सत्यमेव जयते
Ministry of Petroleum & Natural Gas
Government of India

DGH

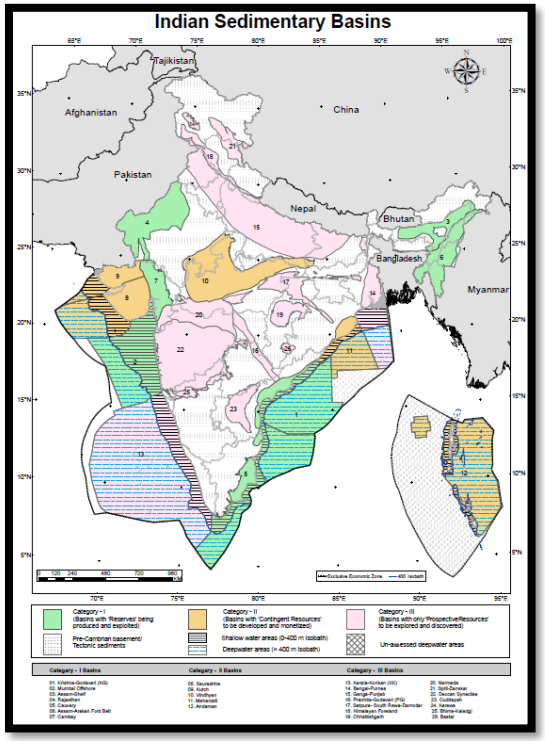
Overview of Indian Sedimentary Basins and Blocks-on-Offer (under OALP II)

Presentation outline

- Indian Sedimentary Basins
- Hydrocarbon Resource Reassessment Study
- Contract Areas-on-Offer
- Summary

Indian Sedimentary Basins

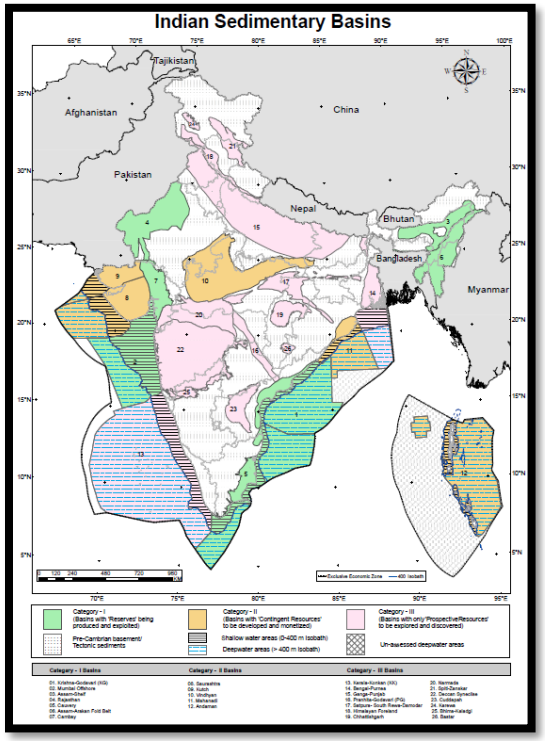
Basin category



- **A new 3-tier category for 26 basins**
- A simplified approach to present the Category based on the instances of **'discovery'** and **'commerciality'**, closely in line with PRMS ideology
- **Category I**: 7 basins which are commercially producing from established petroleum resources ("**RESERVES**")
- **Category II**: 5 basins which have established petroleum resources but are yet to produce commercially ("**CONTINGENT RESOURCES**")
- **Category III**: 14 basins which have prognosticated resources but still to be discovered ("**PROSPECTIVE RESOURCES**")

Indian Sedimentary Basins

Basins under category



Category I

- Krishna-Godavari(KG), Mumbai Offshore, Assam Shelf, Rajasthan, Cauvery, Assam-Arakan Fold Belt and Cambay

RESERVES | CONTINGENT | PROSPECTIVE

Category II

- Saurashtra, Kutch, Vindhyan, Mahanadi and Andaman

CONTINGENT RESOURCES | PROSPECTIVE RESOURCES

Category III

- Kerala-Konkan, Bengal-Purnea, Ganga-Punjab, Pranhita-Godavari(PG), Satpura-South Rewa-Damodar, Himalyan Foreland, Chattisgarh, Narmada, Spiti-Zanskar, Deccan Syneclise, Cuddapah, Karewa, Bhima-Kaladgi, and Bastar

PROSPECTIVE RESOURCES

Hydrocarbon Resource Reassessment Study

Overview of the study

- During 2017, hydrocarbon resource reassessment study was carried out for all 26 basins
- **Assessment done for conventional reservoirs only**
- Reviewed by international domain-experts and Indian basin-experts
- Assessed 13 basins with adequate datasets through “Petroleum System Modeling”
  - 9 basins (Assam Shelf, Cambay, Rajasthan, Mumbai, Krishna-Godavari, Cauvery, Mahanadi, Bengal-Purnea and Kerala-Konkan) : entire area
  - 4 basins (Assam Arakan, Andaman, Kutch and Saurashtra) : part area
- **Identified a total of 177 Plays**
  - 87 in Tertiary, 53 in Mesozoic and 37 Pre-Mesozoic
- **Indentified new plays**
  - Mesozoic reservoirs in 14 basins
  - Basement fractures in many new discoveries

Hydrocarbon Resource Reassessment Study

Results of the study

- Last assessment done in 1995-96 for 15 sedimentary basins :
  - Inplace assessed: 28,085 MMTOE (210 BBBLOE)
- Current assessment done across Onland, Shallow Water and Deep Water
  - Inplace Reassessed: 41,872 MMTOE (315 BBBLOE)
    - **Discovered: 12,076 MMTOE (85 BBBLOE)**
    - Undiscovered: 29,796 MMTOE (230 BBBLOE)
- Increase of total hydrocarbon estimate: 49.1%
- Reassessment at hydrocarbon play level
- A complete geoscientific database with easy-to-use subsurface models, maps and reports

Hydrocarbon Resource Reassessment Study

Results Compared

1995-96 study

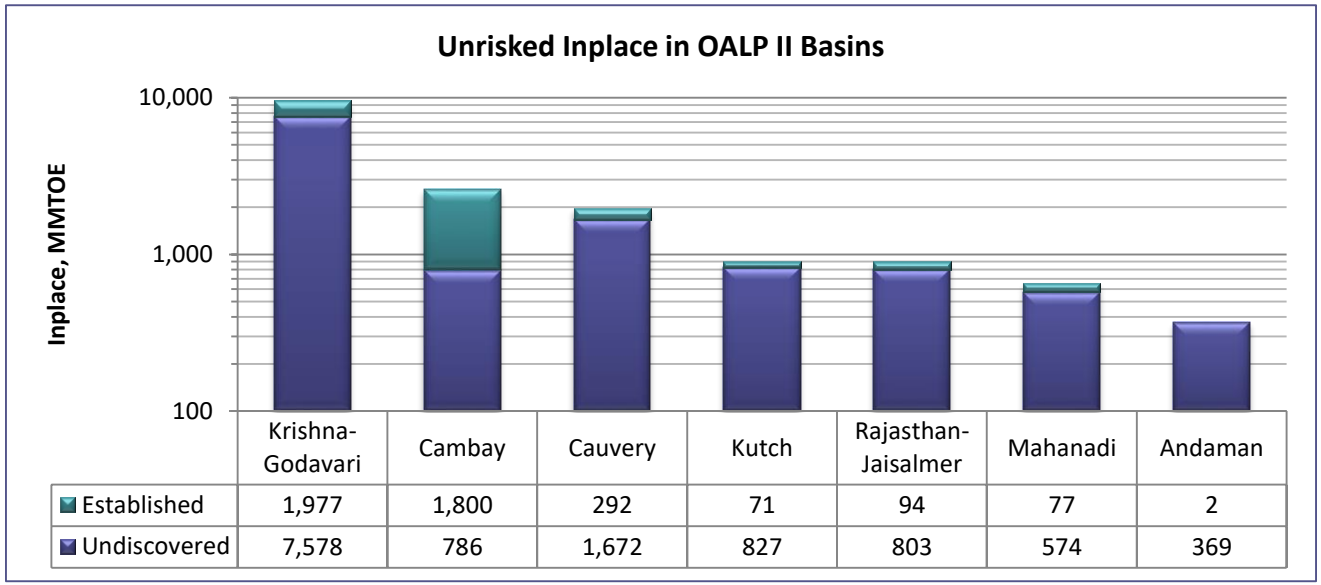
- Carried out for 15 basins
- Areal Yield method used for all basins
- Assessment at basin level
- Deepwater areas excluded and assessed separately
- Limited tools and less data sets

2015-17 study

- All 26 basins re-assessed
- 13 basins/basin areas with good data sets were assessed using improved tools. Rest with Areal Yield
- Assessment at play level
- Deepwater areas included and assessed with basins
- New tools and expanded datasets

Contract Areas-on-Offer

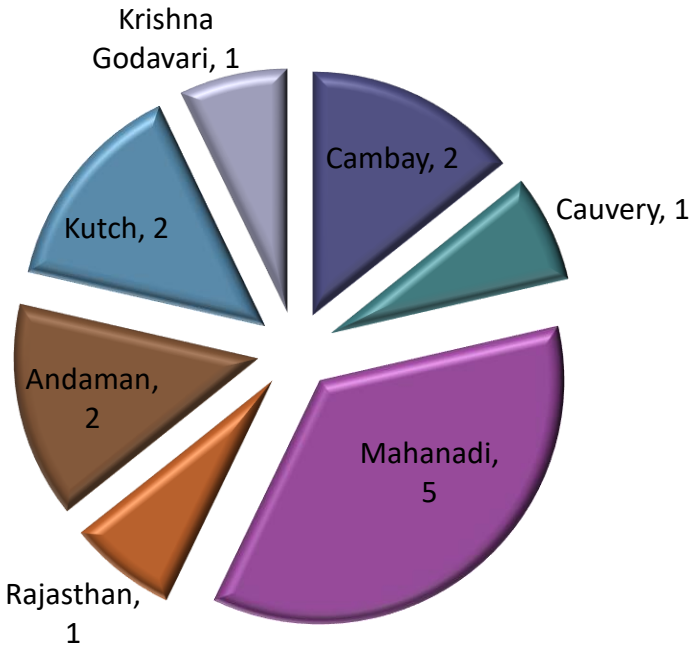
Basin-wise Hydrocarbon Resources



	Krishna-Godavari	Cambay	Cauvery	Kutch	Rajasthan-Jaisalmer	Mahanadi	Andaman
Established	1,977	1,800	292	71	94	77	2
Undiscovered	7,578	786	1,672	827	803	574	369

