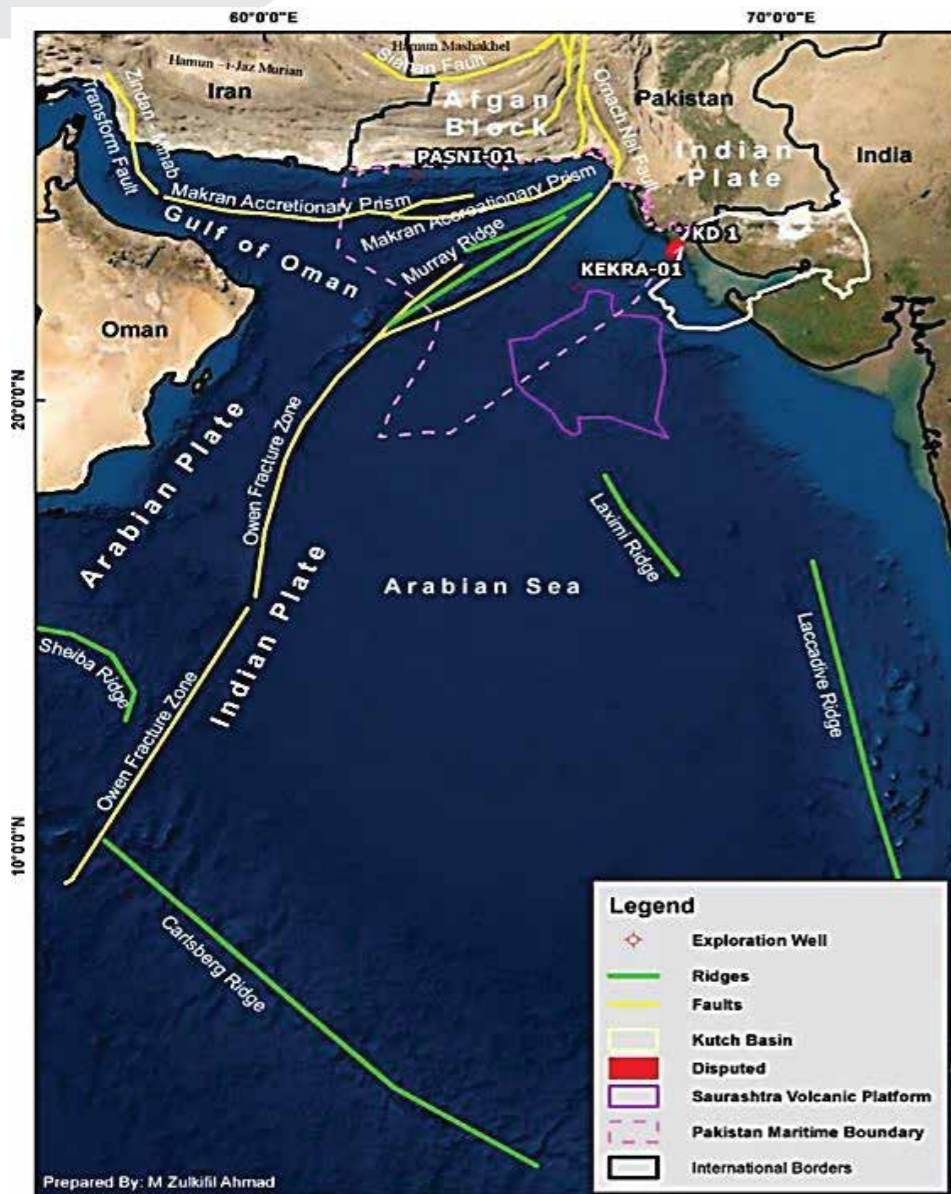


B - Sedimentary environment of source rocks in the Offshore Indus Basin and its adjacent areas in the Paleocene-Eocene



C - Offshore Indus Geological Profile

GEOLOGY & TECTONIC SETTINGS



Pakistan Offshore extends from south 700 km long coastal line along Arabian Sea.

Offshore Indus Basin located between Murray Ridge and Laccadive Ridge is mainly a Passive Margin basin."

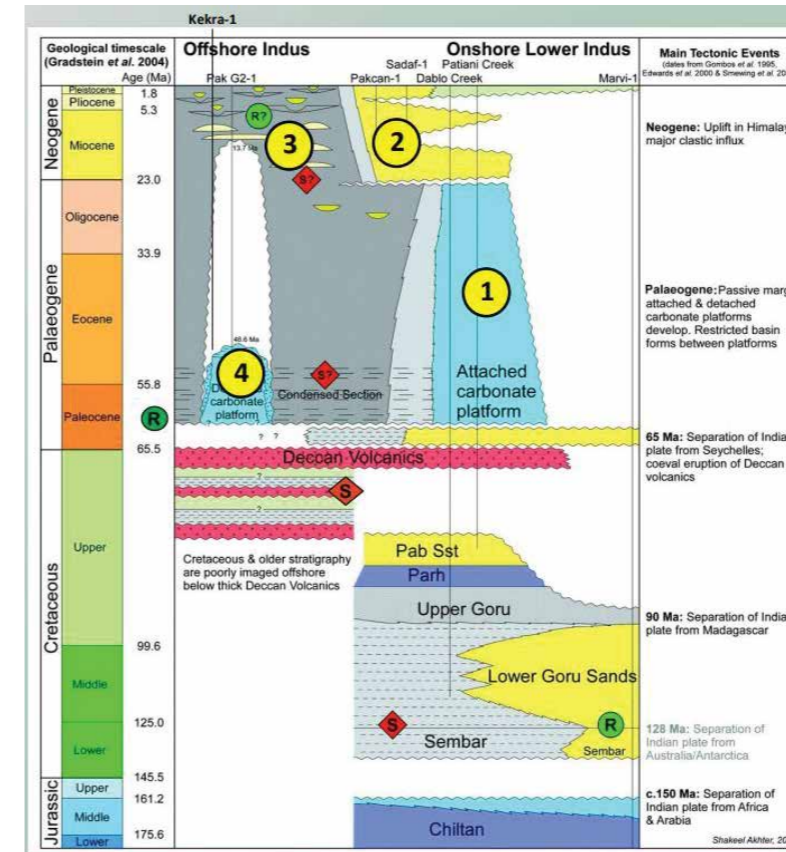
Arabian Sea extends from border of Oman in west to Laccadive Ridge in east toward India; in South to Carlsberg Ridge.

Owen Fracture Zone - Murray Ridge divides Arabian Sea crust into Arabian Plate in west and Indian Plate in east.

Pakistan Offshore divided into Indus Offshore (Saurashtra Volcanic Arc in SSE) in east, extend toward west as Murray Ridge, Dalrymple Trough and Makran Accretionary Prism.

Arabian plate is in the south of Makran Accretionary Prism

GENERALIZED STRATIGRAPHY



Source Rock

Paleocene section has TOC ranging from 1-3%.

Miocene section TOC ranges from 1-3.5% in Indus marine a-1.

300m of source rock interval with TOC range of 1- 3.24% drilled in Pakcan-01 well, however it turned out to be immature.

Seal

The Mud-Clay dominated sediments and intraformational shales packages of Miocene and Oligocene may act as seal for potential reservoirs.

1 Shelf Edge
Paleogene Carbonate Buildup.
Not drilled yet

3 Channel Levees
Untested - Potential candidates for the HC exploration

2 Miocene Delta
Tested by 5 wells; few were drilled off structure & few didn't encounter reservoirs. Pakcan-01 (flowed @ 3.7 MMscfd)

4 Deep Water Carbonate Buildup
Drilled in Pak G2-01 & Kekra-01; excellent reservoir encountered in the wells however lack of charge could be the possible reason for failure.

SOURCE ROCK CORRELATIONS INDUS BASIN & ADJACENT AREAS

Basin / Well	Age	Lithology	TOC %	Type	R ₀ (%)	Remarks
Indus Basin	Lower Cretaceous	Shale	3.5	II and III	0.87	Proven Hydrocarbon reserves exist with good to very good source rock.
	Upper Cretaceous	Shale / Mudstone	2.55 – 1.72	II and III	2.06 - 1.27	
	Paleocene	Shale	1.38 – 1.72		1.07 – 1.29	
	Eocene	Shale	1.19 – 6.19		1.01 – 1.11	
	Oligocene	Shale	9.75		1.44	
Kutch Basin	Lower Eocene	Shale / Lagoonal Lignite	0.86	II and III	0.94	Proven GKH1 well. In Cretaceous thin layers are observed.
	Paleocene	Calcareous Shale / Lignite Seams	0.58 – 0.37	II and III	>1.1	
	Cretaceous	Interbedded Shale and Coal	0.35 - 3	III and II	<0.5	
	Upper Jurassic	Shale	0.1 – 10.65	III and II	0.34 – 0.49	
	Lower Cretaceous	Shale	0.5 – 3			
Pakcan-1	Lower Miocene	Mudstones	0.55 – 3.24		0.6 – 0.9	Potential source rock is present.
Bombay Basin	Paleocene – Lower Eocene	Shale / Coal Seams	0.55-1			Good and mature source rock.
	Oligocene	Shale	≥1			
KS1-1	Paleocene – Eocene	Shale / Mudstones	3-4.5	III		Black Shale (~3m)
Karachi Offshore	Paleocene	Mudstone		III		Good source rock.

Modified after Gong, J. M., Liao, J., Liang, J., Lei, B. H., Chen, J. W., Khalid, M., & Meng, M. (2020). Exploration prospects of oil and gas in the North-western part of the Offshore Indus Basin, Pakistan. China Geology, 3(4), 633-642.

Paleocene

Drilled only in Karachi South-01 well with TOC ranging from 1 – 3%. Pakcan-01 adjacent block.

Miocene

TOC ranges from 1% – 3.5% in Indus Marine A-1

300m of source rock interval with TOC range of 1.26% – 3.24% drilled in Pakcan-01 well, however it turned out to be immature.

RESERVOIR CORRELATIONS INDUS & ADJACENT AREAS

Basin / Well	Age	Lithology	Net Thickness(m)	Phi (v/v)	K (md)	Remarks
Offshore Indus Basin	Miocene	Deltaic Sands	10-20	18-25, with an average of 22	100-500, with an average of 514	Pakcan -01 Good reservoir is present
	Eocene	Reef Limestone				PakG2-01 Excellent reservoir
	Eocene	Reef Limestone		20-28		Kekra-01 Excellent reservoir
Indus Basin	Lower Eocene	Limestone	25	4-30	4	Excellent reservoir
	Paleocene	Sandstones	10	10-25		Good reservoir
	Cretaceous	Sandstones	15	15-22		Excellent reservoir
Kutch Basin	Cretaceous Naliya & Bhuj Formations	Fluvial-Deltaic Sands	30	25 18	32.8	GK-39-1 Very good reservoir GK-22C -1
	Lower Paleocene	Fluvial Sands		20-25	100-1000	GK-29A-1 Excellent reservoir
	Lower Eocene	Limestone	15			KD-1 (Good reservoir)
Bombay Basin	Miocene	Limestone		18-35	50-500	Good to very good reservoir
	Upper Eocene	Limestone		14-22	20-1000	

Modified after Gong, J. M., Liao, J., Liang, J., Lei, B. H., Chen, J. W., Khalid, M., & Meng, M. (2020). Exploration prospects of oil and gas in the North-western part of the Offshore Indus Basin, Pakistan. China Geology, 3(4), 633-642

Plays Types

Shelf Edge Carbonate Buildup

Undrilled

Seal

Intra-formational shales of Miocene and Oligocene may act as top seal.

