Hydrocarbon Prospectivity

Indian Sedimentary Basins

Sedimentary basins in India

Category I:

- Basins which are commercially producing
- Have 'reserves' to produce
- Also have contingent and prospective resources

Category II:

- Basins which have discoveries, yet to produce commercially
- Have 'contingent resources'
- Also have prospective resources

Category III:

- Basins which are yet to have a discovery
- Have only 'prospective resources'

• PRMS of reporting resources and reserves is the basis for such categorization showing the basin maturity

Sedimentary basins and category







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

• Saurashtra, Kutch, Vindhyan, Mahanadi and Andaman

 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

Basins are shown in decreasing order of undiscovered inplace
Saurashtra, Kutch and Bengal-Purnea are under upgrade

Sedimentary basins: new boundaries



- Basins were remapped using latest GIS tools
- Boundaries were redefined, deepwater areas added to respective basins, new areas identified and included
- Shallow water was mapped till 400m water depth and deepwater up to basin boundary/Exclusive Economic Zone ("EEZ"), whichever closer
- Total area: 3.36 million sq km
 - Onland: 1.63 million sq km
 - Shallow water: 0.41 million sq km
 - Deepwater: 1.32 million sq km

Tectonic framework of sedimentary basins



Assessment of conventional hydrocarbons

Last assessment was carried out during 1995-96

- 15 major basins were assessed
- Aerial Yield method was used
- Deepwater areas were assessed separately

During last two decades

- A vast amount of data has been collated
- New basins and plays have opened up
- A few plays/ basins entered into mature stages
- Assessment methodologies have substantially improved

Reassessment of conventional resources was completed in 2017

- All 26 sedimentary basins including deepwater areas were reassessed
- 177 plays were assessed, risk-weighted and concluded with previous findings compared

Results of the study

- Last assessment done for 15 sedimentary basins :
 - Total Inplace assessed: 28,085 MMtoe
 - Deepwater separately assessed with 7,000 MMtoe inplace
- Current assessment done for all 26 basins with deepwater areas included
 - Inplace reassessed: 41,872 MMtoe
 - 15 old basins: 41,004 MMtoe and 11 new basins: 868 MMtoe
 - Discovered: 12,076 MMtoe and Undiscovered: 29,796 MMtoe (71% of the total inplace)
- Increase of total hydrocarbon estimate: 49.1%
- Reassessment at hydrocarbon play level for the first time
- Generated a complete geoscientific database with subsurface models, maps and reports

Assessment 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 datasets were assessed using improved tools . Rest with Aerial Yield method
- Assessment at play level
- Deepwater areas included and assessed with basins
- ✓ New tools and expanded datasets

Hydrocarbon inplace compared



- New studies indicate significant volume increase for KG, Rajasthan, Assam Shelf, Cauvery and Saurashtra basins
- Ganga-Punjab, Himalayan Foreland and Assam-Arakan have reduced numbers for being riskweighted
- New study:
 - 15 basins have cumulative inplace of 41,004 MMtoe
 - Remaining basins contribute to 898 MMtoe only, out of which Vidhyan alone has 632 MMtoe.

Category-wise sedimentary basin area



■ Category I ■ Category II ■ Category III



 Majority of the area are under Category III without a discovery and subject to intense exploration

Territorial distribution across category

Onland Area Shallow water Area Deep water Area





 Nearly half of the area falls in onland, which further occupies 58% of Category III area

Conventional hydrocarbons across category



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total discovered inplace.



Conventional hydrocarbons across geological era



- Total estimated conventional hydrocarbons: 41,868 MMtoe
- 177 plays mapped
- 87 in Tertiary, 53 in Mesozoic and 37 Pre-Mesozoic

Potential in Tertiary-Quaternary plays



Total hydrocarbon inplace



 Total estimated conventional hydrocarbons: 31,655 (Tertiary) +2 (Quaternary) = Gan 31,469 MMtoe. Quaternary potential includes Biogenic plays

Potential in Mesozoic plays



• Total estimated conventional hydrocarbons: 8,594 MMtoe.

Krishna-Godavari (KG) 2935 Cauvery 1929 Rajasthan 1023 Kerala-Konkan (KK) 970 Saurashtra 798 Kutch 763 Mahanadi 80 Pranhita-Godavari (PG) 48 **Bengal-Purnea** 21 Andaman 11 Satpura-South Rewa-Damodar 9 Spiti-Zankskar 5 Karewa 2 Cambay 0

Total hydrocarbon inplace

Potential in Proterozoic plays



Total estimated conventional hydrocarbons: 1,265 Mmtoe, nearly half of it lies in Vindhyan basin

Potential in Palaeozoic plays



• Total estimated conventional hydrocarbons: 221 MMtoe. Includes Gondwana sediments which also have potential for coal-bed methane and shale oil and gas.