Contract Areas-on-Offer

OALP Blocks across Basins

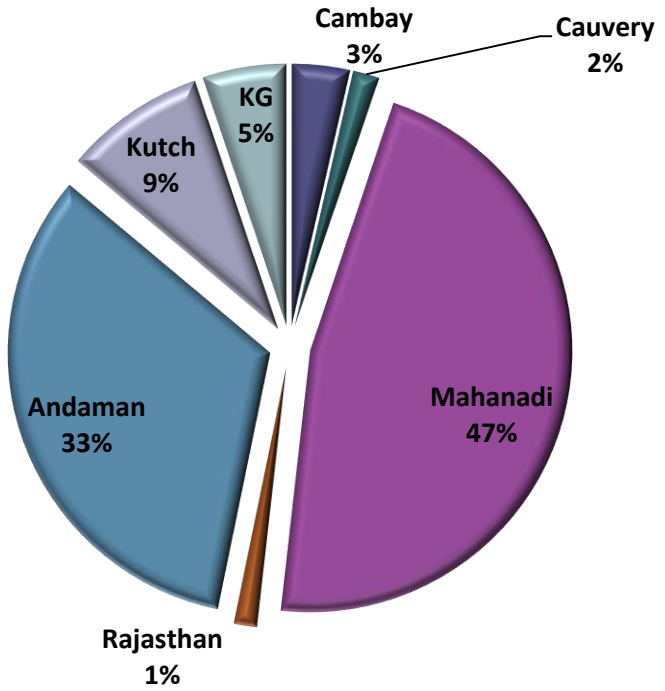


- **Total 14 blocks**
- Distributed into 7 sedimentary basins
- Mahanadi has most number of blocks (5)

- **5 blocks from Category I basins**
- 9 blocks from Category II

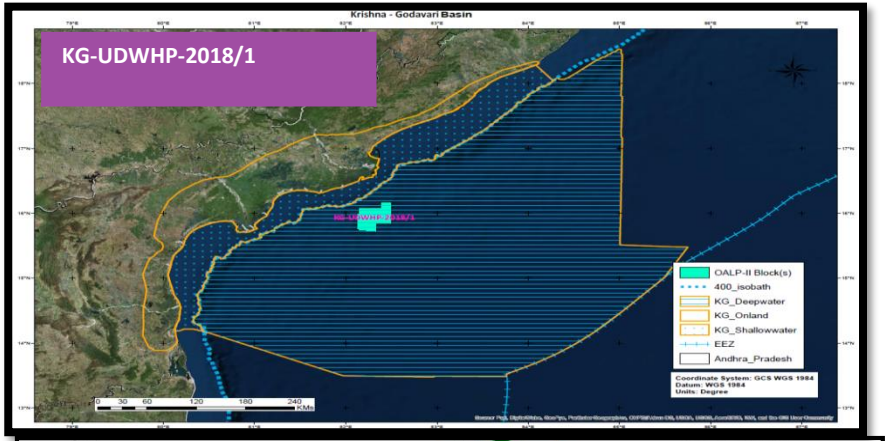
Contract Areas-on-Offer

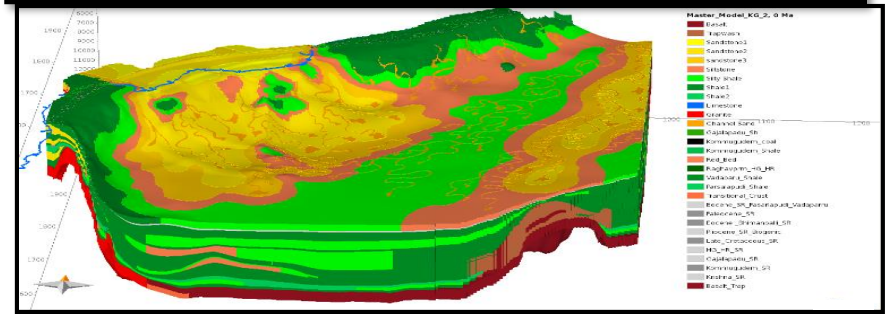
Basin Area across Blocks

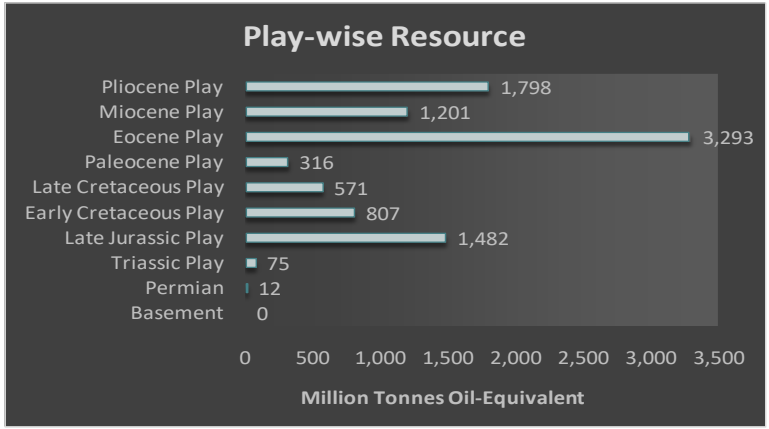


- **Total area 29,233 sq km**
- Mahanadi, Andaman, and Kutch have maximum acreage.
- 8 blocks in Onland (13,733 sq km, 47% of total offering)
- 5 blocks in Shallow Water (13986 sq km, 48%)
- 1 block in Ultra Deep Water (1514 sq km, 5%)

Krishna-Godavari Basin







Prognosticated Resources (In-place MMTOE)		
Discovered	Undiscovered	Total
1,977	**7,578**	9,555

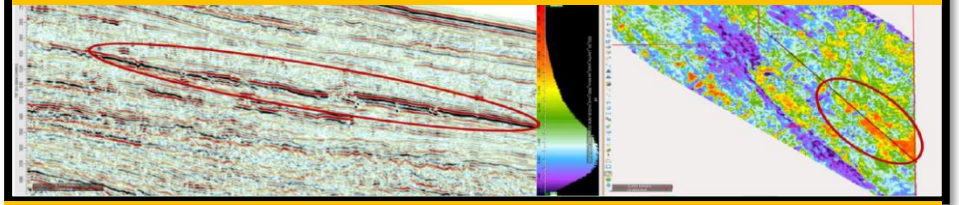
- Total block-on-offer: 1
- Cumulative area: 1,514 sq km

Krishna-Godavari Basin

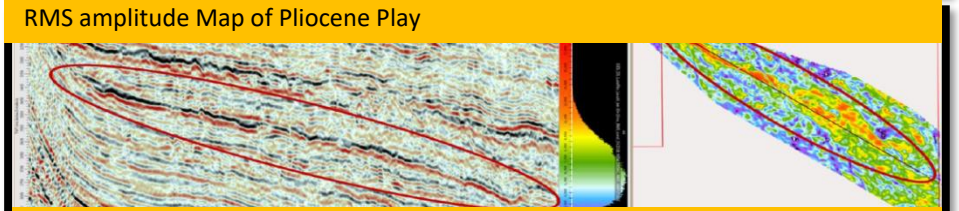
KG-UDWHP-2018/1

- Analogous to discoveries in shallow biogenic and deeper thermogenic plays
- Channelized system within Pleistocene, Pliocene and Miocene plays
- Target Depth: 4800 m.
- Approximate Area 1,514 Sq. Km.
- Datasets: 2D/ 3D seismic, 2 wells