Miocene Delta

Tested by 5 wells, few were off structure & some didn't land in reservoir
Pakcan-01 (flowed @ 3.7 MMscfd)

Channel Levee

Untested – A vast Frontier

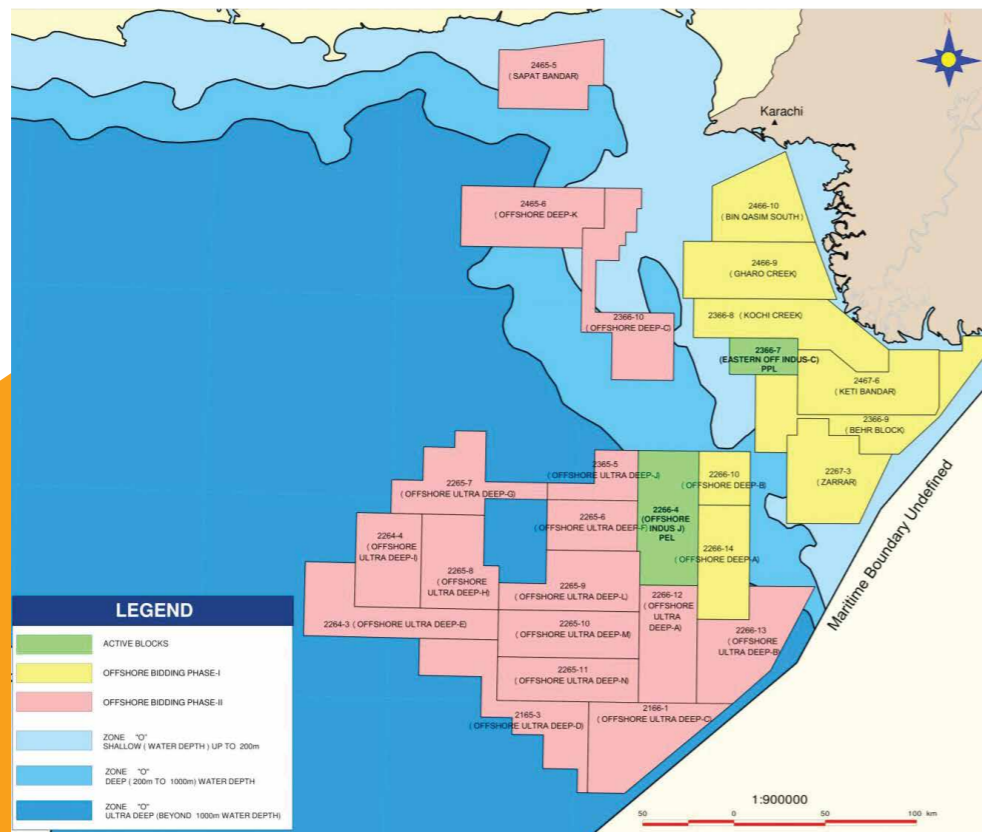
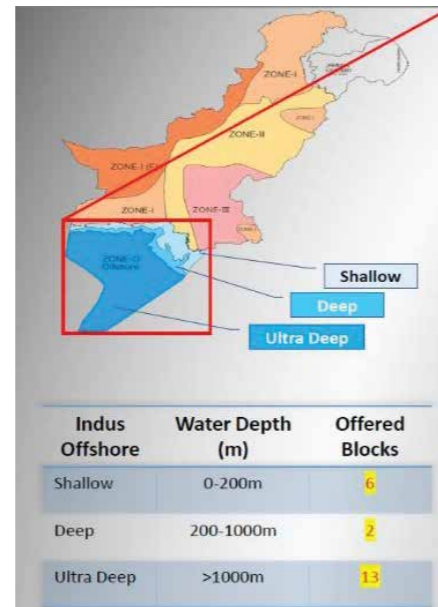
Deep Water Carbonate Buildup

Drilled in Pak G2-1 & Kekra-01, excellent reservoirs but limited knowledge about charge

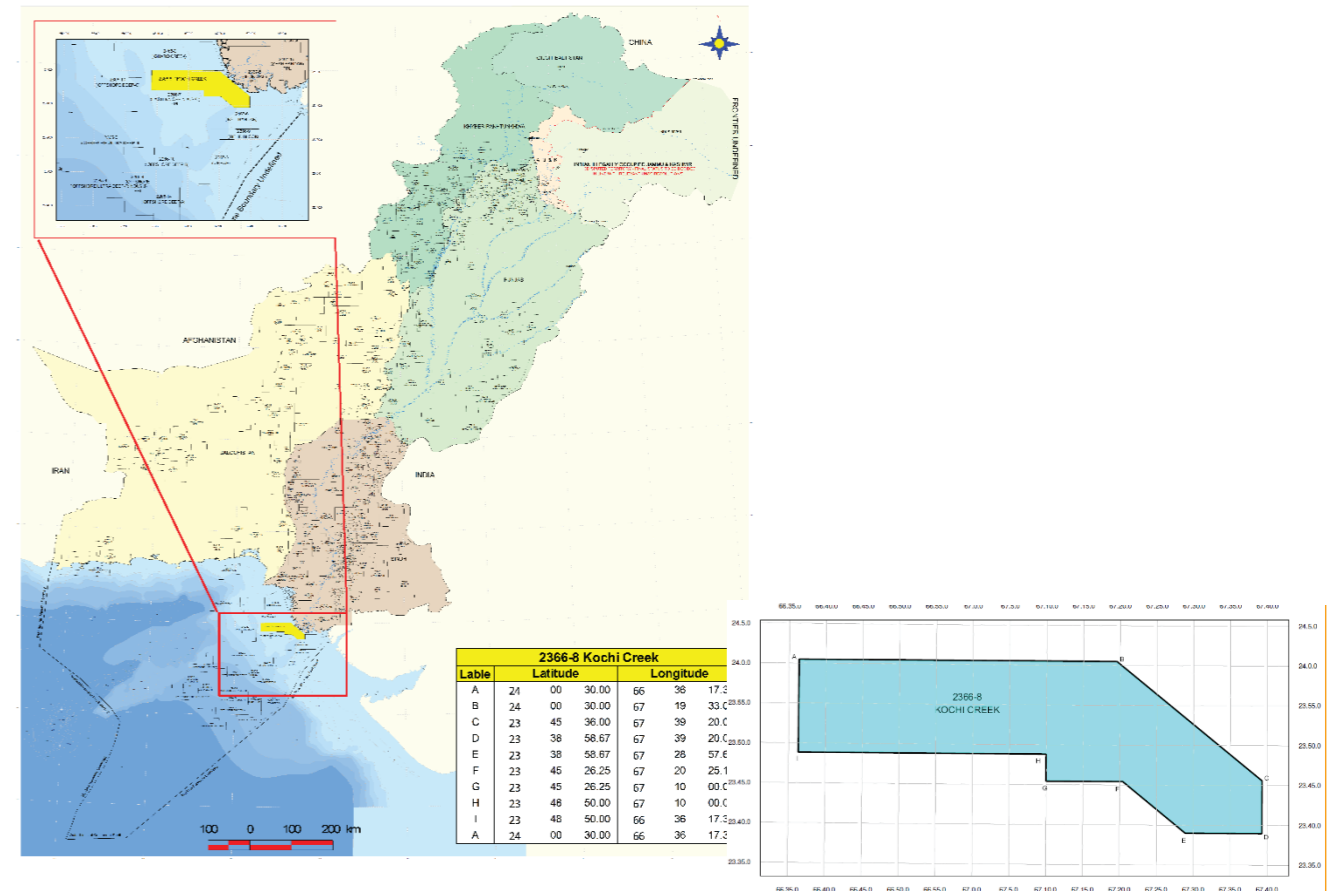
INDUS OFFSHORE BLOCK KOCHI CREEK (2366-8)

KOCHI CREEK (2366-8) INTRODUCTION

Offshore Bidding Phase-I			
S. No.	Blocks	Area Sq.Kms	Grid Area
1	2466-10 Bin Qasim South	2021.69	26.00
2	2466-9 Gharo Creek	2453.05	31.49
3	2366-8 Kochi Creek	2450.14	31.32
4	2367-6 Keti Bandar	2464.75	31.47
5	2366-9 Behr Block	2481.44	31.62
6	2267-3 Zarrar	2424.8	30.74
7	2266-10 Offshore Deep-B	833.78	10.56
8	2266-14 Offshore Deep-A	1774.2	22.33



Location Map of Kochi Creek



2366-8 Kochi Creek		Available Data		Total Area (Sq. Kms)
Zone	O	2D Seismic (L.Kms)	10602.31	2450.14
Grid Area	31.32	3D Seismic (Sq.Kms)	410.99	
		No. Wells	NA	

Key Highlights

Area: 2450.14 Sq. Kms.

Geological Basin: Offshore IndusBasin Pakistan.

Prospectivity Zone: O

Gharo Creek (North), Behr (South) and Offshore Deep C (West) blocks.

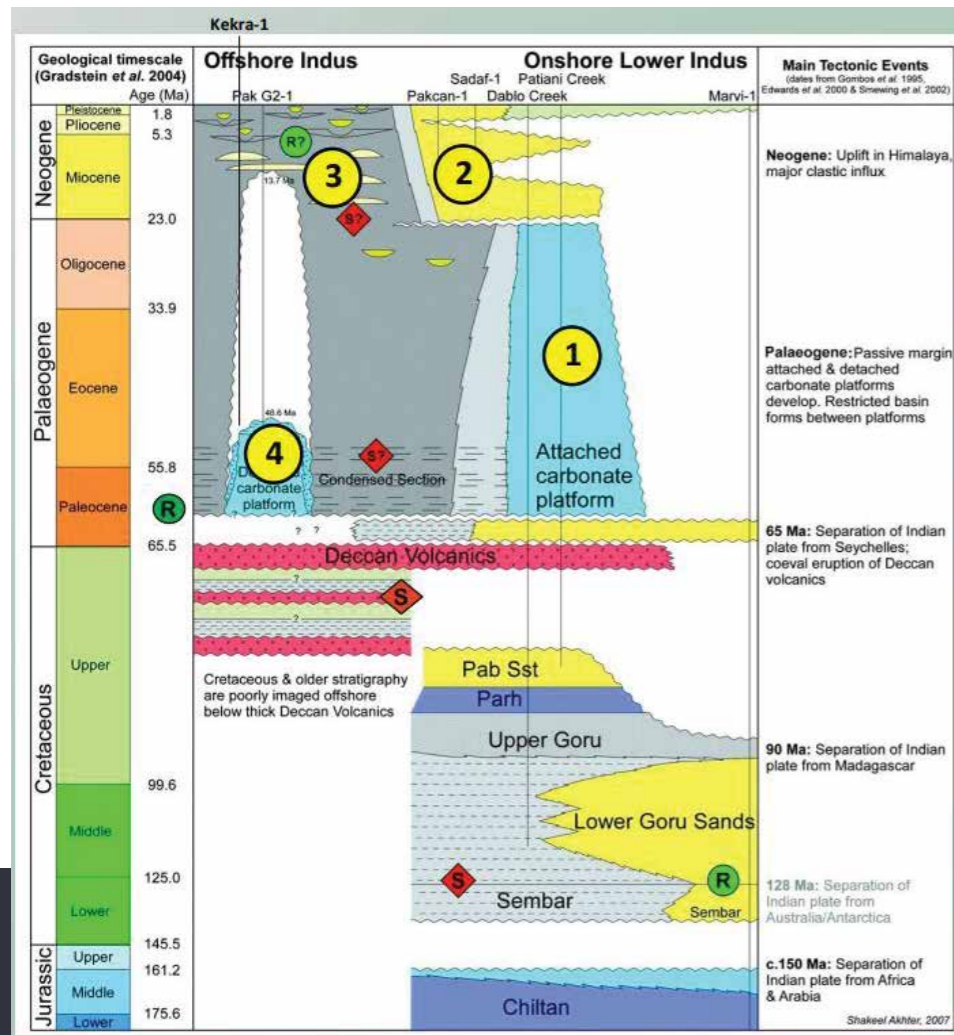
Vicinity wells: Pakcan-01 and Indus Marine-1B.

Pakcan-01 flowed 3.7 MMscfd gas from Middle Miocene Sandstone.

