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
Basin category

- 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”)

![Indian Sedimentary Basins Map](image)
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-PURRENA*(†), Kerala-Konkan, Ganga-Punjab, Pranhita-Godavari(PG), Satpura-South Rewa-Damodar, Himalayan Foreland, Chhattisgarh, Narmada, Spiti-Zanskar, Deccan Synclise, 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>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Basins</th>
<th>Established</th>
<th>Undiscovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mumbai Offshore Basin</td>
<td>4794</td>
<td>4852</td>
</tr>
<tr>
<td>Assam Shelf Basin</td>
<td>1868</td>
<td>4133</td>
</tr>
<tr>
<td>Rajasthan Basin</td>
<td>938</td>
<td>3188</td>
</tr>
<tr>
<td>Cauvery Basin</td>
<td>292</td>
<td>1672</td>
</tr>
<tr>
<td>Cambay Basin</td>
<td>1800</td>
<td>786</td>
</tr>
<tr>
<td>Saurashtra Basin</td>
<td>79</td>
<td>1246</td>
</tr>
<tr>
<td>Kutch Basin</td>
<td>71</td>
<td>827</td>
</tr>
<tr>
<td>Bengal-Purnea Basin</td>
<td>0</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

### Block Area

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Area In Sq.Km.</td>
<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>135</td>
<td>19</td>
</tr>
</tbody>
</table>

- Cauvery Basin: 20%
- Bengal Purnea: 16%
- Assam Shelf Basin: 19%
- Rajasthan Basin: 17%
- Mumbai Offshore: 11%
- Kutch Basin: 9%
- Saurashtra Basin: 7%
- Cambay Basin: 1%
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>Play-wise Conventional Hydrocarbon Inplace (MMTOE)</th>
<th>Discovered</th>
<th>Undiscovered</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eocene - Khulija</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eocene - Bandh</td>
<td>7</td>
<td></td>
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</tr>
<tr>
<td>Paleocene - Sanu</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Cretaceous - Gorra</td>
<td>178</td>
<td></td>
<td></td>
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<tr>
<td>Early Cretaceous - Paliwar</td>
<td>285</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Jurassic - B &amp; B</td>
<td>136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Jurassic - Jaisalmer</td>
<td>108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Jurassic - Lathi</td>
<td>53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permo-Triassic - Bhuana</td>
<td>117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infra-Cambrian - Up Carbonate</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infra-Cambrian - Bilara</td>
<td>299</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infra-Cambrian - Up Jodhpur</td>
<td>143</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eocene - Thumibi</td>
<td>166</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eocene - Dharvi-Dungar</td>
<td>106</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paleocene - Barmer Hill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palaeocene - Fatehgarh</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Volcanics - Rageshwali</td>
<td>45</td>
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</tr>
<tr>
<td>Cretaceous - Ghagar-Hakra</td>
<td>101</td>
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<td></td>
</tr>
<tr>
<td>Basement - Malani</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Area (Sq.Km.) 77,500
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.
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: 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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1800</td>
<td>786</td>
<td>2586</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>1,868</td>
<td>4,133</td>
<td>6,001</td>
</tr>
</tbody>
</table>

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 Palaeocene-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

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

<table>
<thead>
<tr>
<th>Country</th>
<th>Discovered</th>
<th>Undiscovered</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Cretaceous</td>
<td>292</td>
<td>1672</td>
<td>1964</td>
</tr>
<tr>
<td>Basement-CY</td>
<td>21</td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>

**Total Area (Sq Km):** 240,000
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

<table>
<thead>
<tr>
<th>Prognosticated Resources (In-place MMTOE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovered</td>
</tr>
<tr>
<td>4794</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

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>79</td>
<td>1246</td>
<td>1325</td>
</tr>
</tbody>
</table>

Total Area (Sq Km) 194,114
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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>828</td>
<td>828</td>
</tr>
</tbody>
</table>

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.
<table>
<thead>
<tr>
<th><strong>Brief of offer under OALP Round V</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contract blocks-on-offer:</strong></td>
</tr>
<tr>
<td><strong>Target basins:</strong></td>
</tr>
<tr>
<td><strong>Target Plays:</strong></td>
</tr>
<tr>
<td><strong>Prospectivity Level:</strong></td>
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<tr>
<td><strong>Acreage spread:</strong></td>
</tr>
<tr>
<td><strong>Total area on offer:</strong></td>
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<tr>
<td><strong>Individual area size:</strong></td>
</tr>
<tr>
<td><strong>Shallowest target depth:</strong></td>
</tr>
<tr>
<td><strong>Deepest target depth:</strong></td>
</tr>
<tr>
<td><strong>Datasets:</strong></td>
</tr>
</tbody>
</table>
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
National Data Repository

NDR is a centralised E&P Data repository of Indian Sedimentary Basins

Key Features

- Ease of Access
- Integrated with GIS browser
- Physical Data Rooms for data viewing and evaluation of acreages/blocks
- Seamless Data Exchange
- Cutting Edge Technology for Data Management

E&P Data loaded in NDR

- 2D Seismic Data: 2.34 Million LKM
- 3D Seismic Data: 0.79 Million SKM
- Seismic Reports: 14,523 nos.
- Well and log data: 17,898 nos.
- Well Reports: 36,432 nos.

* Statistics As on January 2020
### Data Provided by NDR to E&P Users

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Data Shared for Evaluation of Acreages/Blocks (Since July 2017)</th>
<th>Data Shared Under OALP/DSF Bid Rounds (Since July 2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processed 2D (LKM)</td>
<td>12,40,893</td>
<td>1,29,990</td>
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<tr>
<td>Processed 3D (SKM)</td>
<td>3,03,824</td>
<td>19,450</td>
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<td>Wells</td>
<td>3,714</td>
<td>511</td>
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<tr>
<td>Reports</td>
<td>4,543</td>
<td></td>
</tr>
<tr>
<td>Raw Seismic Data</td>
<td>3D – 11,949 SKM</td>
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<tr>
<td></td>
<td>2D – 4,290 LKM</td>
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</tbody>
</table>

*As on January 2020*

**REGISTERED WITH NDR**

- 251 Companies

**Data provided to**

- 36 Indian E&P companies
- 16 Foreign E&P companies
- 08 Academic Institutes
- 02 Indian Govt. Institutions
NSP 2D Lines provide potential leads in unappraised basinal areas, especially in category-II/III basins.

Hydrocarbon Resource Assessment Study (2017) indicates substantial volume of resource accumulations for further exploration activities in major sedimentary basins of India.

Considerable opportunity exists in mature basins with large areas in open acreages.
Petroleum Systems and Speculative Leads Based on NSP 2D Lines
Potential accumulations exist in open acreage as indicated by the study.
Welcome to an opportunity .. of exploring the ‘undiscovered’ potential of both conventional and un-conventional hydrocarbons, under leveraged fiscal terms and simplified contracts...