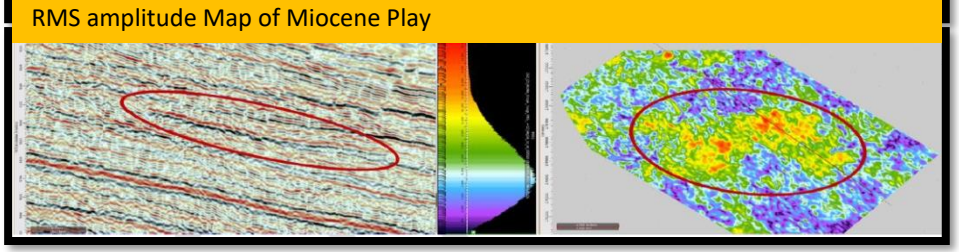
RMS amplitude Map of Pleistocene Play



RMS amplitude Map of Pliocene Play

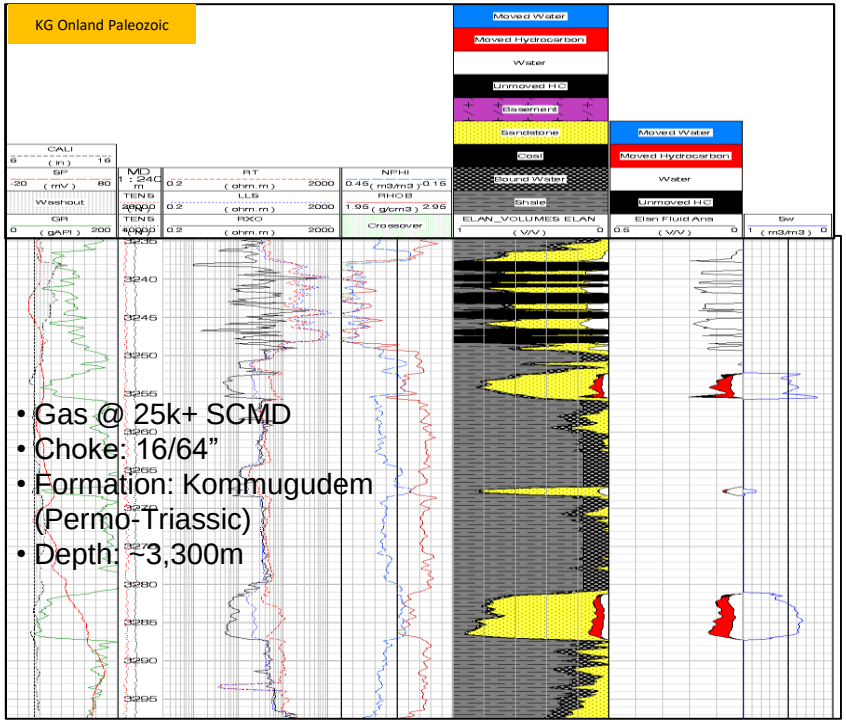


RMS amplitude Map of Miocene Play



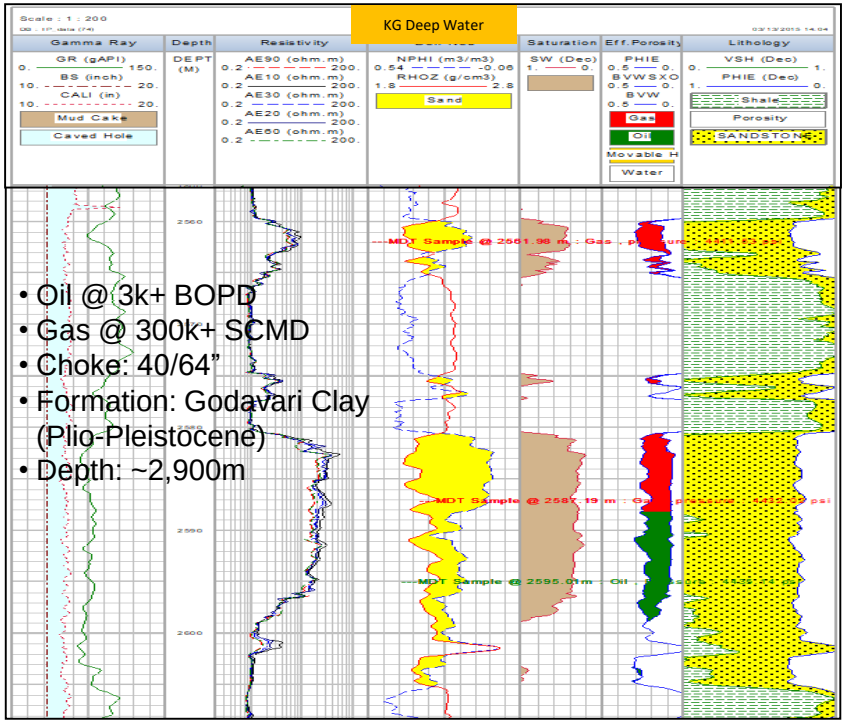
Krishna-Godavari Basin

KG Onland Paleozoic



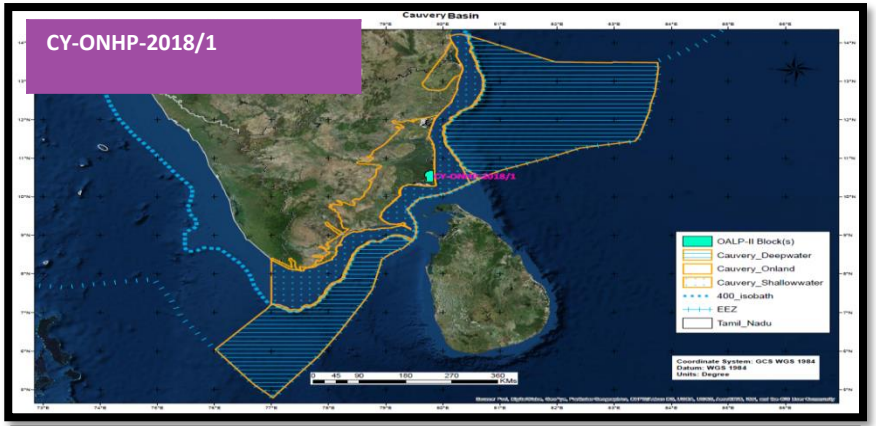
- Gas @ 25k+ SCMD
- Choke: 16/64”
- Formation: Kommugudem (Permo-Triassic)
- Depth: ~3,300m

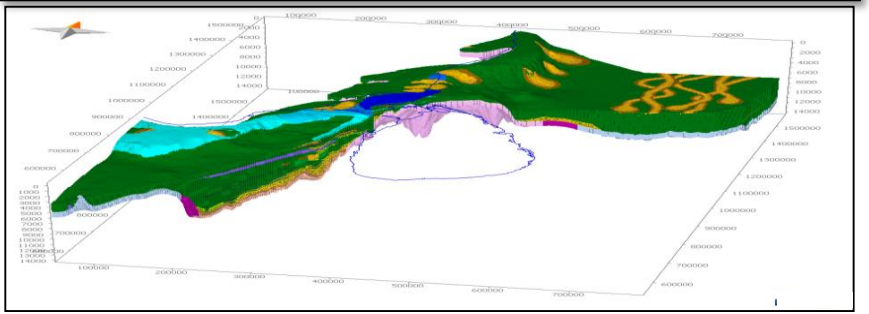
KG Deep Water

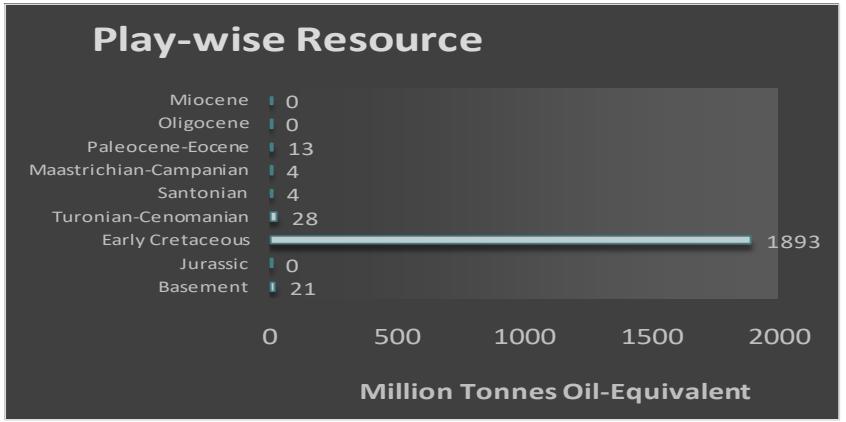


- Oil @ 3k+ BOPD
- Gas @ 300k+ SCMD
- Choke: 40/64”
- Formation: Godavari Clay (Plio-Pleistocene)
- Depth: ~2,900m

Cauvery Basin







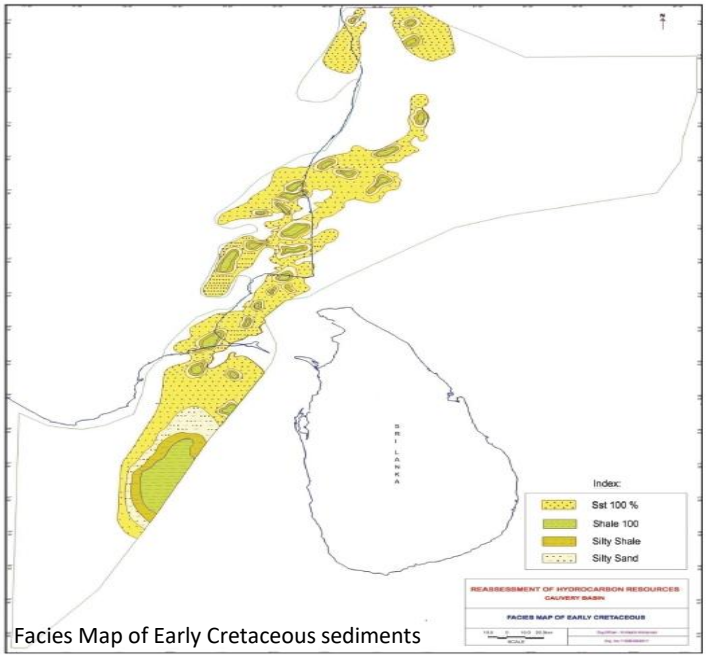
Prognosticated Resources (In-place MMTOE)		
Discovered	Undiscovered	Total
292	**1,672**	1,964