This shows the petroleum system exists and well may be drilled at the edge of sand body.

Indus Marine-1B indicated gas shows but failed due to mechanical issues. (Gong et al., 2020).

STRATIGRPHY & PETROLEUM SYSTEM



Source Rock

Paleocene section with toc ranging from 1-3%.

Play Types: Miocene Delta

Tested by 5 wells.

Few off structure & few didn't find reservoir.

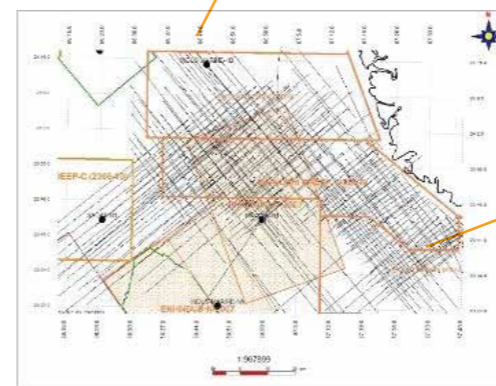
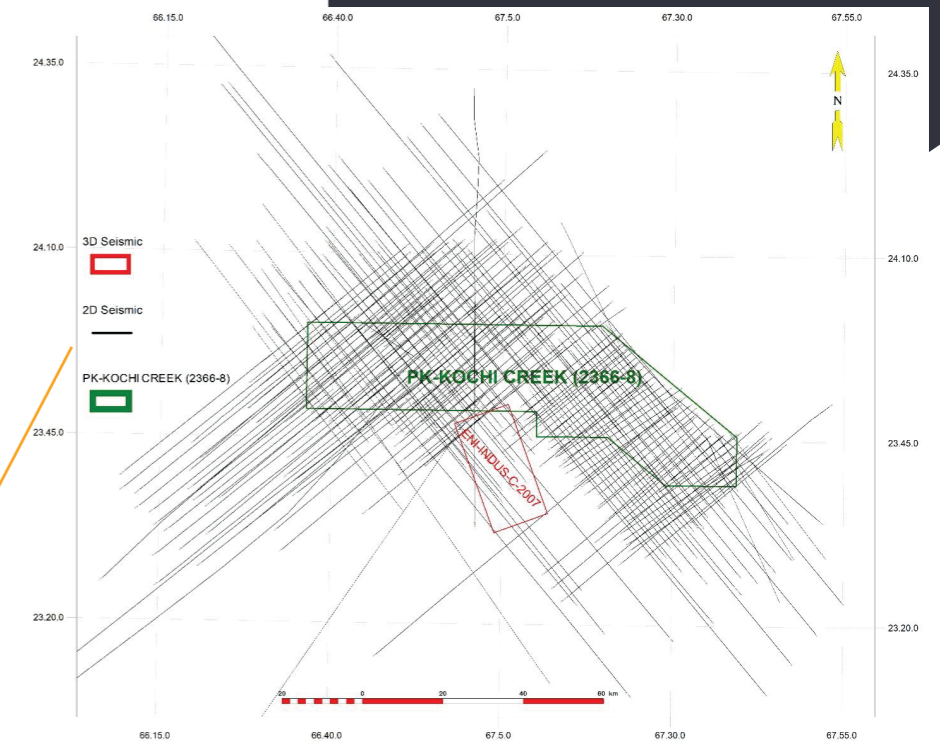
Reservoir Seal Pairs

Miocene deltaic sands act reservoir
The mud-clay dominated sediments.
And intraformational shales packages of Miocene.
Oligocene may act as seal for potential reservoirs.

Trap Geometries

Fault block and rollover against growth faults in shelf margin basin. Pinch outs are also observed..

AVAILABLE DATASETS



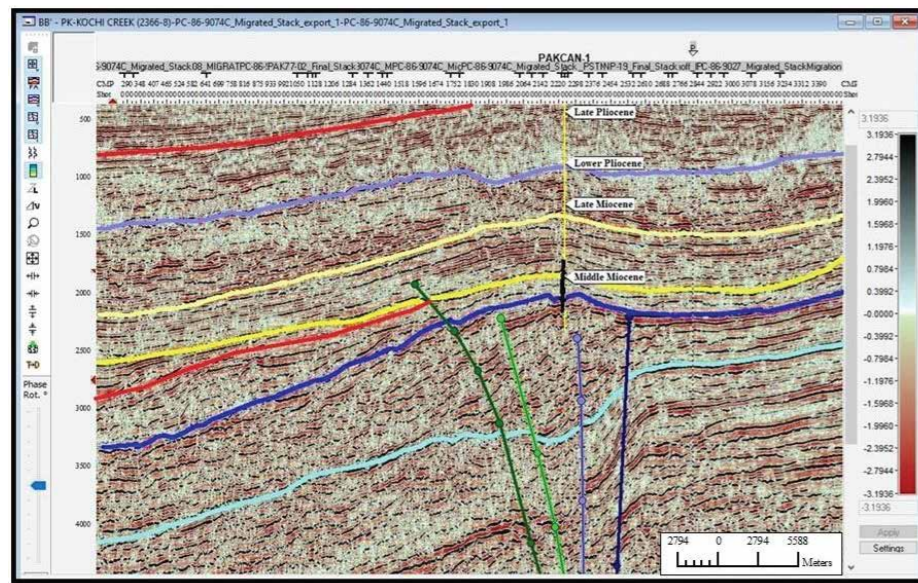
Seismic Data

10602.308575 2D (L.Km's)
410.99 3D (Sq.Km's)

Wells

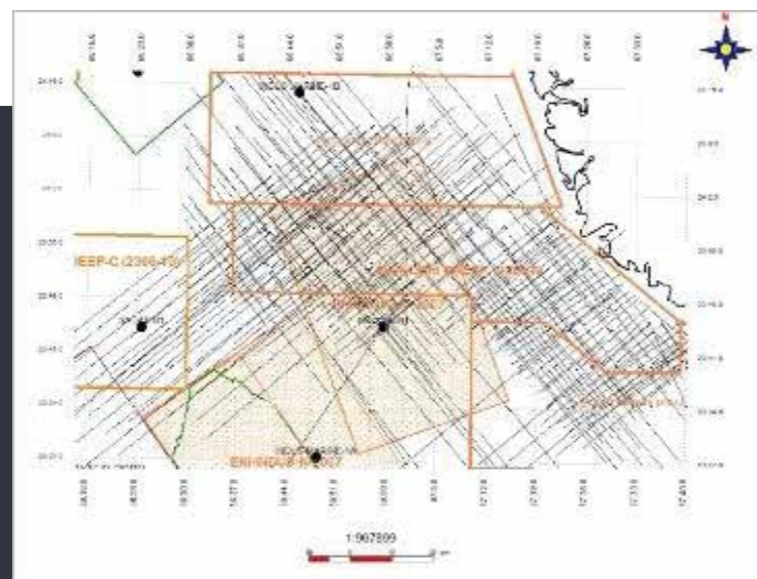
No well
Pakcan-01 – drilled in adjacent block

INTERPRETED SEISMIC SECTION

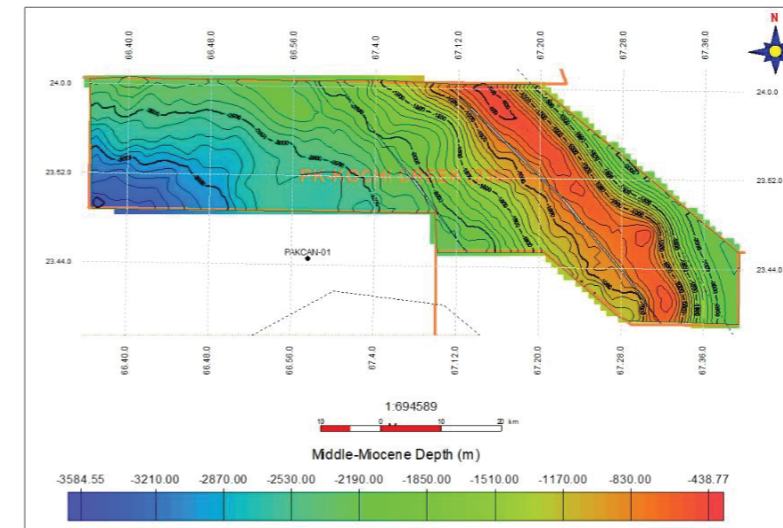


- Lower Pliocene
- Late Miocene
- Lower Pliocene
- Middle Miocene
- Base Miocene
- Pinch outs

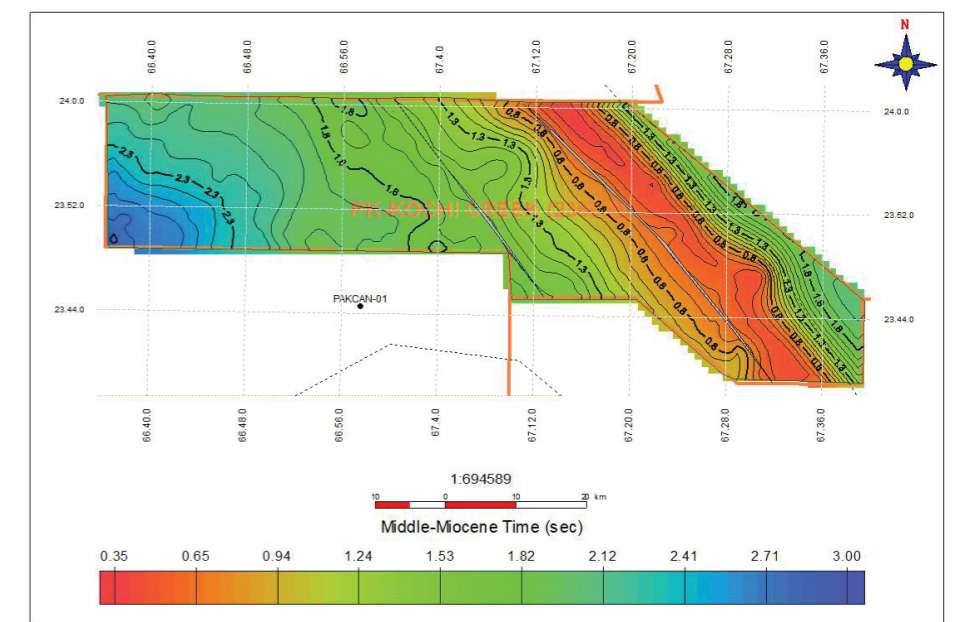
Fault block and rollover against growth faults in shelf margin basin. Pinch outs are also observed.



