Technical Overview of Exploration Blocks-on-Offer (OALP Bid Round V)
Presentation outline

- Indian Sedimentary Basins
- Hydrocarbon Resource Reassessment Study
- 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 different categories

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-PURREA*†, 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 ‘Eight’ target basins under Round V Offer
†Under upgrade to Category II
Basin category (Area and Inplace)

- Total area: 3.36 million sq.km.
- On land: 1.63 million sq.km.
- Offshore (Shallow): 0.41 million sq.km. (up to 400-m water depth)
- Offshore (Deep and Ultra-deep): 1.32 million sq.km. (beyond 400-m water depth, limited to basin/EEZ boundary)

<table>
<thead>
<tr>
<th>Category</th>
<th>Basins</th>
<th>Type of Basins</th>
<th>Area (in sq.km.)</th>
<th>Conventional Petroleum Inplace (MMTOE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>7</td>
<td>Basins with RESERVES being produced and potential to be exploited at increased recovery</td>
<td>998,325 (30%)</td>
<td>35,511 (85%)</td>
</tr>
<tr>
<td>II</td>
<td>5</td>
<td>Basins with CONTINGENT resources to be developed and put on production</td>
<td>780,974 (23%)</td>
<td>3,877 (9%)</td>
</tr>
<tr>
<td>III</td>
<td>14</td>
<td>Basins with only PROSPECTIVE resources to be intensively explored and discovered</td>
<td>1,586,150 (47%)</td>
<td>2,481 (6%)</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>Total</td>
<td>3,365,449</td>
<td>41,871</td>
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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
Basin-wise Hydrocarbon Inplace

![Unrisked Inplace in OALP V Basins](image)

<table>
<thead>
<tr>
<th>Basin</th>
<th>Inplace, MMTOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mumbai Offshore</td>
<td>4794</td>
</tr>
<tr>
<td>Assam Shelf Basin</td>
<td>1868</td>
</tr>
<tr>
<td>Rajasthan Basin</td>
<td>938</td>
</tr>
<tr>
<td>Cauvery Basin</td>
<td>292</td>
</tr>
<tr>
<td>Cambay Basin</td>
<td>1800</td>
</tr>
<tr>
<td>Saurashtra Basin</td>
<td>79</td>
</tr>
<tr>
<td>Kutch Basin</td>
<td>71</td>
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<tr>
<td>Bengal Purnea</td>
<td>0</td>
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Established

<table>
<thead>
<tr>
<th>Basin</th>
<th>Inplace, MMTOE</th>
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<tr>
<td>Established</td>
<td>4852</td>
</tr>
<tr>
<td>Undiscovered</td>
<td>4133</td>
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<tr>
<td>Rajasthan Basin</td>
<td>3188</td>
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<tr>
<td>Cauvery Basin</td>
<td>1672</td>
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<tr>
<td>Cambay Basin</td>
<td>786</td>
</tr>
<tr>
<td>Saurashtra Basin</td>
<td>1246</td>
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<tr>
<td>Kutch Basin</td>
<td>827</td>
</tr>
<tr>
<td>Bengal Purnea</td>
<td>828</td>
</tr>
</tbody>
</table>

**Note:** Bengal-Purnea is under category-upgrade with discovered inplace
OALP Blocks across Basins

- **Total 11 blocks on offer**
- Distributed in 8 sedimentary basins
- Rajasthan, Cambay and Assam shelf have 2 blocks each
- **8 blocks from Category I basin**
- 2 blocks from Category II basin
- 1 block from Category III basin
Basin Area across Blocks

- Total area 19,789 Sq. Km.
- Cauvery Basin has maximum acreage with ultra-deepwater area
- Mumbai and Saurashtra Basin have shallow water area
- Other basins have onland acreage on offer

- Cauvery Basin 20%
- Bengal Purnea 16%
- Rajasthan Basin 17%
- Assam Shelf Basin 19%
- Kutch Basin 9%
- Mumbai Offshore 11%
- Saurashtra Basin 7%
- Cambay Basin 1%

[block diagram showing area distribution across basins]

[bar chart showing block area with approximate values for different blocks]

<table>
<thead>
<tr>
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<td>4064</td>
<td>3170</td>
<td>2405</td>
<td>2247</td>
<td>1819</td>
<td>1693</td>
<td>1520</td>
<td>1421</td>
<td>1278</td>
<td>133</td>
<td>19</td>
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</table>
BASIN-WISE BRIEF OF BLOCKS ON OFFER
RAJASTHAN (BIKANER-NAGAUR SUB-BASIN)

- Blocks on offer: 2
- Area: 3,340 sq km

Prognosticated Resources (In-place MMTOE)