- Total block-on-offer: 1
- Cumulative area: 474 sq km

Cauvery Basin

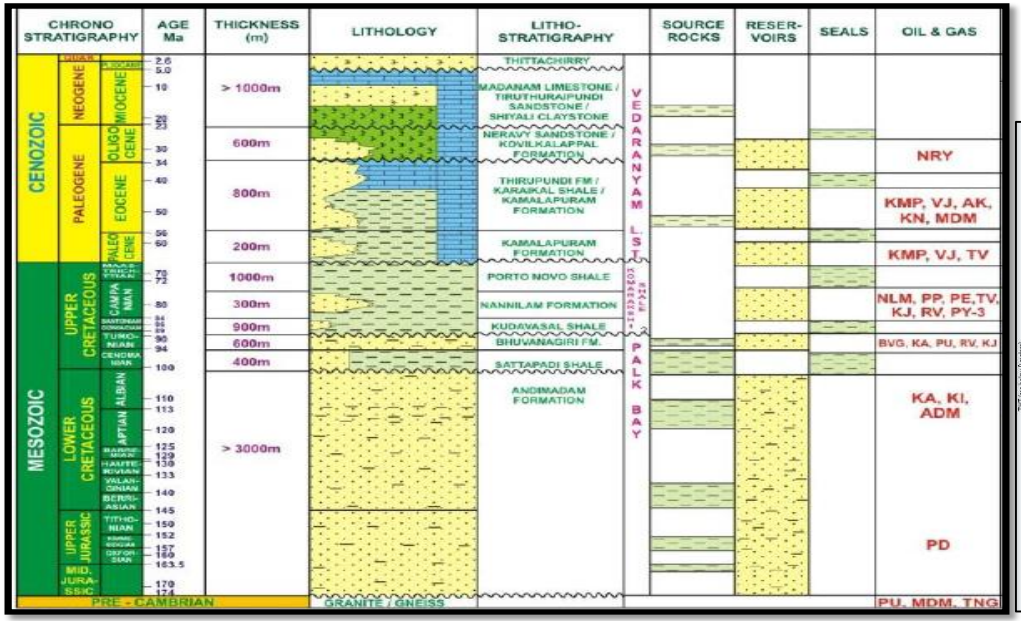
CY-ONHP-2018/1

- Analogous to oil discovery Bhuvanagiri Formation (Upper Cretaceous)
- Plays expected in Basement, Cretaceous, Paleocene
- Basement undrilled, producing in other area
- Target Depth for wells: 2,000 m.
- Area: 474 Sq. Km.
- Datasets: 2D/3D seismic and 4 wells

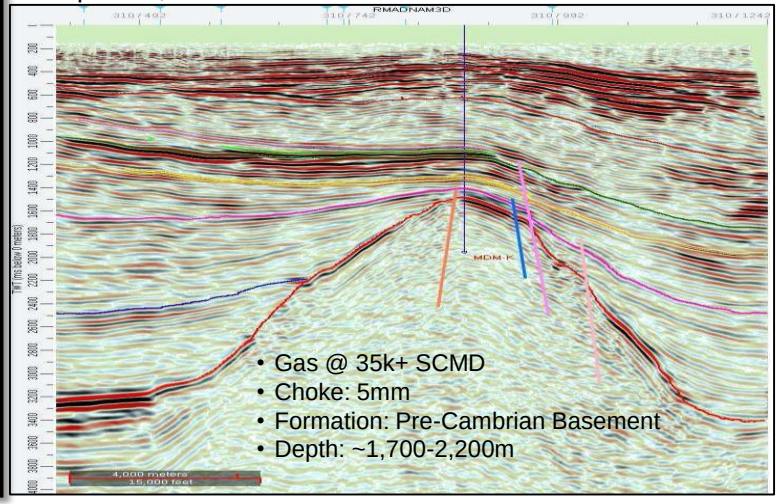


Facies Map of Early Cretaceous sediments

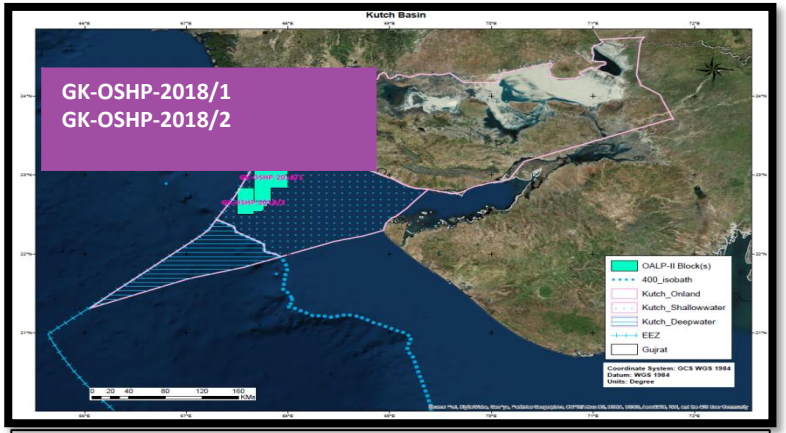
Cauvery Basin

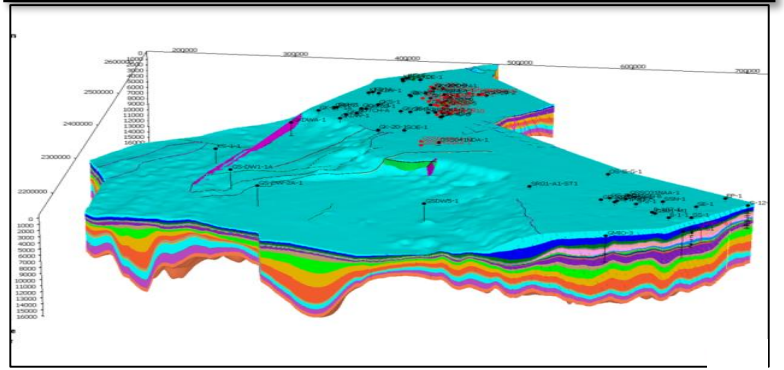


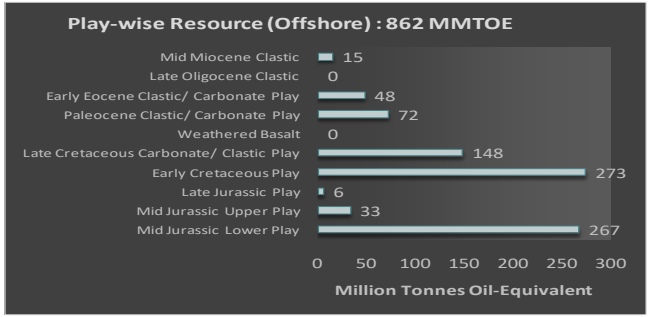
- Gas @ 40k+ SCMD
- Choke: 5mm
- Formation: Kamalapuram (Eocene)
- Depth: ~1,500m

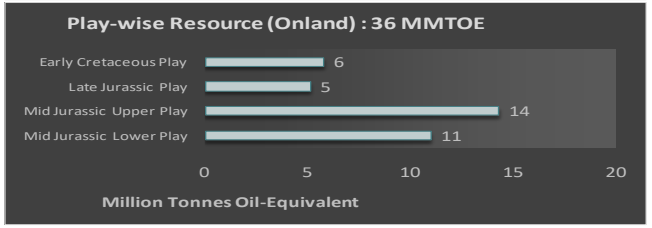


Kutch Basin









Prognosticated Resources (In-place MMTOE)

Discovered	Un-discovered	Total
71	**827**	898

- Total blocks-on-offer: 2
- Cumulative area: 2,544 sq km

Kutch Basin

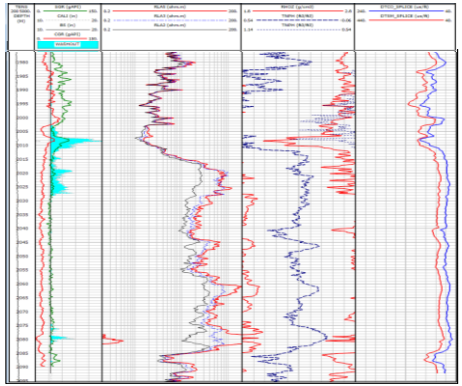
GK-OSHP-2018/1

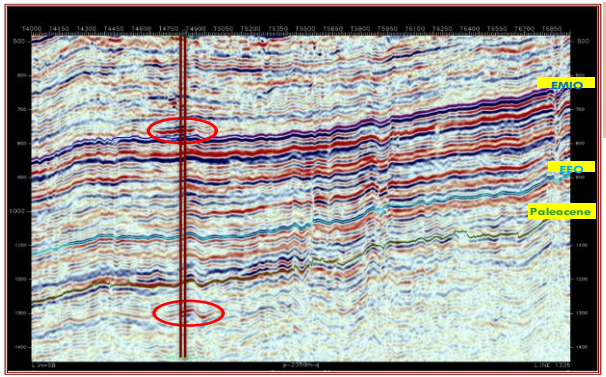
- Close to producing field, KD situated northerly
- Oilgo-Miocene strati-structural plays
- Target Depth for wells: 2,000 m.
- Area 1,732 Sq. Km.
- 2D seismic : Available

GK-OSHP-2018/2

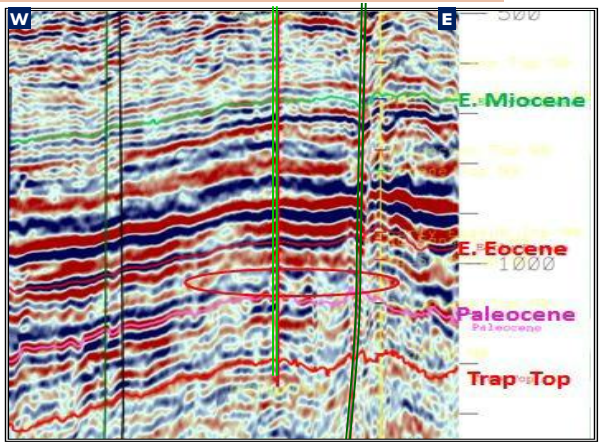
- Close to producing field, KD situated northerly
- Oilgo-Miocene strati-structural plays
- Potential for Mesozoic
- Target Depth for wells: 2,000 m.
- Area 812 Sq. Km.
- 2D seismic : Available

