Overview of Indian Sedimentary Basins and Blocks-on-Offer (under OALP Bid Round IV)
Presentation outline

- Indian Sedimentary Basins
- Hydrocarbon Resource Reassessment Study
- OALP Blocks-on-Offer
- Basin-wise Brief of Blocks-on-Offer
- Summary
INDIAN SEDIMENTARY BASINS
• A new 3-tier category for 26 basins
• A simplified approach to present the Category based on the maturity of resources in line with PRMS standard
• **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”)
Basins under category

Category I
- Krishna-Godavari(KG), Mumbai Offshore, Assam Shelf, **RAJASTHAN***, Cauvery, Assam-Arakan Fold Belt and Cambay

Category II
- Saurashtra, Kutch, **VINDHYAN***, Mahanadi and Andaman

Category III
- **BENGAL-PURNEA***†, Kerala-Konkan, Ganga-Punjab, Pranhita-Godavari(PG), Satpura-South Rewa-Damodar, Himalyan Foreland, Chhattisgarh, Narmada, Spiti-Zanskar, Deccan Syneclise, Cuddapah, Karewa, Bhima-Kaladgi and Bastar

*Shown in bold caps are ‘three’ target basins under Round IV Offer
†Under proposed upgradation to Category II
HYDROCARBON RESOURCE REASSESSMENT STUDY
Overview of the study

- During 2017-18, hydrocarbon reassessment was carried out for all 26 basins
- **Assessment done for conventional reservoirs only**
- Reviewed by international domain-specialists and Indian basin-experts
- 13 basins with adequate datasets were assessed through “Petroleum System Modeling”
  - 9 basins (Assam Shelf, Cambay, Rajasthan, Mumbai, KG, Cauvery, Mahanadi, Bengal-Purnea and Kerala-Konkan) : Entire area
  - 4 basins (Assam Arakan, Andaman, Kutch and Saurashtra) : Part area
- **177 hydrocarbon plays were identified**
  - 87 in Tertiary, 53 in Mesozoic and 37 Pre-Mesozoic
- **New plays included**
  - Mesozoic reservoirs in 14 basins
  - Basement fractures in many new discoveries
Results of the Study

• Last assessment done in 1995-96 for 15 sedimentary basins:
  • Total Inplace assessed: 28,085 MMTOE (206 BBBLOE)
  • Deepwater separately assessed with 7,000 MMTOE inplace
• Current assessment done for all 26 basins with deepwater areas included
  • Inplace Reassessed: 41,872 MMTOE (307 BBBLOE), including 11 basins not earlier assessed with 868 MMTOE inplace
    – Discovered:    12,076 MMTOE (  89 BBBLOE)
    – Undiscovered: 29,796 MMTOE (218 BBBLOE), 71% of the total inplace
• Increase of total hydrocarbon estimate: 49.1%
• Reassessment at hydrocarbon play level
• A complete geoscientific database with subsurface models, maps and reports
Results compared

1995-96 study
- Carried out for 15 basins
- Simplistic tools and limited datasets
- Areal Yield (AY) method used for all basins
- Assessment at ‘basin’ level
- Deepwater areas excluded and assessed separately

2017-18 study
- All 26 basins re-assessed
- Sophisticated tools and expanded datasets
- 13 basins/basin areas with enough datasets were assessed through 3D petroleum system modeling
- Assessment at ‘play’ level
- Deepwater included and assessed with basins
BLOCKS-ON-OFFER-OALP IV
Basin-wise Hydrocarbon Resources

(Target Basins/Sub-basins (★) under Bid Round IV)

- Vindhyan: 633 MMTOE
- Bengal-Purnea: 582 MMTOE (BP Purnea 217 MMTOE, BP Onshore 28 MMTOE, BP Offshore 0 MMTOE, VN Basin 0 MMTOE)
- Rajasthan: 2,772 MMTOE (RJ Jaisalmer 896 MMTOE, RJ Bikaner-Nagaur 457 MMTOE, RJ Barmer 0 MMTOE)

Figures in MMTOE
OALP Blocks across Basins

- Total 7 blocks on offer
- Distributed into 3 sedimentary basins
- Vindhyan has most number of blocks (5)
- 5 blocks from Category II basin
- 1 block from Category III basin
- 1 block from Category I basin
Basin Area across Blocks

- Total area 18,510 Sq. Km. (Approx.)
- Vindhyan Basin has maximum acreage
- All 7 blocks falling in Onland Area

Vindhyan 72%
Bengal-Purnea 17%
Rajasthan 11%

<table>
<thead>
<tr>
<th>Block Area (Sq Km)</th>
<th>3,131</th>
<th>2,119</th>
<th>2,731</th>
<th>3,078</th>
<th>3,097</th>
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Vindhyan Basin

Prognosticated Resources (In-place MMTOE)

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<th>Discovered</th>
<th>Undiscovered</th>
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<td>Blocks-on-offer</td>
<td>5</td>
<td>631</td>
<td>632</td>
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<tr>
<td>Area</td>
<td></td>
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<td>13,260 sq km</td>
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Thermogenic gas plays are established in the eastern part of the basin (Son Valley) within Lower Vindhyan Group in the following stratigraphic units:

- Rohtas Fm
- Mohana Fm
- Jardepahar Fm

Gas discoveries in wells namely Nohta-2, Damoh-4 and Jabera-4, mostly in Rohtas Fm. Gas shows in Mohana Fm.