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Proven</th>
<th>Undiscovered</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Infra-Cambrian</td>
<td>15</td>
<td>299</td>
<td>454</td>
</tr>
<tr>
<td>Barbheri</td>
<td></td>
<td>143</td>
<td>157</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>45</td>
<td>101</td>
<td>146</td>
</tr>
<tr>
<td>Basement</td>
<td>8</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>443</td>
<td>458</td>
</tr>
</tbody>
</table>

Total Area (Sq.Km.): 77,500

Play-wise Conventional Hydrocarbon Inplace (MMTOE)

- Eocene - Khuliala: 1
- Eocene - Bandhaj: 7
- Paleocene - Sanu: 11
- Mid Cretaceous - Goru: 178
- Early Cretaceous - Paliwar: 285
- Late Jurassic - B&B: 136
- Mid Jurassic - Jalalpur: 108
- Early Jurassic - Lathi: 53
- Permo-Triassic - Bhunwa: 117

- Infra-Cambrian - Up Carbonate: 15
- Infra-Cambrian - Bilara: 143
- Infra-Cambrian - Up Jodhpur: 299
- Eocene - Thumbl: 166
- Eocene - Dharvi-Dungri: 106
- Paleocene - Bajner Hill: 672
- Palaeocene - Fatehpur: 45
- Volcanics - Rajeshwar: 101
- basement - Malani: 8

**Total: 1,674 MMTOE**
RJ-ONHP-2019/2:
- Jodhpur and Upper Carbonate are identified plays
- In the sub-basin, these 2 plays have estimated inplace of 143 MMTOE (Jodhpur) and 15 MMTOE (Upper Carbonate)
- Sandstone reservoirs of Jodhpur Formation are believed to be charged from source rocks of Bilara Formation, - an established fact from Baghewala discovery of heavy oil
- Target depth for wells: 500 m
- Area: 1,520 Sq. Km. | Datasets: 2D seismic
RJ-ONHP-2019/3:

- Jodhpur and Upper Carbonate are identified plays.
- In the sub-basin, these 2 plays have estimated in-place of 143 MMTOE (Jodhpur) and 15 MMTOE (Upper Carbonate).
- Sandstone reservoirs of Jodhpur Formation are believed to be charged from source rocks of Bilara Formation, an established fact from Baghewala discovery of heavy oil.
- Target depth for wells: 800 m.
- Area: 1,819 Sq. Km. | Datasets: 2D seismic, 3D seismic.
CAMBAY BASIN

- Blocks on offer: 2
- Cumulative area: 172 sq km

Prognosticated Resources (In-place MMTOE)

<table>
<thead>
<tr>
<th></th>
<th>Discovered</th>
<th>Undiscovered</th>
<th>Total</th>
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<tbody>
<tr>
<td>Oligo-Miocene</td>
<td>25</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Late Eocene</td>
<td>66</td>
<td></td>
<td>66</td>
</tr>
<tr>
<td>Middle Eocene</td>
<td></td>
<td></td>
<td>1,273</td>
</tr>
<tr>
<td>Early Eocene</td>
<td>321</td>
<td></td>
<td>321</td>
</tr>
<tr>
<td>Late Palaeocene</td>
<td>512</td>
<td></td>
<td>512</td>
</tr>
<tr>
<td>Early Palaeocene</td>
<td>388</td>
<td></td>
<td>388</td>
</tr>
<tr>
<td>Cretaceous-Docuan Trap</td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Total Area (Sq Km) 53,500
CB-ONHP-2019/1:
- Located in the northern part of the Cambay Basin in Ahmedabad-Mehsana-Block, surrounded by Sobhasan Field to the west and Mansa Field to the south-east.
- Occurrence of heavy oils in nearby wells of Pre-NELP CB-ON/3 block.
- Identified hydrocarbon plays: Kadi, Olpad Formation and fractured/weathered trap.
- Target depth for wells: 1,200 m.
- Area: 19 Sq. Km. | Datasets: 2D seismic, 3D seismic, 3 wells, reports.
CB-ONHP-2019/2:

- Located in the northern part of Narmada-Tapti Block of Cambay Basin surrounded by many discovered fields like Ankleshwar, Kosamba, Motwan, West Motwan, Sisodra, Elao and Kim
- The petroleum system identified in south Cambay Basin indicate multiple source rocks
- Identified hydrocarbon plays: Paleocene/Early Eocene and Early/Middle Eocene
- Target depth for wells: 1,000 m
- Area: 153 Sq. Km. | Datasets: 2D seismic, 3D seismic, 5 wells, reports
## ASSAM SHELF BASIN