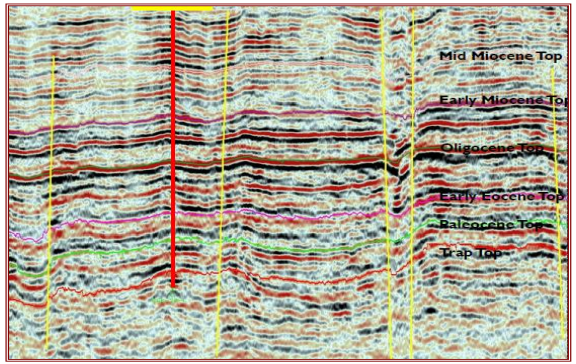
Kutch Basin





- Gas @ 160k+ SCMD
- Choke: 32/64”
- Formation: Chhasra (Mid. Miocene)
- Depth: ~900m





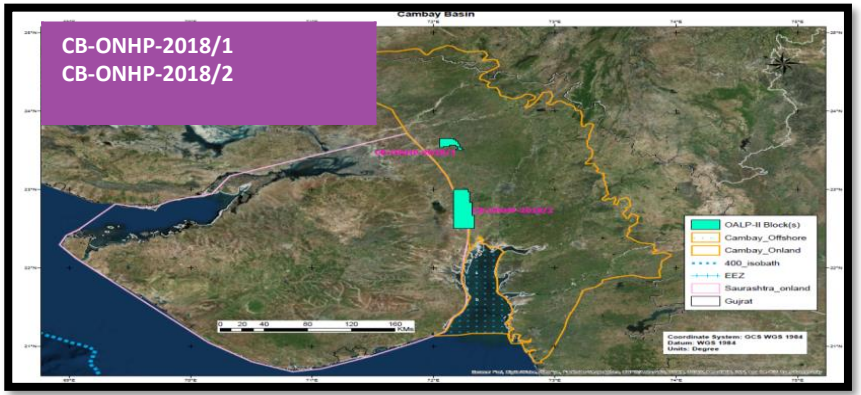
- Gas @ 45k+ to 190k+ SCMD
- Choke: 32/64”
- Formation: Jakhau (Early Eocene)
- Depth: ~1,300 to 1,500m

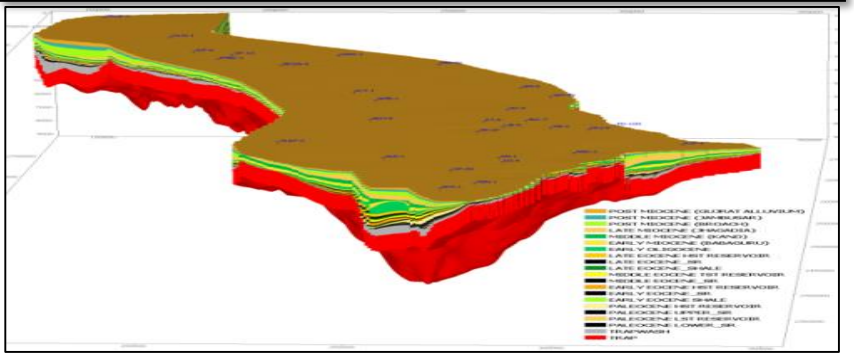
- Gas @ 125k+ SCMD
- Choke: 32/64”
- Formation: Deccan Trap (Late Cretaceous)
- Depth: ~1,450-1,500m

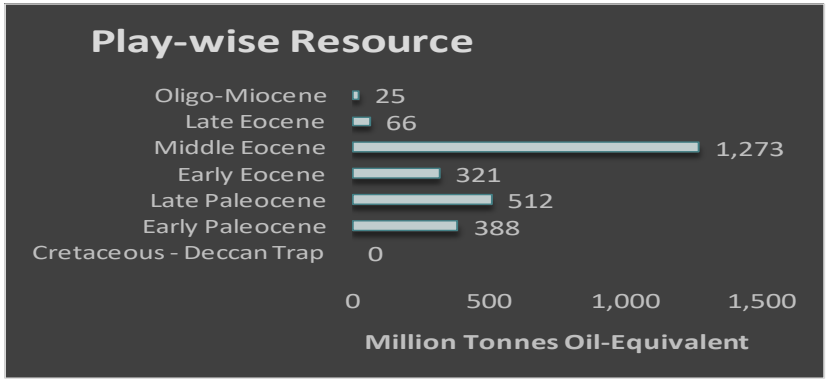
ONLAND

- Gas discovery
- Jhurio Formation (Jurassic)
- Depth: ~2,500-2,600m

Cambay Basin







Prognosticated Resources (In-place MMTOE)		
Discovered	Undiscovered	Total
1,800	**786**	2,586

- Total blocks-on-offer: 2
- Cumulative area:1,032 sq km

Cambay Basin

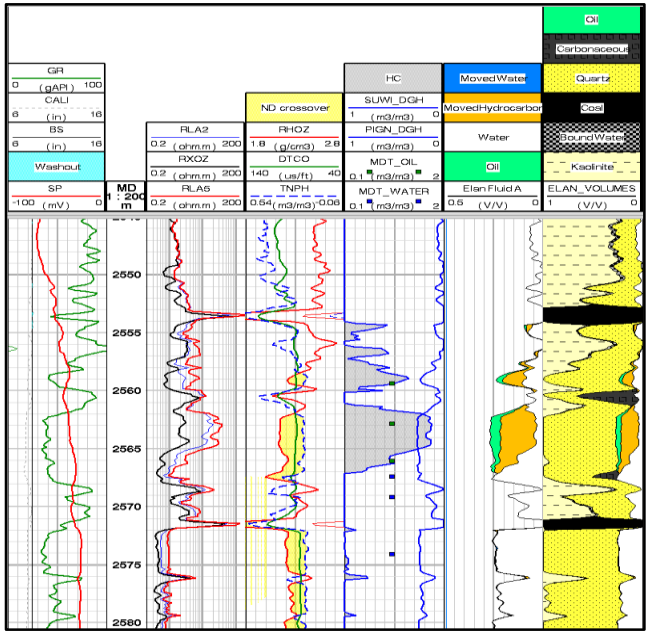
CB-ONHP-2018/1

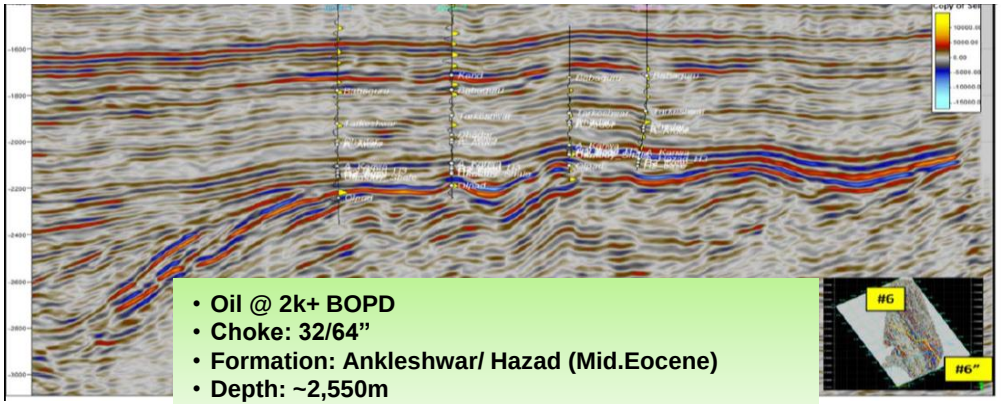
- Middle-Eocene Play: Close to producing Becharaji and Modhera fields from Kalol Formation
- Paleocene-Early Eocene Play: Leads from Modhera#2 well, Older Cambay Shale and Olpad Formation being secondary target
- Target Depth for wells: 1,500m.
- Area: 185 Sq. Km.
- 2D seismic : Available
- 3D seismic : Available

CB-ONHP-2018/2

- Eocene Play: Adjoining Baola Gas field, producing from Oolitic reservois
- Mesozoic Play: Seismic data indicative of thick Mesozoic sediments below the Deccan Trap section
- Target Depth for wells: 3,000m.
- Area: 847 Sq. Km.
- 2D seismic : Available
- 3D seismic : Available

Cambay Basin





- **Oil @ 2k+ BOPD**
- **Choke: 32/64”**
- **Formation: Ankleshwar/ Hazad (Mid.Eocene)**
- **Depth: ~2,550m**

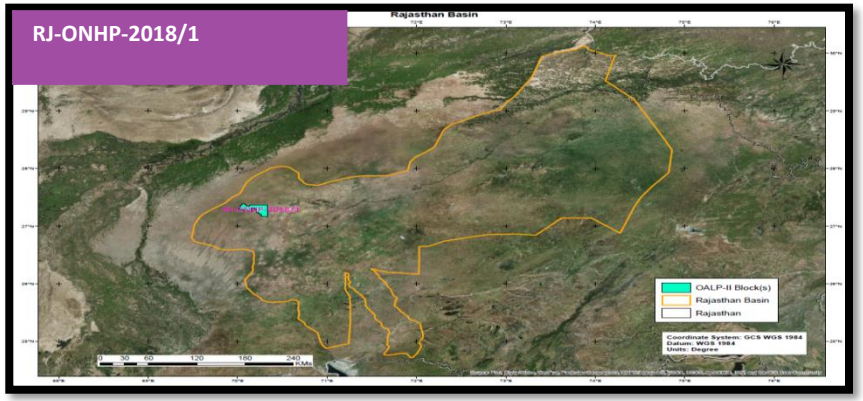
Miocene Basal Sands (MBS)

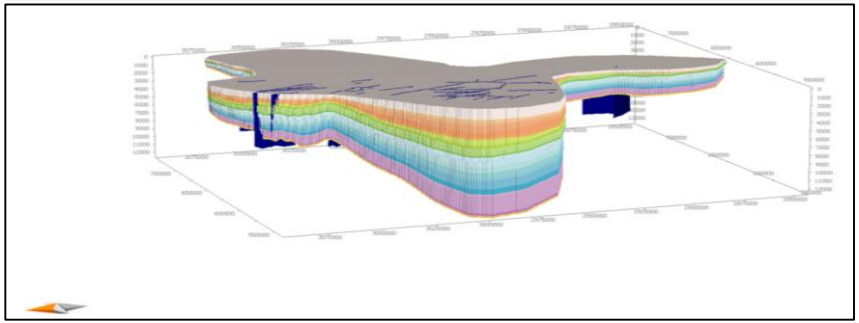
- Oil discovery
- Oil @ 200+ BOPD, 5mm bean
- Southern part (Akholjuni area)
- Depth: ~1,450m