Potential gas discovery Jardepahar Fm.
Vindhyan Basin

RECENT DISCOVERY at well, Hatta-2 in Vindhyan Basin

- Notified gas discovery in Jardepahar Object-II (2,150-2,182m)
- Flowed gas 48k SCMD through 4 mm bean
Vindhyan Basin

VN-ONHP-2019/1
- Located in Son Valley part of Vindhyan Basin, surrounding VN-ONN-2009/3 block
- ‘Thermogenic’ gas plays are established in shallow and deep stratigraphic levels
- Gas indications in Nohta-Damoh-Jabera wells (Rohtas Fm)
- Gas discovery in Hatta-2 well in block VN-ONN-2009/3 block (Jardepahar Fm)
- Identified hydrocarbon plays: Rohtas Limestone and Jardepahar Clastics
- Target depth for wells: 3,000 m
- Area: 2,731 Sq. Km.
- Datasets: 2D seismic, 1 well

Vindhyan Basin
Vindhyan Basin

VN-ONHP-2019/2
- Located in Son Valley part of Vindhyan Basin, surrounding VN-ONN-2009/3 block
- ‘Thermogenic’ gas plays are established in shallow and deep stratigraphic levels
- Gas indications in Nohta-Damoh-Jabera wells (Rohtas Fm)
- Gas discovery in Hatta-2 well in block VN-ONN-2009/3 block (Jardepahar Fm)
- Identified Plays: Jardepahar Clastics
- Target depth for wells: 3,000 m
- Area: 3,078 Sq. Km.
- Datasets: 2D seismic
Vindhyan Basin

 VN-ONHP-2019/3

- Located in Son Valley part of Vindhyan Basin, surrounding VN-ONN-2009/3 block
- ‘Thermogenic’ gas plays are established in shallow and deep stratigraphic levels
- Gas indications in Nohta-Damoh-Jabera wells (Rohtas Fm)
- Gas discovery in Hatta-2 well in block VN-ONN-2009/3 block (Jardepahar Fm)
- Area favourable for exploration of Nohta plays in west of Nohta and Gunjora Structure trending parallel to the NW-SE Chandpur-Jabera fault
- Identified plays: Rohtas Limestone and Jardepahar Clastics
- Target depth for wells: 3,000 m
- Area: 3,097 Sq. Km.
- Datasets: 2D seismic
Located in Son Valley part of Vindhyan Basin, surrounding VN-ONN-2009/3 block

‘Thermogenic’ gas plays are established in shallow and deep stratigraphic levels

Gas indications in Nohta-Damoh-Jabera wells (Rohtas Fm)

Gas discovery in Hatta-2 well in block VN-ONN-2009/3 block (Jardepahar Fm)

Both shallow carbonates within Rohtas and Mohana Limestone formations and clastic reservoirs within deeper Jardepahar Formation are the target prospects

Identified plays: Rohtas Limestone, Mohana Limestone and Jardepahar Clastics

Target depth for wells: 2,600 m

Area: 2,933 Sq. Km.

Datasets: 2D seismic
Vindhyan Basin

VN-ONHP-2019/5
- Located in Son Valley part of Vindhyan Basin, surrounding VN-ONN-2009/3 block
- ‘Thermogenic’ gas plays are established in shallow and deep stratigraphic levels
- Gas indications in Nohta-Damoh-Jabera wells (Rohtas Fm)
- Gas discovery in Hatta-2 well in block VN-ONN-2009/3 block (Jardepahar Fm)
- Both shallow carbonates within Rohtas and Mohana Limestone formations and clastic reservoirs within deeper Jardepahar Formation are the target prospects
- Jardepahar, Mohana and Rohtas are possible gas plays. Two identified prospects to probe Jardepahar Porcellanite and deeper Kajrahat Limestone.
- Target depth for wells: 3,500 m
- Area: 1,422 Sq. Km.
- Datasets: 2D seismic
Bengal-Purnea Basin

Prognosticated Resources (In-place MMTOE)

<table>
<thead>
<tr>
<th></th>
<th>Discovered</th>
<th>Undiscovered</th>
<th>Total</th>
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<tr>
<td>Block-on-offer</td>
<td>0</td>
<td>828</td>
<td>828</td>
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<tr>
<td>Area</td>
<td></td>
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<td>3,131 sq km</td>
</tr>
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</table>