MIDDLE MIOCENE MAPS



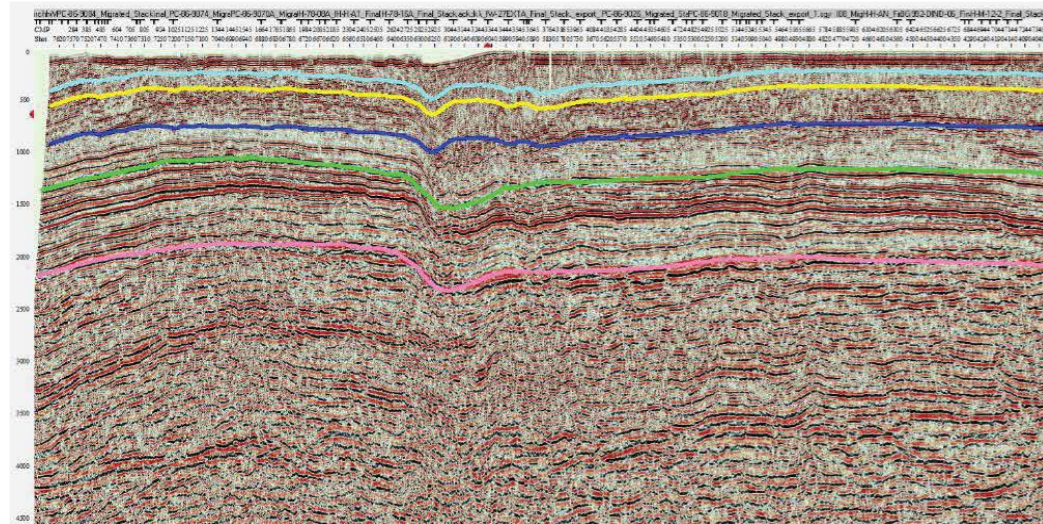
Depth (m) Map



TWT (Sec) Map

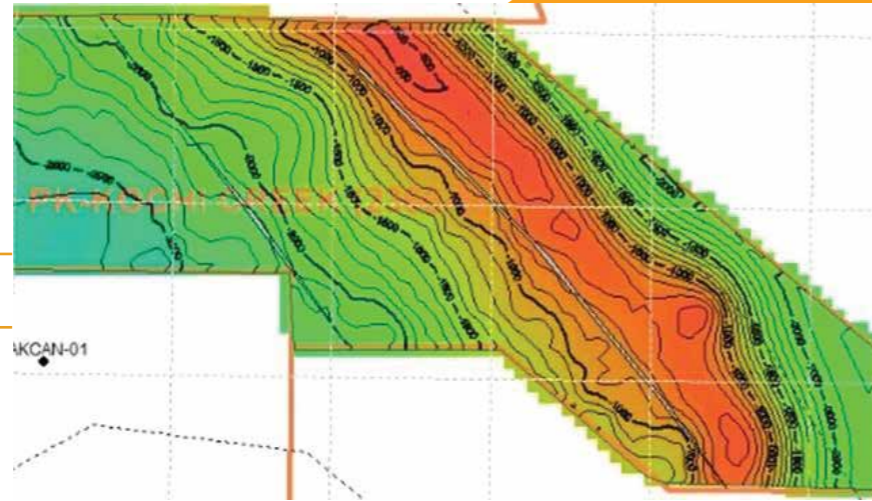
Structural highs / culminations are observed at 0.35-0.65 sec and -830-(-438.77) mTVDSS

BLOCK POTENTIAL



- Lower Pliocene
- Late Miocene
- Middle Miocene
- Base Miocene
- Early Miocene

LEAD NAME	A
Reservoir Age	Miocene
Water Depth	120m
Target Depth	1300 m
Area	100 Sq. Km Mean Value
Net Thickness	10m Mean Case
OGIP (Mean)	~2100 Bcf



Risks

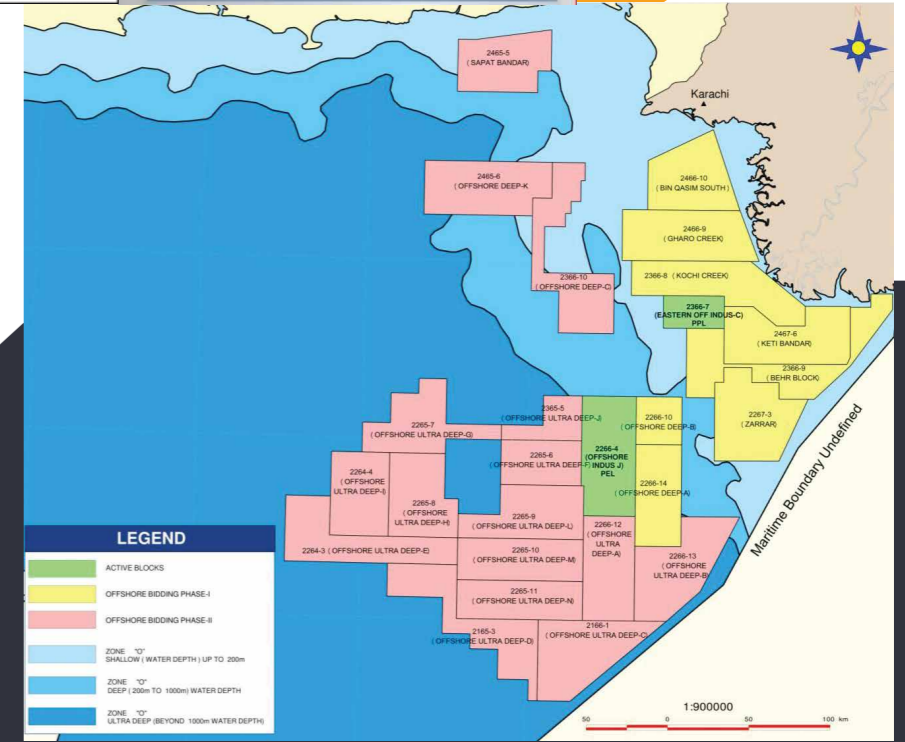
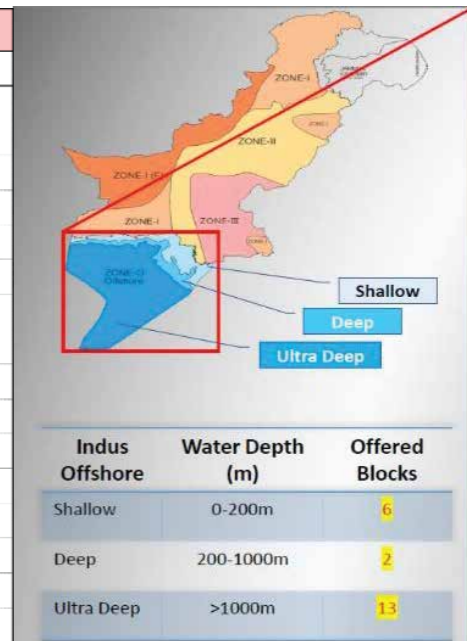
- Source & charge: low risk
- Reservoir: low to medium risk
- Seal: low to medium risk
- Trap: low to medium risk

OPPORTUNITIES

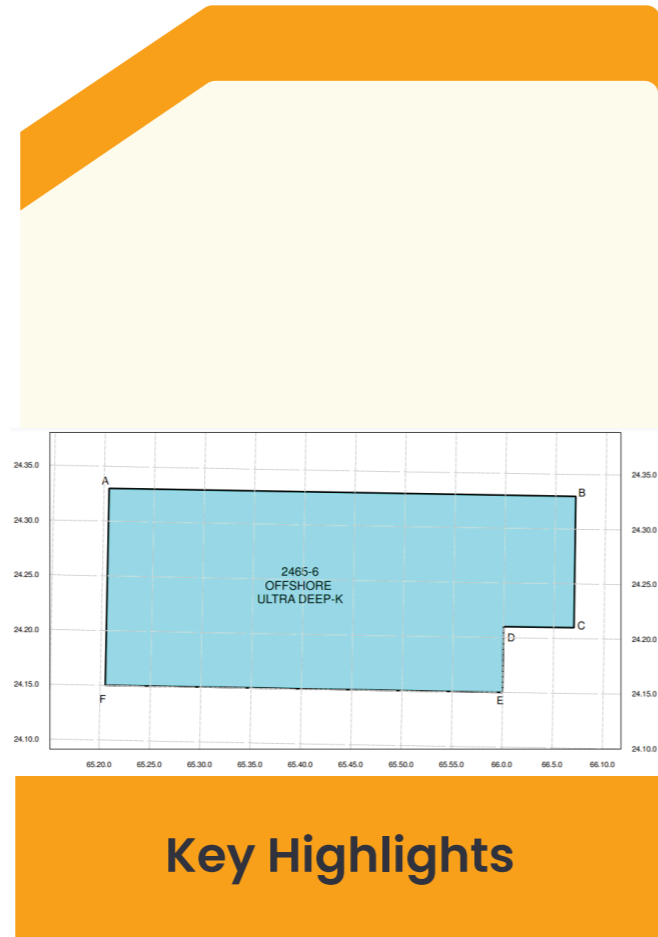
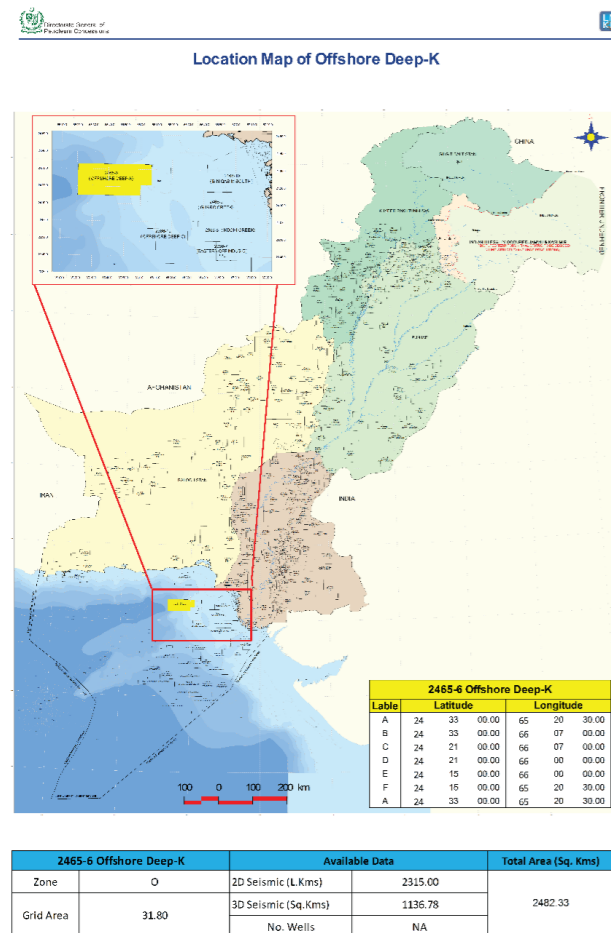
- Pakistan Offshore basin is divided into two major basins with multiple plays.
- Indus Offshore is the largest and least-explored basin with estimated Resource potential of 10-40 TCF.
- Indus Offshore has a working petroleum system proven by noncommercial flow of 3.7 MMcfd at Pakcan-01.
- Majority is Gas play with Possibility of oil play in the eastern periphery

INDUS OFFSHORE BLOCK DEEP K (2465-6)

Offshore Bidding Phase-II			
S. No.	Blocks	Area Sq.Kms	Grid Area
1	2266-12 Offshore Ultra Deep-A	2055.49	25.87
2	2266-13 Offshore Ultra Deep-B	2451.61	30.85
3	2166-1 Offshore Ultra Deep-C	2475.04	31.01
4	2165-3 Offshore Ultra Deep- D	2444.86	30.63
5	2264-3 Offshore Ultra Deep- E	2429.76	30.44
6	2265-6 Offshore Ultra Deep- F	1373.56	17.36
7	2265-7 Offshore Ultra Deep-G	2048.36	26.00
8	2265-8 Offshore Ultra Deep-H	1976.92	24.98
9	2264-4 Offshore Ultra Deep-I	1859.69	23.50
10	2365-5 Offshore Ultra Deep-J	900.36	11.40
11	2465-6 Offshore Deep-K	2482.33	31.80
12	2366-10 Offshore Deep -C	2482.83	31.69
13	2265-9 Offshore Ultra Deep-L	2087.59	27.83
14	2265-10 Offshore Ultra Deep-M	1999.10	26.65
15	2265-11 Offshore Ultra Deep-N	1860.21	24.80
16	2465-5 Sapat Bandar	1894.66	24.49