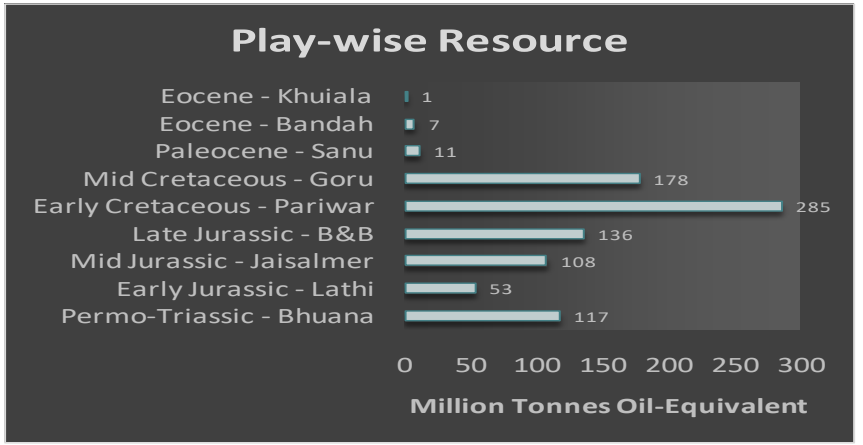
K-III/K-IV

- Oil discovery
- Oil @ 25+ BOPD, 12/64” bean
- Eastern margin (Dehgam area)
- Depth: ~1,250m

Rajasthan sub-basin - Jaisalmer







Prognosticated Resources (In-place MMTOE)

Discovered	Undiscovered	Total
94	**803**	897

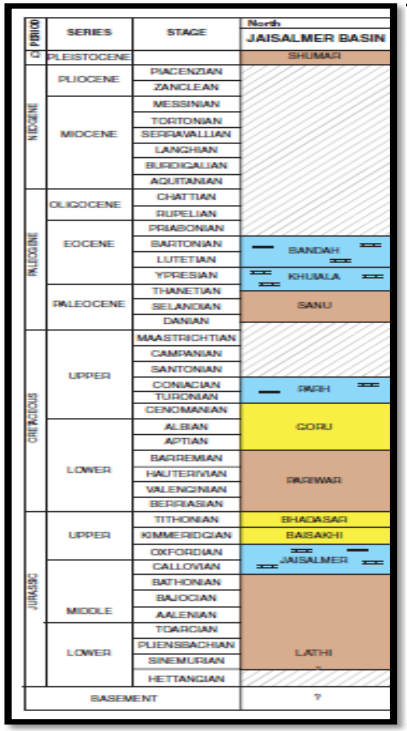
- Total block-on-offer: 1
- Area: 417 sq km

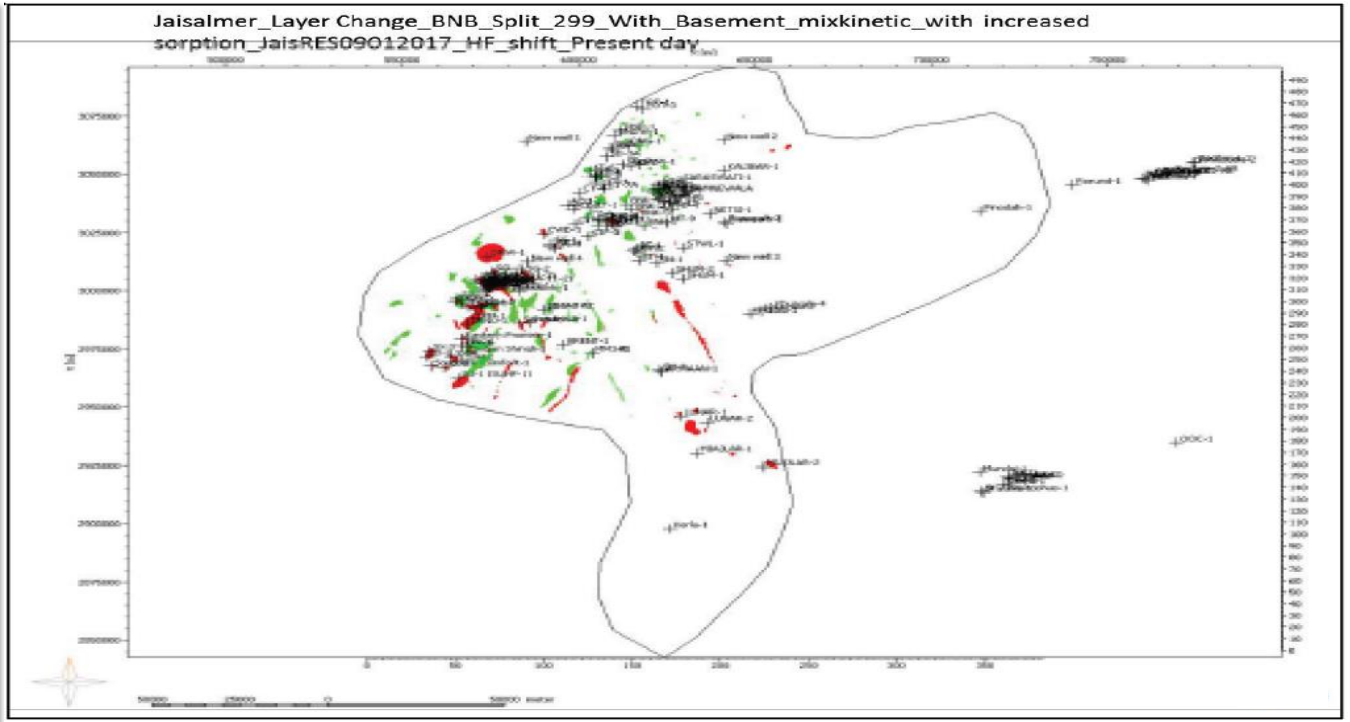
Rajasthan sub-basin - Jaisalmer

RJ-ONHP-2018/1

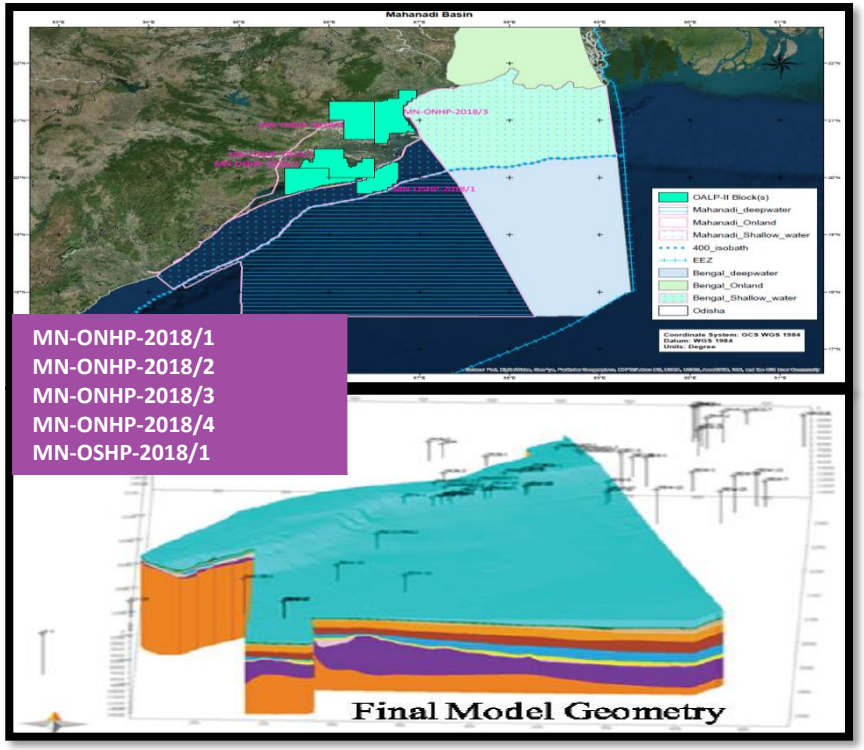
- Cretaceous and Paleocene Play: Close to discovered fields of Chinnewala Tibba, Bakhri Tibba, Kharatar in the west and Ghotaru field in the north
- Prospects in Sanu, Lower Goru and Pariwar Formation
- Target Depth: 1,000m
- Area: 417 Sq. Km.
- 2D seismic : Available

Rajasthan sub-basin - Jaisalmer





Mahanadi Basin



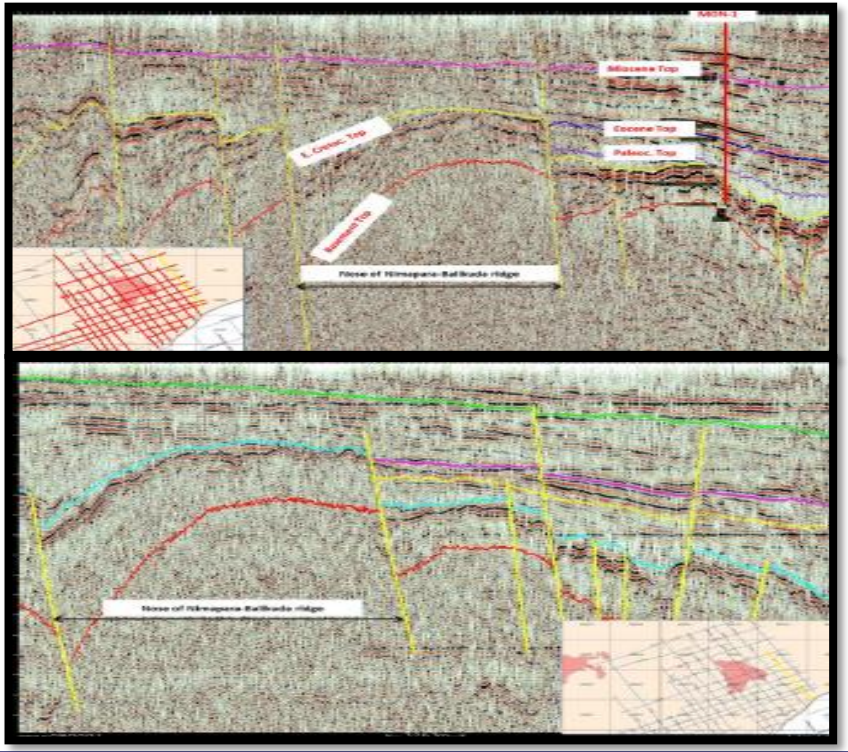
Prognosticated Resources (In-place MMTOE)		
Discovered	Undiscovered	Total
77	**574**	651