Potential in Achaean plays



Category I basin potential



Archean Proterozoic Paleozoic Mesozoic Tertiary Quarternary

Total estimated conventional hydrocarbons: 35,509 MMtoe (85% of total inplace over 30% of total basin area)

Category II basin potential



Proterozoic Mesozoic Tertiary

Total estimated conventional hydrocarbons: 3,876 MMtoe (9% of total inplace over 23% of total area)

Category III basin potential



Proterozoic Paleozoic Mesozoic Tertiary

Total estimated conventional hydrocarbons: 2,483 MMtoe (6% of total inplace over 47% of total area)

Hydrocarbon resource conversion



* Includes production from coal bed methane

* Btoe> Billion ton oil-equivalent, 1 ton = 6.29/oil density (0.89) = 7.07 barrel

Unconventional resources

Coal Bed Methane (CBM)

- India's inplace: 2,600 BCM
- 11 active CBM blocks out of 33 awarded in 4 rounds of CBM bidding
- Blocks spread over 11 States
- Reserves: 295 BCM
- Cumulative production (31.01.20): 3.63 BCM
- Production: 1.8 MMSCMD from 4 blocks
- Operational area: 4,503.5 sq. km.

Shale oil and gas

- Exploration efforts carried out so far by NOCs under Shale Gas & Oil Policy, 2013
- A total of 28 wells drilled by ONGC in Cambay , KG, Cauvery Assam Shelf and Assam- Arakan Fold Belt .
- A total of 4 wells drilled by OIL in Assam Shelf and Jaisalmer Basin.
- No established shale Gas/Oil reserves yet
- Resource estimates by 3 agencies in different basins
- ONGC (Aug.'13) estimated Shale Gas inplace of 5,309 BCM for 5 basins- Cambay, KG, Cauvery, Ganga, Assam
- CMPDI (July'13) estimated Shale Gas resources of 1,297 BCM for Gondwana basins
- USGS (Jan.'11) estimated resources of Shale Gas of 173 BCM for 3 basins: Cambay, KG & Cauvery

Unconventional resources: Gas hydrate

- Natural Gas Hydrate Program Expedition (NGHP) was formed to explore and develop the gas hydrate resources of Indian subcontinent in three stages.
 - The first stage was to identify the presence of gas hydrate deposits in Indian Offshore Basins
 - The second stage was to identify gas hydrate in sand rich geological setting within gas hydrate stability zone and suitable locations for production testing
 - During the second stage, 42 gas hydrate wells at 25 sites were completed in deep water areas of Krishna Godavari and Mahanadi offshore in Eastern Coast of India
 - The third stage is to carry out production testing
- In 2016, ONGC reported prognosticated gas hydrate inplace of nearly 9 TCF in KG basin



Data access and enrichment

National Data Repository (NDR)

- Set up in 2017 in DGH premises, NDR hosts the country's complete E&P database.
- All bidding of acreages under HELP and DSF Policy are now through NDR
- Companies can view, analyze and buy data at a nominal cost
- Data uploaded on NDR till December 2019:
 - 2.319 million LKM of 2D seismic data
 - 0.787 million SKM of 3D seismic data
 - 17,707 wells and well logs
 - 35,823 well reports

National Seismic Programme (NSP)

- NSP is a 2D seismic data acquisition program in Indian sedimentary basins where scanty or little data were available
- Campaign started in October 2016
- Data generation ongoing, to be completed within 5 years by NOCs
- Data generated are processed and continuously uploaded in NDR
- Target : 48,243 Line Kilometer (LKM) Acquired: 43,112 LKM (89%) as of December 2019

Status of appraisal





• Preliminary findings. Study under finalization

Opportunities to bidders

Contract areas are all pre-assessed by prospective bidders or pre-defined by Government

- Information on block-level prospectivity outlined by originator through due diligence report under Open Acreage Licensing Programme (OALP)
- Information Dockets are available for fields on offer under Discovered Small Field bid rounds
- 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 continuously 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
 - Until then Cores/ Drill-cuttings/ Fluid samples can be accessible from NOC's Core Labs, declared as National Assets



Welcome to opportunities ...

of exploring the 'undiscovered' potential of both conventional and un-conventional hydrocarbons as well as developing the discovered hydrocarbon resources, under leveraged fiscal terms and simplified contracts...