OFFSHORE DEEP K (2465-6) INTRODUCTION



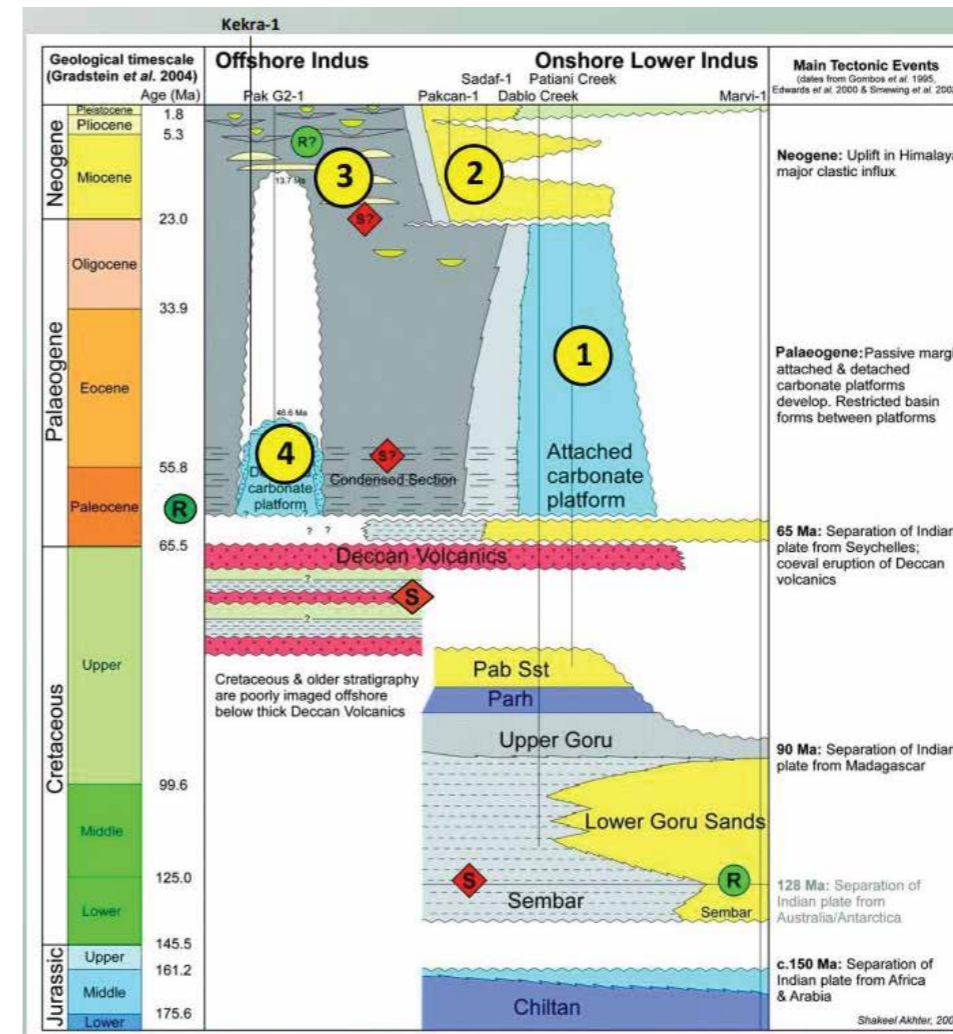
Area: 2482.33 Sq. Kms.

Geological Basin: Offshore Indus Basin Pakistan.

Prospectivity Zone: O
Offshore Deep C (South) block.

Vicinity wells: Indus Marine-1C and Indus Marine-1D.
Results from Indus Marine 1C indicate a mature source (medium to light oil); modern well control can overcome the high formation pressures in Eocene reservoir.

STRATIGRAPHY & PETROLEUM SYSTEM



Seal Pairs

Miocene deltaic sands act as reservoir

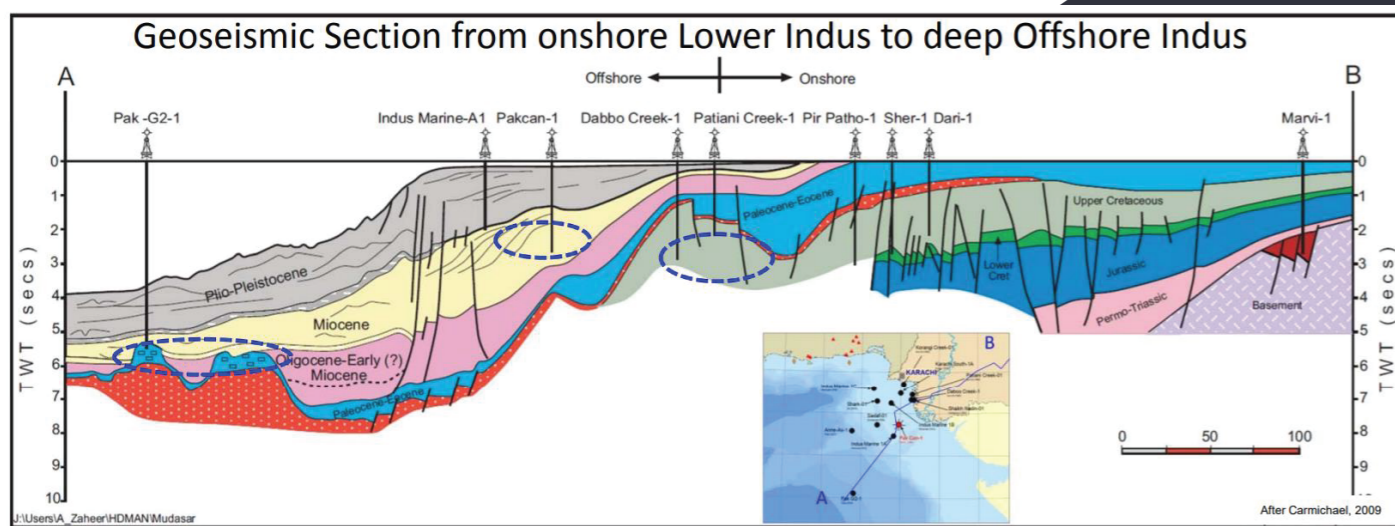
The mud-clay dominated sediments and intraformational shales packages of Miocene act as seals.

Eocene Carbonates overlain by clay are also perspective reservoirs

Trap Geometries

Rollovers / Growth fault related anticlines, pinchouts along with deeper carbonate structures

GEOSEISMIC SECTION DEEP OFFSHORE

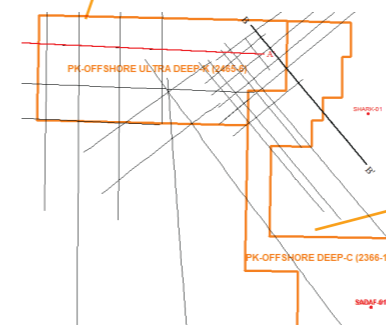
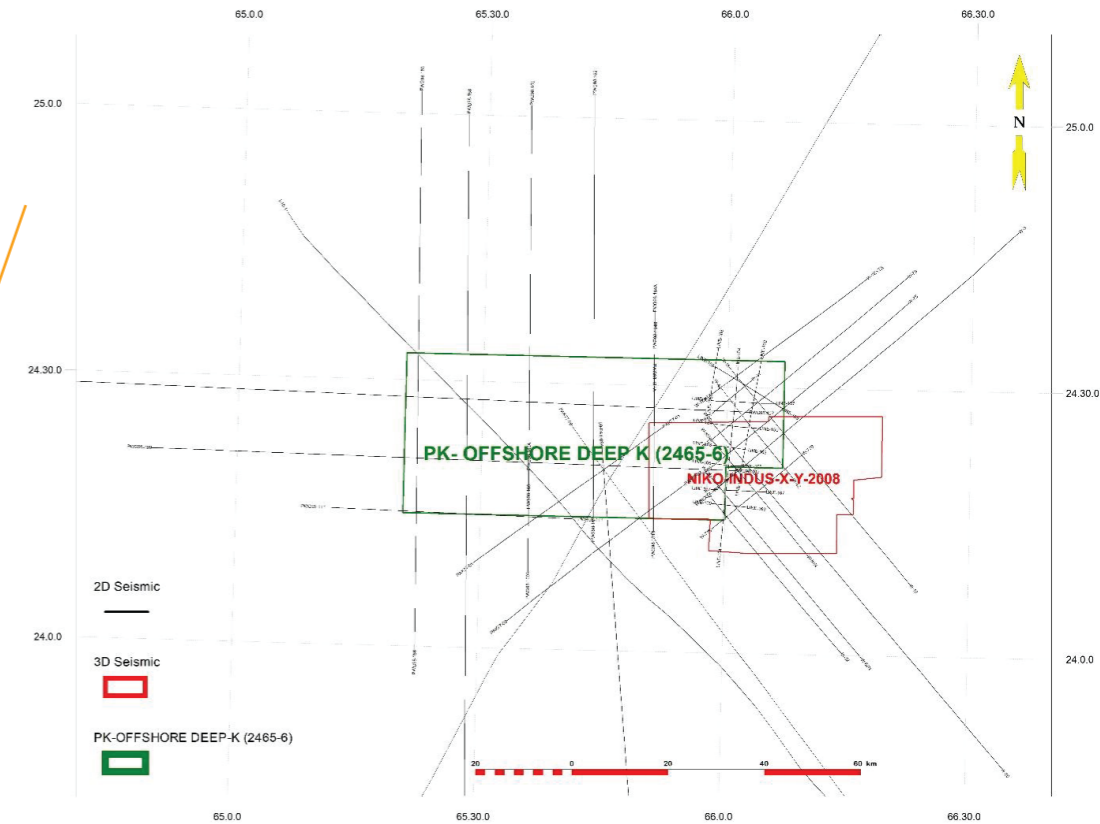


Play Types: Carbonate Buildups

Tested by 1 well (Indus Marine-1C).

Mechanical Failure prevented reaching target.

GEOSEISMIC SECTION DEEP OFFSHORE



Seismic Data

2315 2D (L. Km's)

1136.78 3D (Sq.Km's)