- Total blocks-on-offer: 5
- Area: 13,634 sq km

Mahanadi Basin

MN-ONHP-2018/1

- Early Cretaceous Syn-rift Play: Lacustrine source rocks, reservoir rocks defined by alluvial fans and deltaic sediments and seal facies of intra-formational shales
- Neogene Play: Shallow biogenic gas evidenced from surface gas seepages
- Target Depth for wells: 1,900m.
- Area: 2,934 Sq. Km.
- 2D seismic : Available

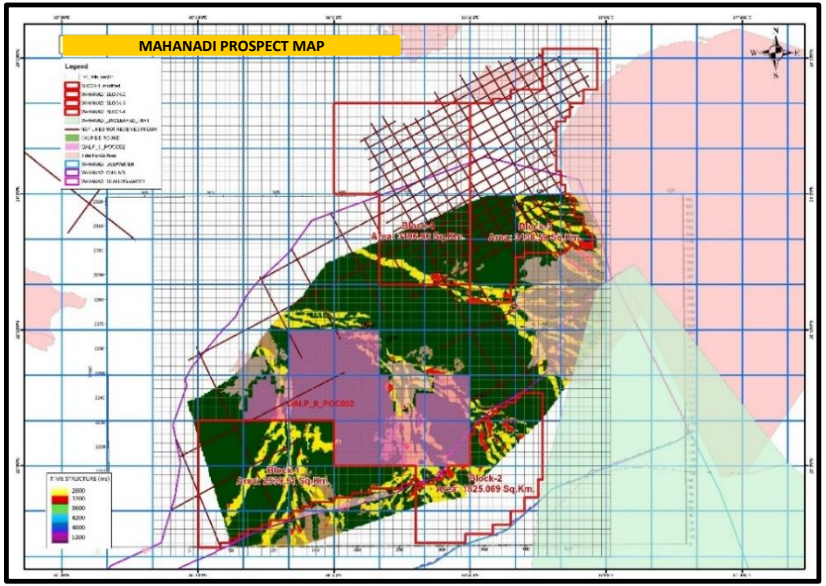


Mahanadi Basin

MN-ONHP-2018/2

- Both Tertiary and Cretaceous play
- Tectonic trend of Mesozoic section analogous to the producing Basins to the south like Cauvery and Krishna-Godavari
- The well, MON-3 falling in proposed area has good quality source rock

- Target Depth for wells: 2,000m.
- Area 2,539 Sq. Km.
- 2D seismic : Available

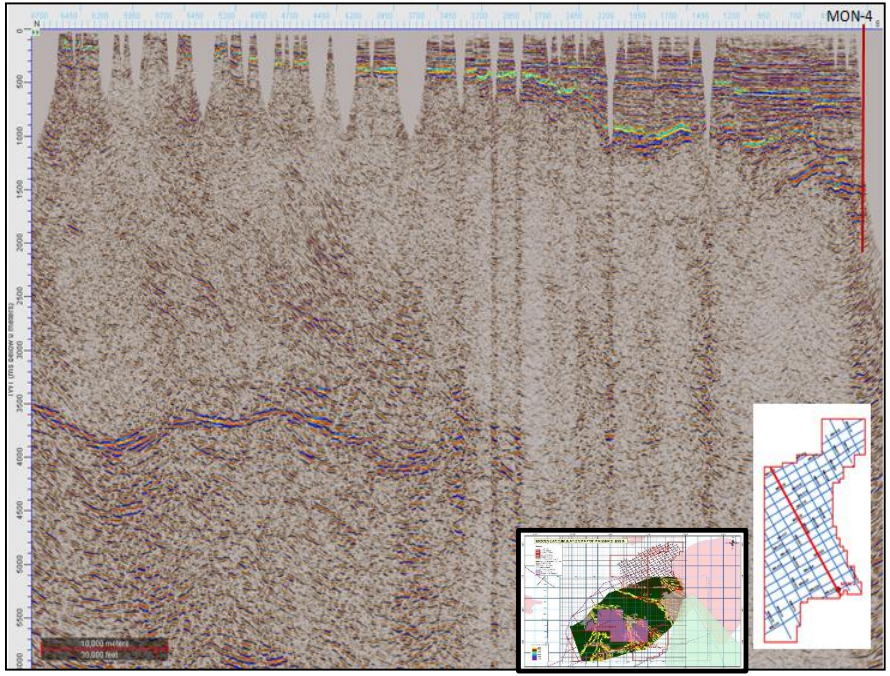


Mahanadi Basin

MN-ONHP-2018/3

- Up-dip prospects,
- The well MON-2 falling near to proposed area has hydrocarbon shows in deeper Mesozoic prospect
- Seismic anomalies in Mesozoic

- Target Depth for wells: 4,500 m.
- Area: 3,138 Sq. Km.
- 2D seismic : Available (+NSP)



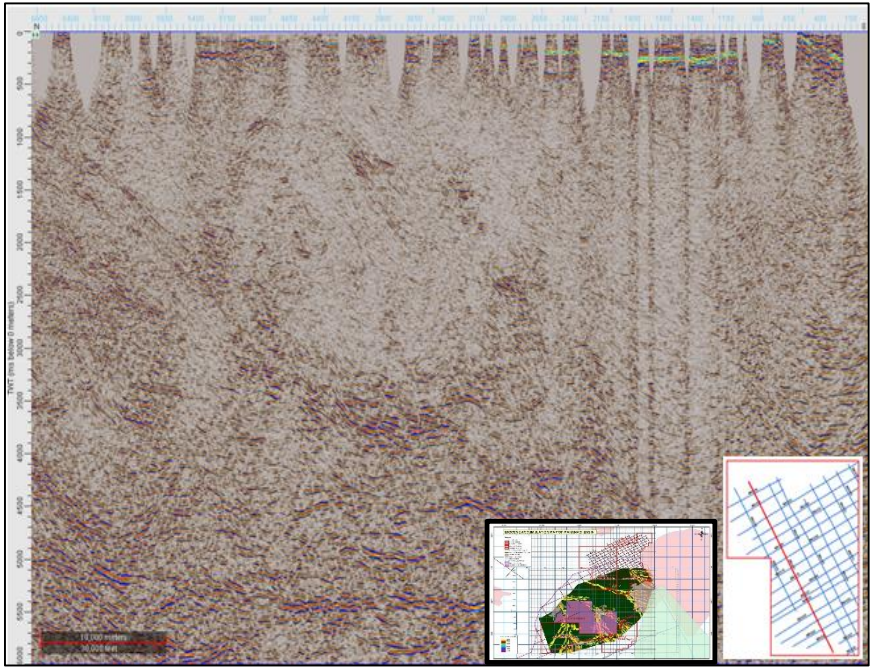
Seismic section across the Block

Mahanadi Basin

MN-ONHP-2018/4

- The well MON-4 falls in the proposed area
- Tertiary and Cretaceous plays are primary targets
- Tectonic trend of Mesozoic section analogous to the producing Basins to the south like Cauvery and Krishna-Godavari

- Target Depth for wells: 5,500 m.
- Area: 3,197 Sq. Km.
- 2D seismic : Available (+NSP)