- Block-on-offer: 1
- Area: 3,131 sq km

Play-wise Conventional Hydrocarbon Inplace (MMTOE)

Eocene
Oligocene
Mid Miocene
Upper Miocene
Pliocene
Gondwana

Prognosticated Resources

- Discovered
- Undiscovered
- Total

Block-on-offer: 1
Area: 3,131 sq km

BP-ONHP-2019/1
Bengal-Purnea Basin

RECENT DISCOVERY at well, Ashokenagar-1 in onland part of Bengal-Purnea Basin

- Notified gas discovery in Upper Miocene Object-I (2,377-2,388m)
- Flowed gas 105k SCMD through 8 mm bean
Bengal-Purnea Basin

- **BP-ONHP-2019/1**
  - Located in the south-western part of Bengal onland
  - Strati-structural plays are present within Paleocene-Late Cretaceous sequences representing channels in low stand stratigraphic framework
  - 2 plays are identified: ‘Thermogenic’ hydrocarbon in Lower Pliocene-Miocene sequence and ‘Biogenic’ from Upper Pliocene sequence
  - Target Depth for wells: 3,450 m
  - Area: 3,131 Sq. Km.
  - Datasets: 2D and 3D seismic, 3-well data and reports
Rajasthan (Bikaner-Nagaur Sub-basin)

**Prognosticated Resources (In-place MMTOE)**

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<tr>
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<th>Discovered</th>
<th>Undiscovered</th>
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<tr>
<td><strong>Block-on-offer:</strong></td>
<td>1</td>
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<tr>
<td><strong>Cumulative area:</strong></td>
<td>2,119 sq km</td>
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- **Eocene - Khula**
- **Eocene - Bandh**
- **Paleocene - Sanu**
- **Mid Cretaceous - Goru**
- **Early Cretaceous - Parwar**
- **Late Jurassic - B&B**
- **Mid Jurassic - Jaisalmer**
- **Early Jurassic - Lathi**
- **Permo-Triassic - Bhuana**
- **Infra-Cambrian - Up Jodhpur**
- **Infra-Cambrian - Bilara**
- **Infra-Cambrian - Up Carbonate**
- **Eocene - Thumbli**
- **Eocene - Dharavi-Dungar**
- **Paleocene - Barmer Hill**
- **Paleocene - Pateshgarh**
- **Volcanics - Rageshwari**
- **Cretaceous - Ghaggar-Hakra**
- **Basement - Malani**

**Play-wise Conventional Hydrocarbon Inplace (MMTOE)**

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<th>Play</th>
<th>Discoverd</th>
<th>Undiscovered</th>
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<tr>
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<td>15</td>
<td>443</td>
<td>458</td>
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<tr>
<td>Barmer</td>
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<tr>
<td>Rajasthan</td>
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**RJ-ONHP-2019/1**

- **Rajasthan (Bikaner-Nagaur Sub-basin)**
- **OALP Blocks**

**Indian Sedimentary Basins**

- **Basement**
- **Malani**
- **Cretaceous**
- **Ghaggar-Hakra**
- **Volcanics**
- **Rageshwari**
- **Paleocene**
- **Fatehgarh**
- **Barmer Hill**
- **Barmer**

**Play-wise Conventional Hydrocarbon Inplace (MMTOE)**

- **Rajasthan**
- **Barmer**
- **Bikaner**
Rajasthan (Bikaner-Nagaur Sub-basin)

- Prospectivity lies in Jodhpur Formation and shallower Upper Carbonate Formation
- Jodhpur Formation has established hydrocarbons (Baghewala heavy oil discovery)
- Target Depth: 1,000 m.
- Area: 2,119 Sq. Km.
- Datasets: 2D Seismic

RJ-ONHP-2019/1
Brief of Blocks on Offer

- Contract blocks-on-offer: 7
- Target basins: 3
- Prospectivity Level: Category I (1), Category II (1), Category III (1)
- Acreage spread: Onland
- Total area on offer: 18,510 sq km (Approx.)
- Individual area size: 1,422 to 3,131 sq km
- Shallowest target depth: 1,000 m
- Deepest target depth: 3,500 m
- Datasets: Seismic, well logs, well information and reports
Opportunities to OALP bidders

– Contract areas are all pre-assessed by prospective bidders
  – Information on block-level prospectivity outlined by originator through due diligence report
  – **Basin-specific Technical Booklets** are available online

– NDR ready with 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 resources are now available**

– **NCR (“National Core Repository”)** has been conceptualized
  – **Cores/ Drill-cuttings/ Fluid samples** are accessible from NOC’s Core Labs, now declared as National Assets
Welcome to an opportunity of exploring the ‘undiscovered’ potential of both conventional and un-conventional hydrocarbons, under renewed terms. Leveraging fiscal benefits and contractual simplicity.