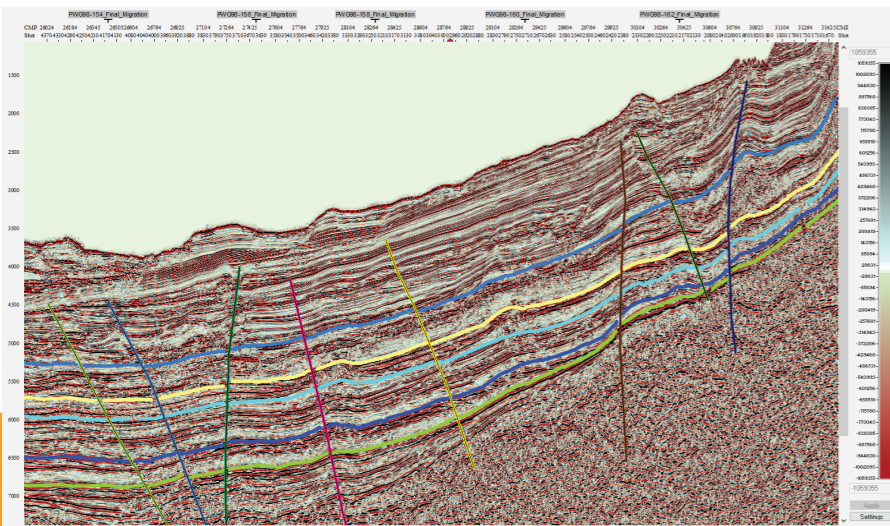
Wells

No well

Indus Marine-1C and
Indus Marine-1D

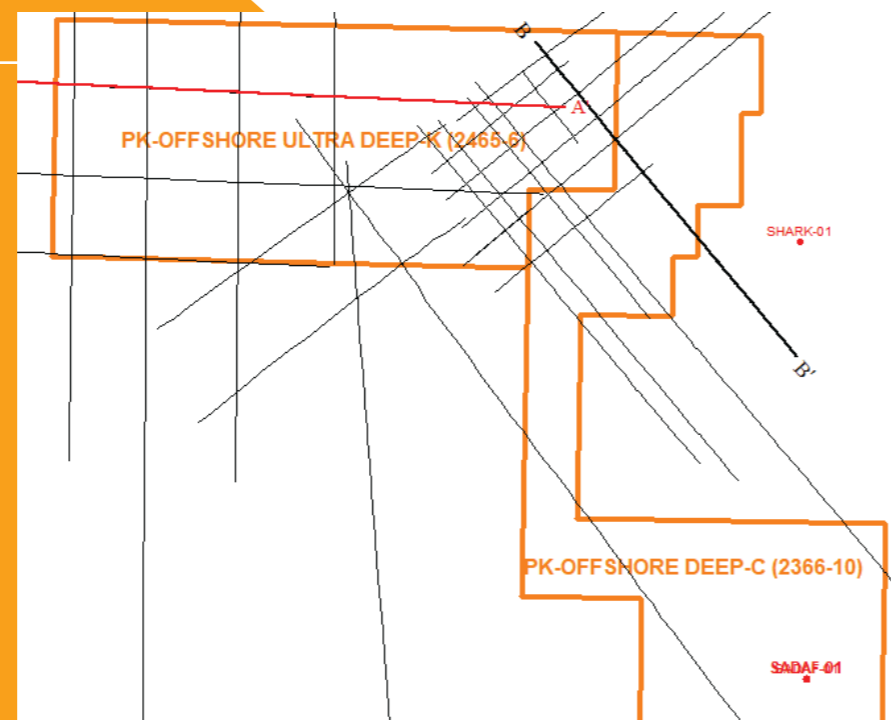
drilled in adjacent block

INTERPRETED SEISMIC SECTION

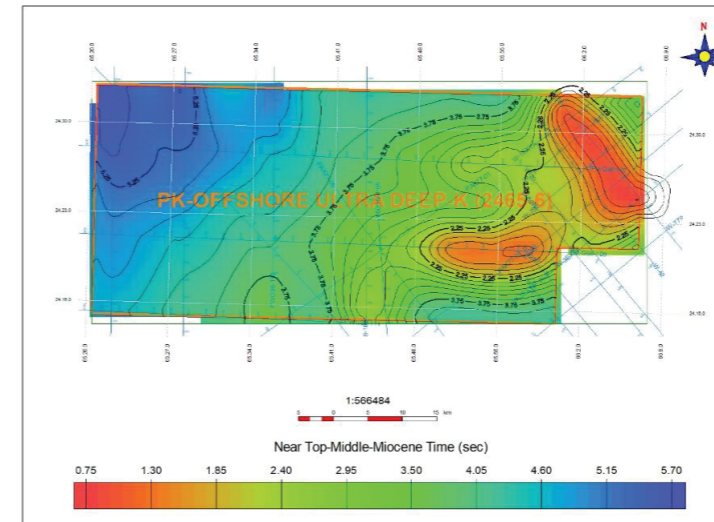


- Intra-Tartonian
- Near Top Miocene
- Near Base Middle Miocene
- Intra Middle Miocene I
- Intra Middle Miocene II

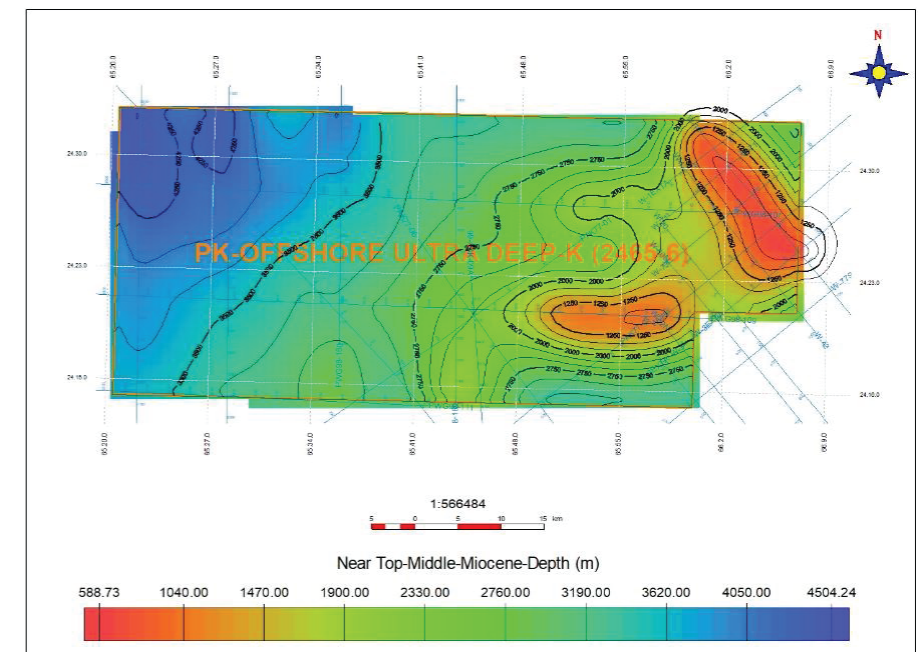
Fault block and rollover against growth faults in shelf margin basin. Pinch outs are also observed.



INTERPRETED SEISMIC SECTION



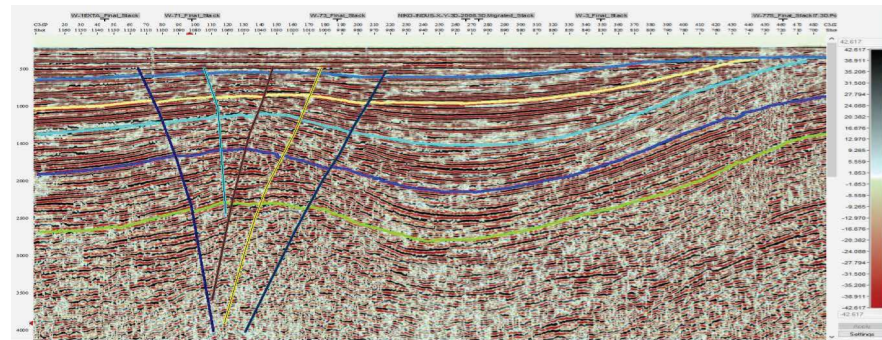
TWT (Sec) Map



Depth (m) Map

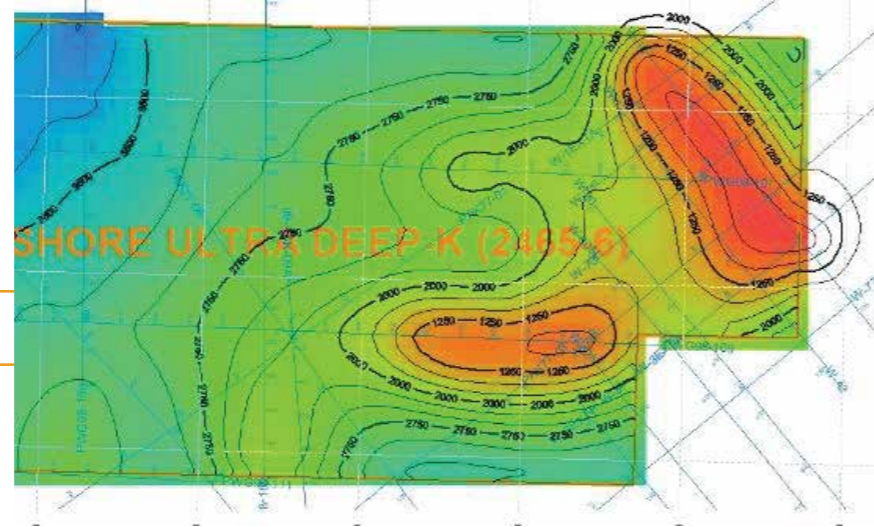
Structural highs / culminations are observed at 588.73-1040 mTVDSS

BLOCK POTENTIAL



- Intra-Tortonian
- Near Top Miocene
- Near Base Middle Miocene
- Intra Middle Miocene I
- Intra Middle Miocene II

LEAD NAME	A
Reservoir Age	Miocene
Water Depth	200-800m
Target Depth	1250 m
Area	90.58 SqKm Mean Value
Net Thickness	10m Mean Case
GIIP (Mean)	1800.16 Bcf



Risks

Source & charge: medium to high risk

- Reservoir: low to medium risk
- Seal: low to medium risk
- Trap: low to medium risk

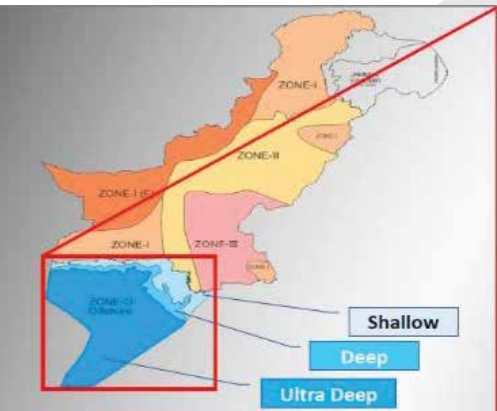
OPPORTUNITIES

Pakistan Offshore basins is divided into two major Basins (Indus & Makran) with multiple plays.

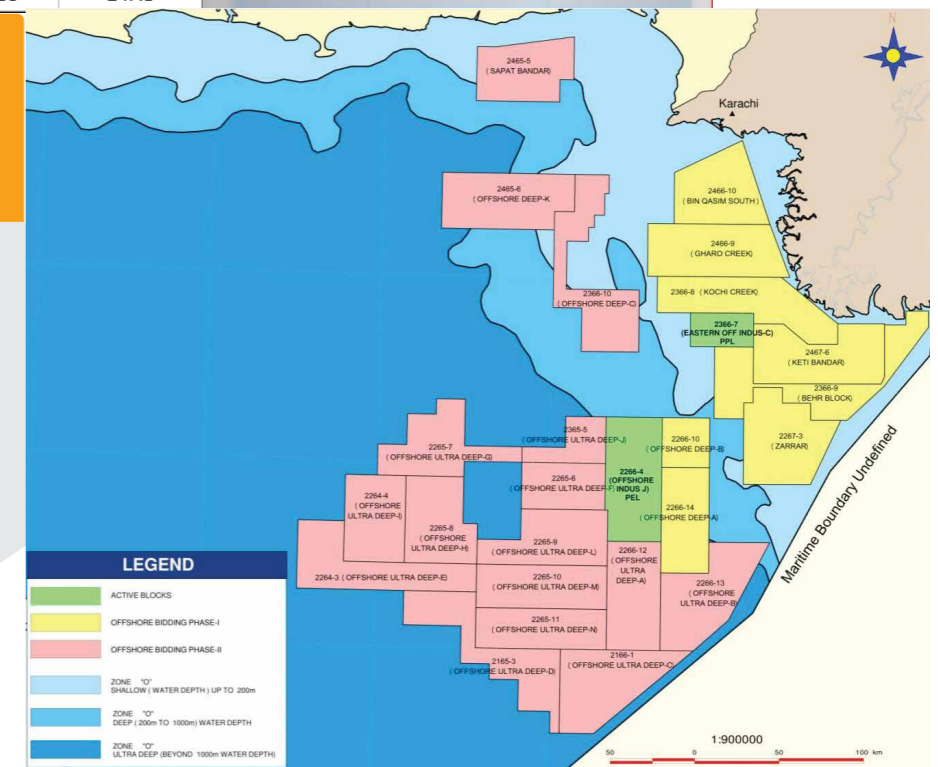
- Indus Offshore is the largest and least-explored basin with estimated Resource potential of 10-40 TCF.
- Indus Offshore has a working petroleum system proven by noncommercial flow of 3.7 MMcfd a Pakcan-01.
- Majority is Gas play with Possibility of oil play in the eastern periphery

INDUS OFFSHORE BLOCK ULTRA DEEP C (2166-1)