- **Blocks on offer:** 2
- **Cumulative area:** 3,683 sq km

### Prognosticated Resources (In-place MMTOE)

<table>
<thead>
<tr>
<th></th>
<th>Discovered</th>
<th>Undiscovered</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1868</td>
<td>4133</td>
<td>6001</td>
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</tbody>
</table>

### Total Area (Sq Km)

- **Total Area:** 56,000

### Cumulative Resources

<table>
<thead>
<tr>
<th>Age</th>
<th>Discovered MMTOE</th>
<th>Undiscovered MMTOE</th>
<th>Total MMTOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plio-Grinux</td>
<td>142</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miocene-Tipam</td>
<td></td>
<td></td>
<td>2,123</td>
</tr>
<tr>
<td>Late Oligocene</td>
<td>1,517</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Oligocene</td>
<td>607</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Eocene</td>
<td>534</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Eocene</td>
<td>599</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paleocene</td>
<td>578</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**ASSAM SHELF BASIN**

- **Blocks on offer:** 2
- **Cumulative area:** 3,683 sq km

---

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

<table>
<thead>
<tr>
<th>Age</th>
<th>Discovered MMTOE</th>
<th>Undiscovered MMTOE</th>
<th>Total MMTOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plio-Grinux</td>
<td>142</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miocene-Tipam</td>
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<td>2,123</td>
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<tr>
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<tr>
<td>Late Eocene</td>
<td>534</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Eocene</td>
<td>599</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paleocene</td>
<td>578</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Total Area (Sq Km):** 56,000
AA-ONHP-2019/1:

- Located north of Kaziranga National Park in the north bank of the river Brahmaputra
- Reservoirs are believed to be charged from Paleocene-Eocene source rocks with expected entrapments as fault-bound-to-four way closures. Few shallower targets within Oligo-Miocene are envisaged to be secondary targets
- Identified hydrocarbon plays: Paleocene-Eocene
- Target depth for wells: 4,000 m
- Area: 1,278 Sq. Km. | Datasets: 2D seismic.
AA-ONHP-2019/2:

- Located in Lakhimpur area on the north bank of the river Brahmaputra.
- Reservoirs within the Paleocene-Eocene Formation (high reflective package above basement) is the primary exploration target. These reservoirs are expected to be charged from source rock of Paleocene-Eocene Formation (Kopili and Lakadon). Expected entrapments are fault bound closures.
- Identified hydrocarbon plays: Paleocene-Eocene.
- Target depth for wells: 3500 m.
- Area: 2,405 Sq. Km. | Datasets: 2D seismic, 3D seismic, 3 wells, reports.
CAUVERY BASIN

Block-on-offer: 1
Cumulative area: 4,064 sq km
CY-UDWHP-2019/1:

- Located in the area north-eastern extension of Ariyalur-Pondicherry and Tranquebar sub-basins, bounded by the OALP shallow water blocks CY-OSHP-2017/1 and CY-OSHP-2017/2 in the west, the extension of Karaikal High in the south and the ultra-deep area in the east.
- Commercially established reservoirs in the shallow offshore areas are in Basement, Bhuvanagiri and Nannilam Formation. PY-3 field has flowed hydrocarbons from Basement and Nannilam Formation while PY-1 field is primarily producer from Basement. Ganesha field is producer from Bhuvanagiri and Lower Nannilam sands.
- Identified hydrocarbon plays: Synrift/Andimadam, Bhuvanagiri, Nannilam, Kamalapuram and Basement
- Target depth for wells: 3,500 m
- Area: 4064 Sq. Km. | Datasets: 2D seismic, 3D seismic, 4 wells, reports
MUMBAI BASIN

- Block-on-offer: 1
- Cumulative area: 2,247 sq km

### Prognosticated Resources (In-place MMTOE)

<table>
<thead>
<tr>
<th></th>
<th>Discovered</th>
<th>Undiscovered</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4794</td>
<td>4852</td>
<td>9646</td>
</tr>
</tbody>
</table>

Total Area (Sq Km) **212,000**
MB-OSHP-2019/1:

- Located in the southern part of shelf margin area towards the east of deepwater Blocks, BB-OS-DW-I & -BB-OS-DW-II and south of the NELP block MB-OSN-2005/3.
- With 2 gas discoveries in MBS053NAA-1 and MBS053NAG-1 in the southern NELP block, the Pliocene-Pliocene biogenic petroleum system has been established.
- Identified hydrocarbon plays: Paleocene-Eocene Carbonate-Panna, Miocene-Pliocene Biogenic
- Target depth for wells: 1,050 m
- Area: 2,247 Sq. Km. | Datasets: 2D seismic, 3D seismic, 2 wells, reports
KUTCH BASIN