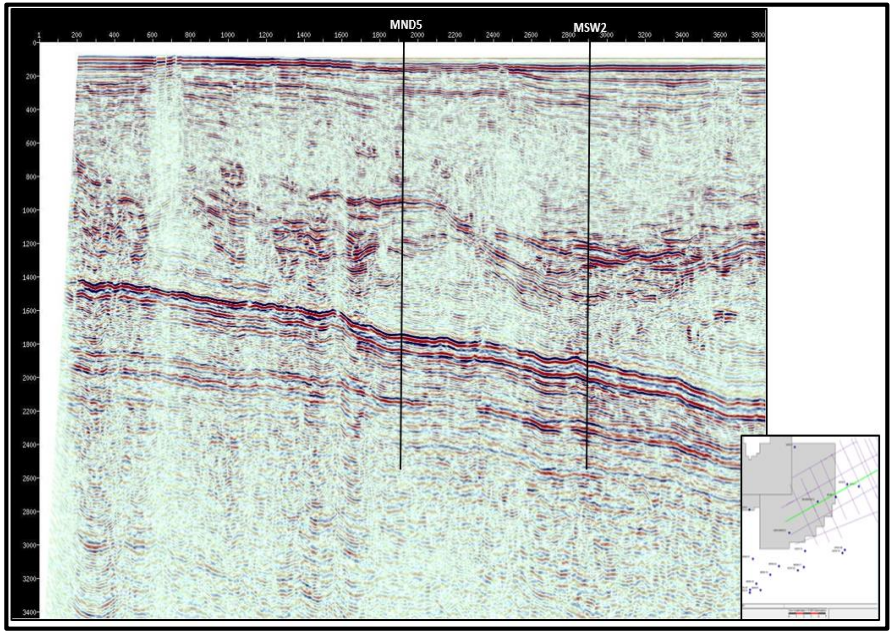
Seismic section across the Block

Mahanadi Basin

MN-OSHP-2018/1

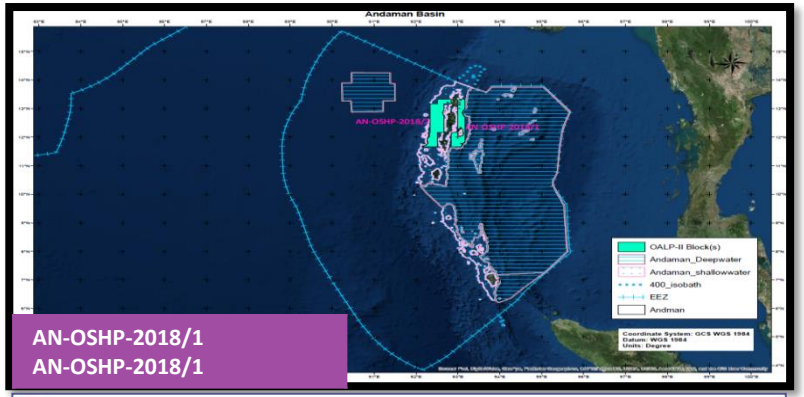
- Located adjacent to PSC blocks
- Tertiary plays are primary targets
- Basin analogy: The well MSW-2, MSW-3 had gas indications. The well MDW-10 has mixed gas in Paleogene fan
- Biogenic gas discovery from Miocene slope fans in the offset block

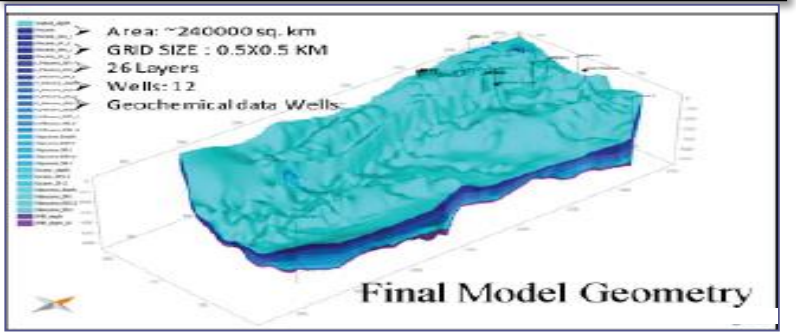
- Target Depth for wells: 3,000m.
- Area: 1,825 Sq. Km.
- 2D/3D seismic : Available
- Wells: 2 wells in the Block and 4 nearby wells

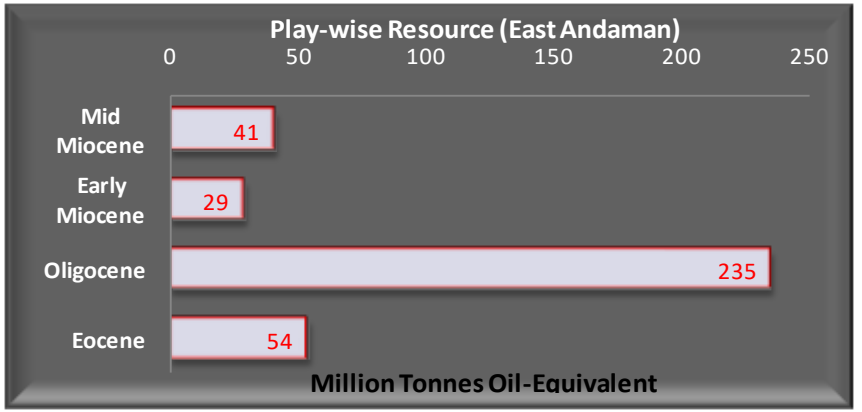


Seismic section across the Block

Andaman Basin







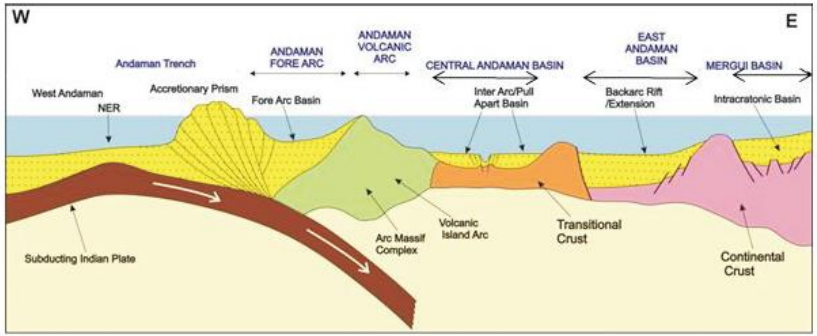
Prognosticated Resources (In-place MMTOE)		
Discovered	Undiscovered	Total
2	**369**	371

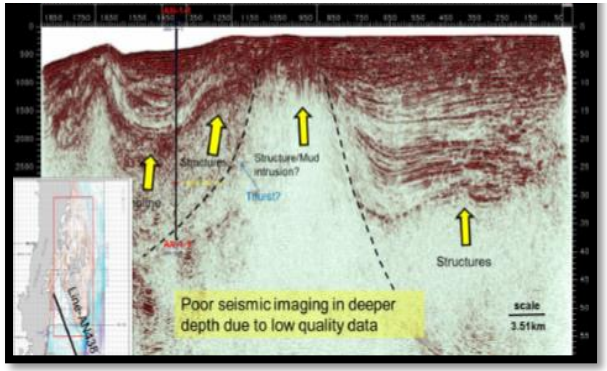
- Total blocks-on-offer: 2
- Area: 9,616 sq km

Andaman Basin

AN-OSHP 2018/1:

- Shallow water Block, water depth 5-110m, located in outer Fore-arc setting of East Andaman
- 2D seismic lines available
- Proposed area part of the AN-1 structure where the first drilled well flowed gas from Middle Miocene Limestone
- Mid Miocene Carbonate Play and Paleocene-Eocene Clastic play are potential targets
- Leads from mud volcanics with hydrocarbon presence (fluorescence)
- Source rock has Type II Kerogen
- Anticline adjacent to mud volcanoes and presence of large slope strata are favourable target areas
- Target Depth for wells: 2,600m
- Area: 3,669 Sq. Km.



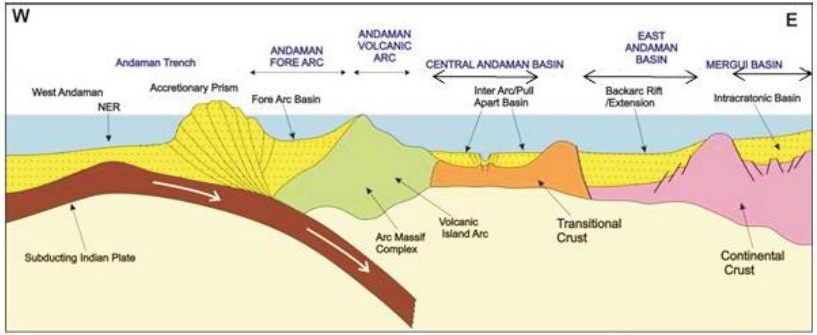


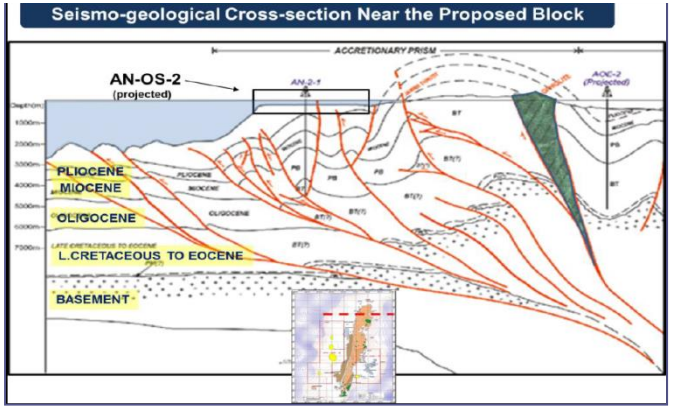
Representative seismic section

Andaman Basin

AN-OSHP 2018/2:

- Shallow water Block, water depth 50-400, located within the Accretionary Prism in the west of Andaman Islands
- Paleocene-Eocene clastic play
- Leads from mud volcanics with hydrocarbon presence (fluorescence)
- Source rock has Type II Kerogen
- Anticline adjacent to mud volcanoes and presence of large slope strata are favourable target areas
- Target Depth for wells: 2,450m.
- Area: 5,947 Sq. Km.





Brief of Contract Areas

- Contract Blocks-on-offer: 14
- Total area on offer: 29,233sq km
- Individual area size: 185 to 5,947 sq km
- The Shallowest Target Depth at 1,000 m
- The deepest Target Depth at 5,500 m
- Wells, seismic, well reports and petroleum resource reports

Opportunities to OALP bidders

- Contract areas are largely pre-assessed by prospective bidders
  - Information on block-level prospectivity outlined by originator through due diligence report
  - **Basin-specific Technical Booklets** will be available for constituent contract areas
- NDR has already set up the data rooms
  - **Industry-standard interpretation software** with full G&G functionality are available for basic interpretation
- Continued chance of access to NDR for more/missed-out data
  - NDR is updated with new data continuously
  - **Basin-specific information on hydrocarbon resource reports are now available**
- NCR ("National Core Repository") is currently conceptualized
  - **Access to Cores/ Drill-cuttings/ Fluid samples** is now available from across basins from NOC's Core Labs, now declared National Asset

Welcome to an opportunity ..
of exploring the 'undiscovered' potential of hydrocarbons, both conventional and un-conventional under two contract formats.. with attractive fiscal and contractual terms ..