Offshore Bidding Phase-II			
S. No.	Blocks	Area Sq.Kms	Grid Area
1	2266-12 Offshore Ultra Deep-A	2055.49	25.87
2	2266-13 Offshore Ultra Deep-B	2451.61	30.85
3	2166-1 Offshore Ultra Deep-C	2475.04	31.01
4	2165-3 Offshore Ultra Deep- D	2444.86	30.63
5	2264-3 Offshore Ultra Deep- E	2429.76	30.44
6	2265-6 Offshore Ultra Deep- F	1373.56	17.36
7	2265-7 Offshore Ultra Deep-G	2048.36	26.00
8	2265-8 Offshore Ultra Deep-H	1976.92	24.98
9	2264-4 Offshore Ultra Deep-I	1859.69	23.50
10	2365-5 Offshore Ultra Deep-J	900.36	11.40
11	2465-6 Offshore Deep-K	2482.33	31.80
12	2366-10 Offshore Deep -C	2482.83	31.69
13	2265-9 Offshore Ultra Deep-L	2087.59	27.83
14	2265-10 Offshore Ultra Deep-M	1999.10	26.65
15	2265-11 Offshore Ultra Deep-N	1860.21	24.80
16	2465-5 Sapat Bandar	1894.66	24.49



Indus Offshore	Water Depth (m)	Offered Blocks
Shallow	0-200m	6
Deep	200-1000m	2
Ultra Deep	>1000m	13

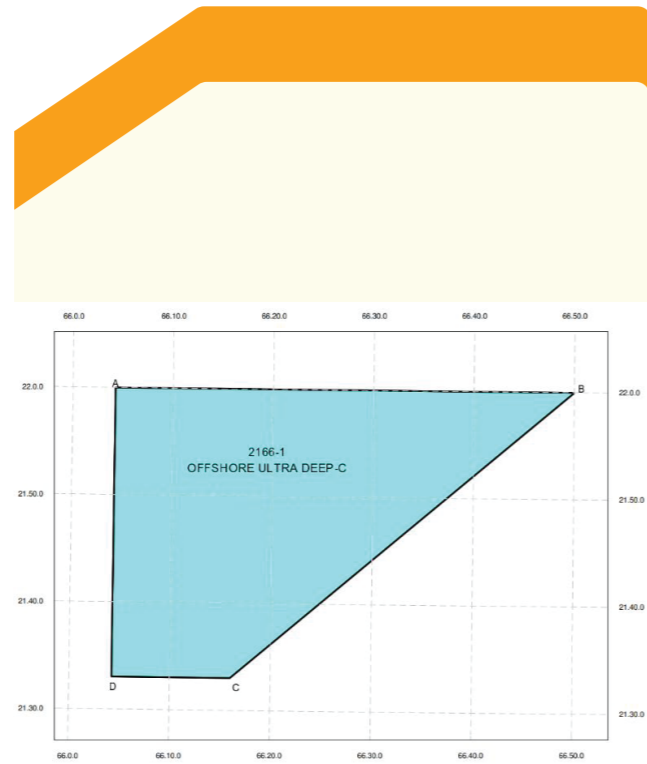
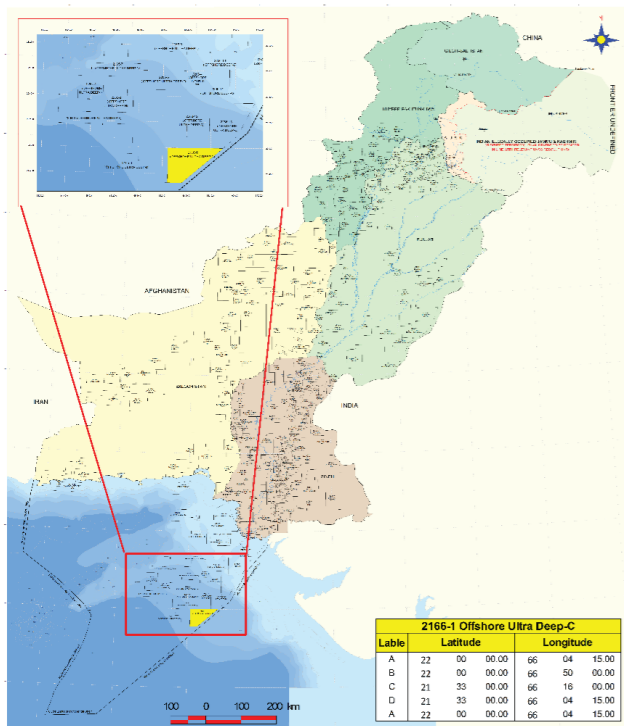


LEGEND	
[Green Box]	ACTIVE BLOCKS
[Yellow Box]	OFFSHORE BIDDING PHASE-I
[Red Box]	OFFSHORE BIDDING PHASE-II
[Light Blue Box]	ZONE '0' SHALLOW (WATER DEPTH) UP TO 200m
[Medium Blue Box]	ZONE '0' DEEP (200m TO 1000m) WATER DEPTH
[Dark Blue Box]	ZONE '0' ULTRA DEEP (BEYOND 1000m WATER DEPTH)

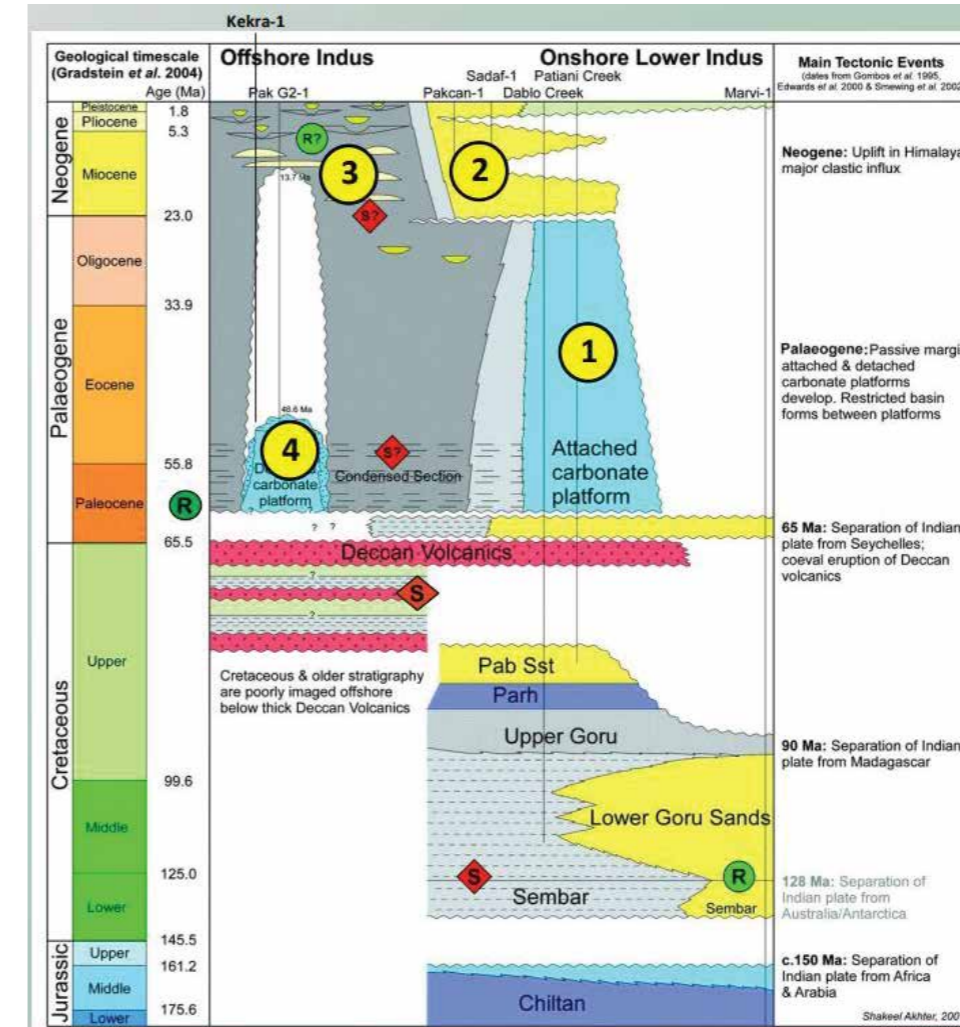
OFFSHORE ULTRA DEEP C (2166-1) INTRODUCTION

STRATIGRPHY & PETROLEUM SYSTEM

Location Map of Offshore Ultra Deep-C



Key Highlights



Source Rock
Paleocene section with TOC ranging from 1-3%.

Reservoir Seal Pairs

The intraformational shales packages of Miocene.
Oligocene may act as seal for potential reservoirs.

Trap Geometries

Carbonate platforms and reefs deposits (Oligocene, Paleocene Carbonate platform)

Area: 2475.04Sq. Kms.

Geological Basin: Offshore Indus Basin Pakistan.