- **Block-on-offer:** 1
- **Cumulative area:** 1,693 sq km

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

<table>
<thead>
<tr>
<th></th>
<th>Discovered</th>
<th>Undiscovered</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>71</td>
<td>827</td>
<td>898</td>
</tr>
</tbody>
</table>

**Total Area (Sq Km):** 58,554
GK-ONHP-2019/1:

- Located to the east of OALP block GK-ONHP-2017/1.
- Minor gas has been reported from well Nanak-G from Jhuran limestone of Mesozoic. The well Lakhpat-1 has flowed gas during testing from Bhuj Formation
- Identified hydrocarbon plays: Mid Jurassic deltaic play (Jhurio, Jumara and Jhuran Formations) and Early Cretaceous deltaic play (Bhuj Formation)
- Target depth for wells: 2,300 m
- Area: 1,693 Sq. Km. | Datasets: 2D seismic
SAURASHTRA BASIN

Block-on-offer: 1
Cumulative area: 1421 sq km
GS-OSHP-2019/1

- Located adjacent to the OALP block GS-OSHP-2017/1 in the east
- Existence of a Mesozoic-Mesozoic Petroleum System has been established on the basis of the discovery of Jurassic play at well, GSS041NAA-1 and Jurassic/Cretaceous play at GSS041NAA-2.
- Identified hydrocarbon plays: Jurassic and Cretaceous
- Target depth for wells: 2,200 m
- Area: 1,421 Sq. Km.
- Datasets: 2D seismic, 3D seismic
BENGAL-PURNEA BASIN

- **Block-on-offer:** 1
- **Area:** 3,170 sq km

### Prognosticated Resources (In-place MMTOE)

<table>
<thead>
<tr>
<th></th>
<th>Discovered</th>
<th>Undiscovered</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>828</td>
<td>828</td>
</tr>
</tbody>
</table>

| Total Area (Sq Km) | 121,914 |

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

<table>
<thead>
<tr>
<th>Formation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
<td></td>
<td>17</td>
<td>54</td>
<td>38</td>
<td>126</td>
<td>110</td>
<td>191</td>
<td>13</td>
<td>42</td>
<td>70</td>
<td>10</td>
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</tbody>
</table>

- Bengal Land
- Bengal Offshore
- Purulia Land
- Purulia Offshore

### Generalised Stratigraphic Column

- **Depth Range:** 2000 m
- **Lithology:**
  - Sedimentary
  - Basalt
  - Granite
  - Limestone
  - Coal
  - Muscovite
  - Granite
  - Basalt
  - Granodiorite
  - Granodiorite

### Geological Section Across Bengal Shelf

- **Depth:** 2000 m
- **Stratigraphy:**
  - Bengal Alluvium
  - Bengal Fluvial
  - Bengal Island
  - Bengal Delta
  - Bengal Delta

### Prognosticated Resources (In-place MMTOE)

- **Discovered:** 0
- **Undiscovered:** 828
- **Total:** 828

- **Total Area (Sq Km):** 121,914
BP-ONHP-2019/2:

- Located in the north and west of OALP Block BP-ONHP-2019/1 and in south-west of NELP Block WB-ONN-2005/3.
- Strati-structural plays are present within Paleocene-Late Cretaceous sequences representing channels in low stand stratigraphic framework.
- The area has exploration target primarily in Gondwana along with Paleocene and Cretaceous sequence.
- Target Depth for wells: 2,100 m
- Area: 3,170 Sq. Km. | Datasets: 2D seismic
Brief of offer under OALP Round V

- Contract blocks-on-offer: 11
- Target basins: 8
- Target Plays: Pre-Cambrian / Paleocene- Eocene/ Cretaceous(Basement)/ Pliocene(Biogenic)
- Prospectivity Level: Category I (8), Category II (2), Category III (1)
- Acreage spread: Onland (8), Shallow Water (2), Ultra Deep Water (1)
- Total area on offer: 19,789 sq. km.
- Individual area size: 19 to 4,064 sq. km.
- Shallowest target depth: 500 m
- Deepest target depth: 4,000 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 and the presentation are available online

- NDR ready with the Data Rooms
  - Industry-standard G&G interpretation software with full functionality are available for on-the-spot assessment

- Continued access to NDR for more strength/missed-out data
  - NDR is updated with new data including recently acquired seismic 2D data from NSP (“National Seismic Programme”)
  - Basin-specific information on hydrocarbon resources are available

- NCR (“National Core Repository”) has been conceptualized
  - However Cores/ Drill-cuttings/ Fluid samples can be accessible from NOC’s Core Labs, declared as National Assets
Welcome to an opportunity of exploring the ‘undiscovered’ potential of both conventional and un-conventional hydrocarbons, under leveraged fiscal terms and simplified contracts...