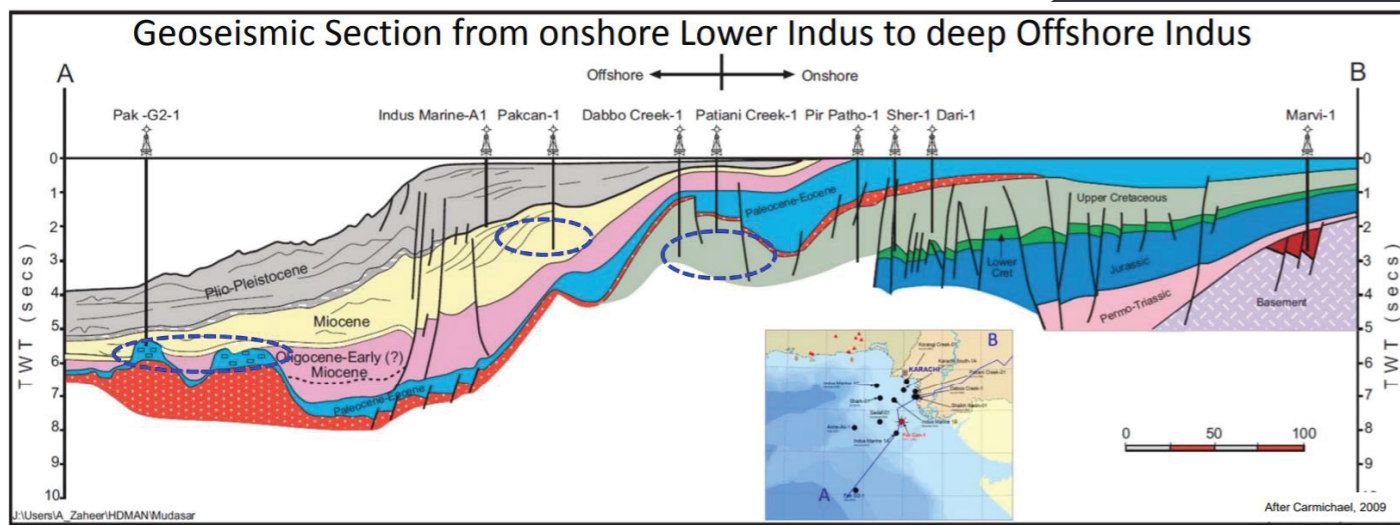
Prospectivity Zone: O

Offshore Ultra Deep A (North) and Offshore Ultra Deep D(West) blocks

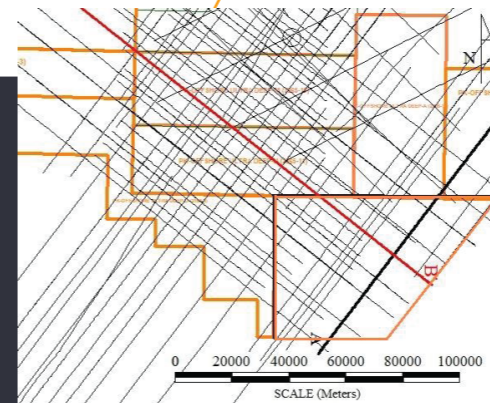
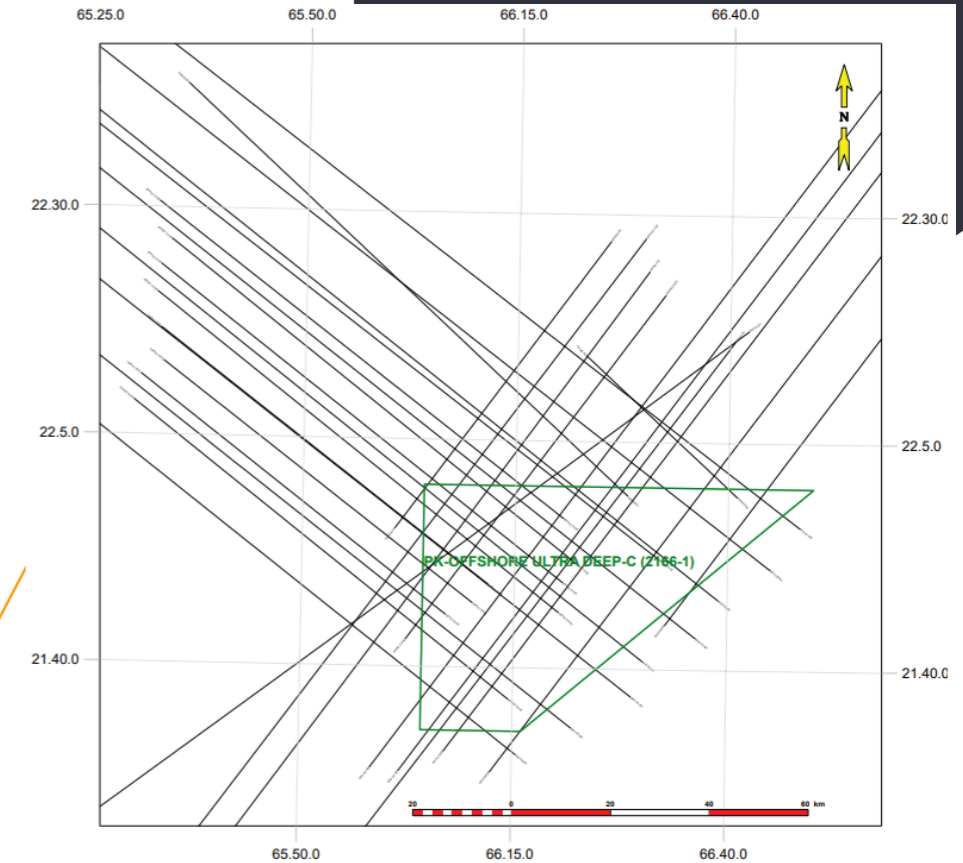
Vicinity wells: akG2-01 and Kekra-01.

PakG2-01 primary target tertiary carbonate. Lack of charge (Gong et al., 2020).
Kekra-01 reached TD Formation i.e., Paleogene Carbonate. Good reservoir but a lack of charge hampered further development (Gong et al., 2020).

GEOSEISMIC SECTION ULTRA DEEP OFFSHORE



AVAILABLE DATASETS



Play Types: Deep water
Carbonate buildup and
turbidities

Drilled in Pak G2-1 & Kekra, excellent reservoirs
but lack of charge

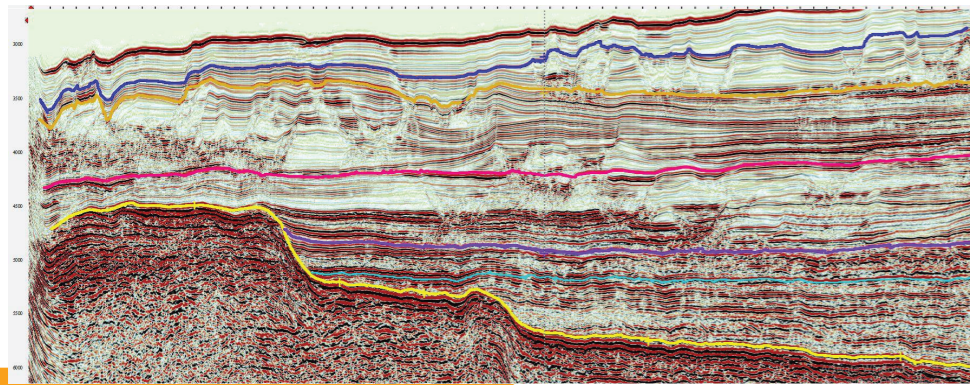
Seismic Data

**5396.58 2D (L. Km's)
No 3D**

Wells

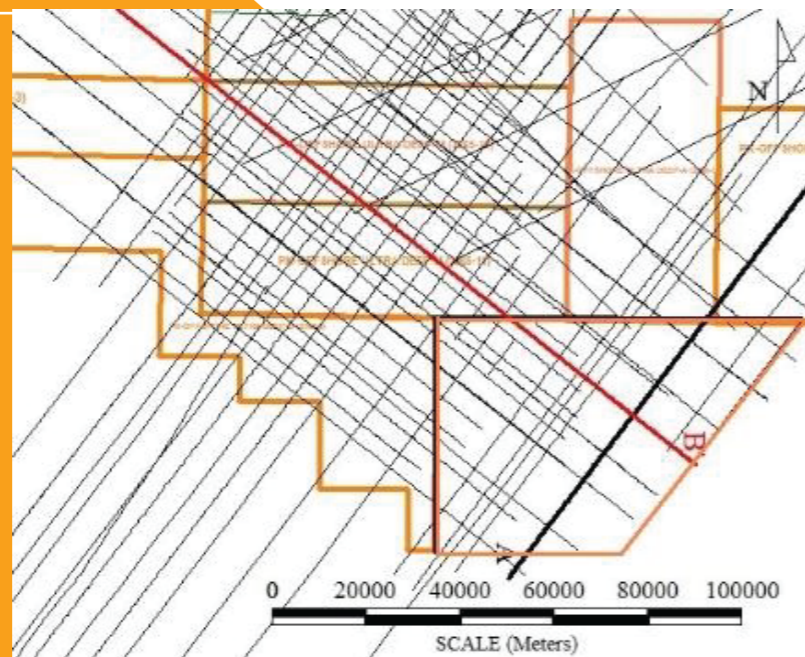
**No well
PakG2-01 and Kekra-01 drilled
in adjacent block**

INTERPRETED SEISMIC SECTION

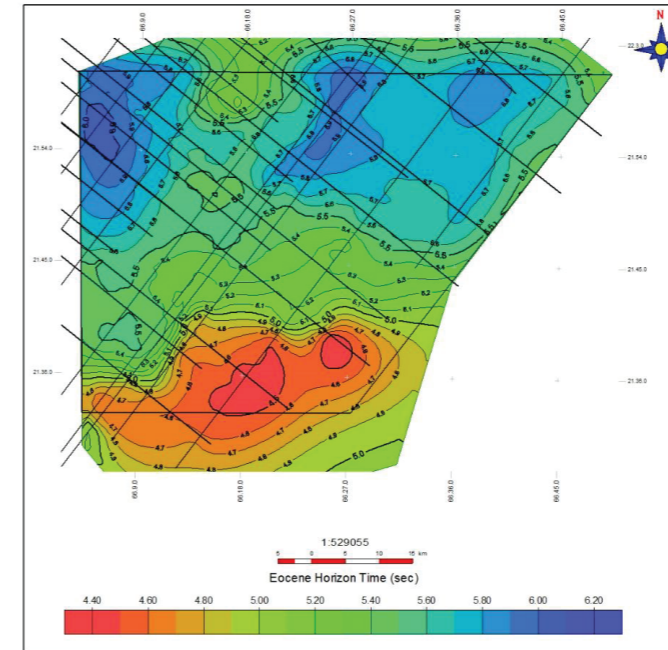


- Intra-Tartonian
- Near Top Miocene
- Pinch out
- Intra Middle Miocene
- Pinch out
- Eocene

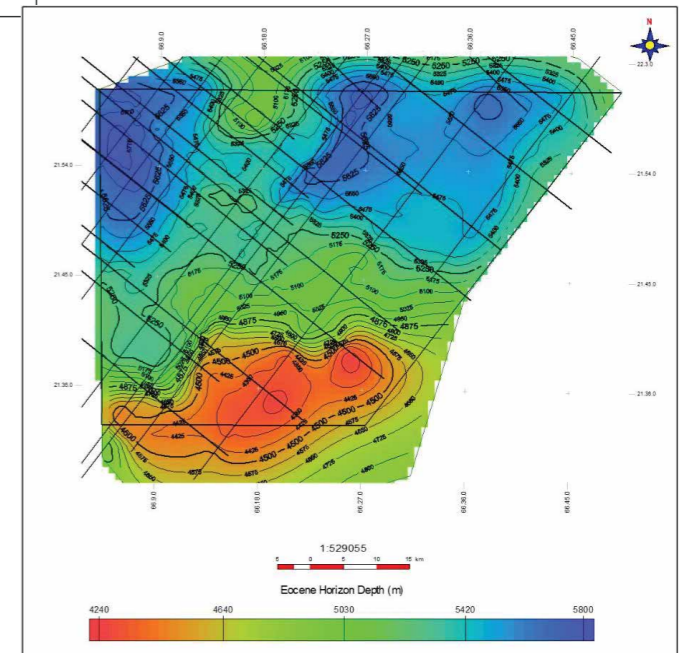
Carbonate platforms and reefs deposits
Pinch outs are also observed.



EOCENE MAPS



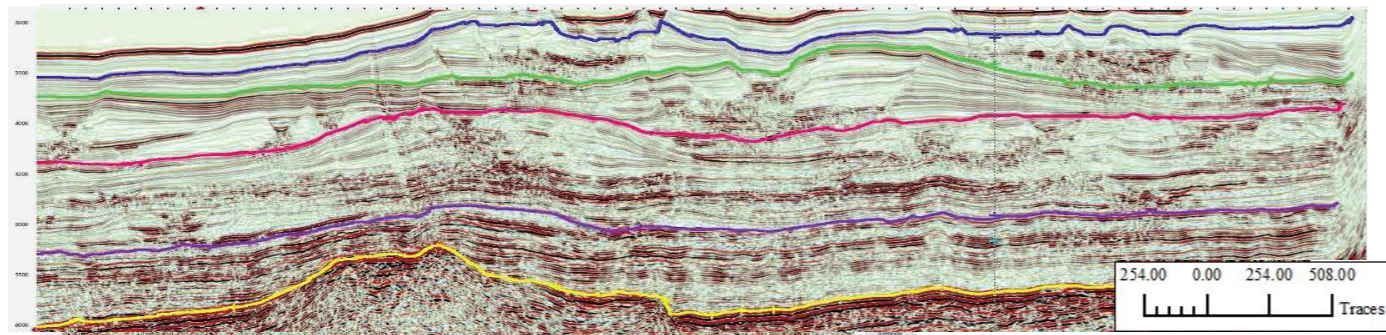
TWT (Sec) Map



Depth (m) Map

Structural highs / culminations are observed
at 4300-4500 mTVDSS.

BLOCK POTENTIAL



LEAD NAME	A
Reservoir Age	Eocene
Water Depth	1900-2500m
Target Depth	4500 m
Area	290 Sq.Km Mean Value
Net Thickness	10m Mean Case
GIIP (Mean)	2500 BCF

- Intra-Tortonian
- Near Top Miocene
- Eocene
- Intra Middle Miocene
- Lower Miocene

Risks

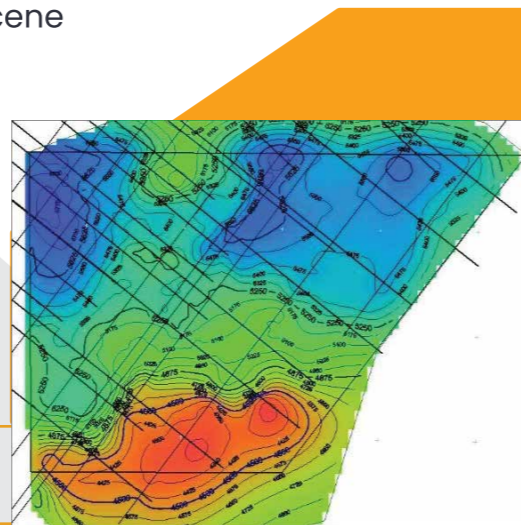
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