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(Part- I)

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STATE REVIEWS
(Offshore Regions)

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OFFSHORE REGIONS

The Government of India notified the Offshore Areas Minerals (Development & Regulation) Act, 2002 (OAMDR Act), No. 17 of 2003 in the Gazette of India, Extraordinary, Part-II, Section-1, dated 31.1.2003. The purpose of the Act is to provide for development and regulation of mineral resources in the territorial waters, continental shelf, exclusive economic zone and other maritime zones of India and to provide for matters connected therewith or incidental thereto. The Act is applicable to all minerals in offshore areas including minerals prescribed under Atomic Energy Act, 1962, but excludes oils and related hydrocarbons as there is separate legislation in force. The Act came into effect from 15.1.2010 vide S.O.338 (E), dated 11.2.2010 notified by the Central Government.

The Act makes it mandatory to undertake reconnaissance, exploration or production operation in the offshore areas in accordance with the prescribed terms and conditions for reconnaissance permit (RP), exploration licence (EL) or production lease (PL) granted under the Act and the rules made thereunder. The availability of the areas for grant of RP, EL or PL shall be notified within six months from the commencement of the Act, and subsequently at such times as considered necessary. The Act empowers the Central Government to make rules for the purpose of the Act including terms and conditions under the RP, EL, PL, etc. The Rules, namely, the Offshore Areas Mineral Concession Rules, 2006 have been framed and notified on 3.11.2006 by G.S.R.691(E) published in the Gazette of India, Extraordinary, Part II, Section 3 (i), No. 539, dated 4.11.2006. The Rules have come into effect on the date on which the Offshore Areas Mineral (Development and Regulation) Act, 2002 came into force, i.e, 15.1.2010.

As per S.O.1341(E) dated 7.6.2010, The Controller General, Indian Bureau of Mines has notified the mineral-bearing offshore blocks available for grant of Exploration Licence. As per the attached Schedule to the said Notification, there are 26 offshore areas available in offshore waters of Bay of Bengal and 37 offshore areas in the offshore waters of Arabian Sea for grant of Exploration Licence.

The orders for grant of exploration licences were issued by the Administering Authority on 05.04.2011 for the 62 exploration blocks (the bounding latitude and longitude of Block Nos. 3 & 32 falling in the Arabian Sea were same and therefore these were considered as a single block and granted as Block No. 3). Before execution of deed granting such licence, the grant of exploration licences in 62 blocks was challenged through the writ petition in the judicature of various High Courts. Due to interim orders passed by various Hon'ble High courts on the writ petition and non disposal of the said petition, the offshore exploration licences granted have not been executed. Besides, it has come to the notice of the Administering Authority that some of the exploration blocks notified for grant of offshore exploration licences vide notification dated 07.06.2010 overlap with areas other than offshore area, to which the OAMDR Act does not apply.

The Central Government vide S.O.19 (E) dated 06.01.2011, published in the Official Gazette, has declared the extent of the Coastal Regulation Zone (CRZ) and has also imposed certain restrictions on the setting up and expansion of industries, operations or processes and the like in the CRZ. The said statutory order states that CRZ shall also apply to the water and the bed area between the Low Tide Line to the territorial water limit (12 Nm) in case of seas and has prohibited in the area so identified as CRZ, inter alia, the mining of sand, rocks and other sub-strata materials except those rare minerals not available outside the CRZ area. In the context of said notification, all the 62 offshore blocks lie within the area identified as CRZ which attracts the prohibition of mining (operation undertaken for the purpose of winning any mineral).

The OAMDR Act provides that the holder of an exploration license for offshore area shall have the exclusive right to a production lease for winning of a mineral. In view of the effect of the CRZ Notification dated 06.01.2011, the purpose of executing the 62 offshore exploration licences could not be realised as the applicants couldnot undertake operations for winning of minerals inspite of grant of production lease after successful completion of exploration operations.

Therefore, taking into consideration all the above stated facts, the Controller General, IBM and administering authority Offshore Areas Minerals (Development & Regulation) vide S.O.19 (E) dated 6th January, 2011, published in the Official Gazette, annulled the Notification issued vide S.O.1341(E) dated 7th June 2010 with effect that all subsequent actions undertaken for grant of the 62 exploration licences hereby stand rescinded.

Government of India has signed 254 contracts under NELP regime with National Oil Companies and private (both Indian and foreign)/ Joint Venture companies. At present, 111 contracts are operational out of the total 310 contracts (254 NELP, 28 Pre-NELP Field round and 28 Pre-NELP Exploration) signed so far under various bidding rounds.

The awarded 254 blocks under NELP regime are at locations in inland (114), offshore shallow water (59) and deepwater (81) areas. As a result of exploratory activities, several unexplored and poorly explored areas, in particular, offshore and deepwater areas, have been appraised through geophysical surveys and exploratory drilling. Till date, 240 hydrocarbon discoveries (125 Oil and 115 Gas) have been made under various regimes and most of the gas discoveries have been made in offshore-shallow (52) and deepwater blocks (40). Details of exploration block awarded/relinquished/operational are provided in Table -1.

Table - 1: Details of Exploration Block Awarded (as on 01.04.2017)

Round	No. of blocks awarded	No. of blocks relinquished	No. of opertional blocks
NELP-I	24	21	3
NELP-II	23	20	3
NELP-III	23	19	4
NELP-IV	20	16	4
NELP-V	20	15	5
NELP-VI	52	41	11
NELP-VII	41	27	14
NELP-VIII	32	18	14
NELP-IX	19	4	15
Total	**254**	**181**	**73**

***Source**:India's Hydrocarbon Outlook, 2016-17, Directorate General of Hydrocarbons, Ministry of Petroleum & Natural Gas.*

In order to explore and produce new sources of natural gas from coal-bearing areas, the Government had formulated a CBM Policy in 1997, wherein CBM being Natural Gas is explored and exploited under the provisions of OIL Fields (Regulation & Development) Act 1948 (ORD Act 1948) and Petroleum & Natural Gas Rules 1959 (P&NG Rules 1959) administered by Ministry of Petroleum & Natural Gas (MOP&NG). CBM policy was aimed to provide attractive fiscal and contractual framework for exploration and production of CBM which is an environment-friendly clean gas fuel similar to conventional natural gas. In order to harness CBM (Coal Bed Methane) potential in the country, CBM blocks were offered through international competitive bidding for exploration and production for the first time in the year 2001. Under the CBM policy, till date, four rounds of CBM bidding have been implemented by MoP&NG, resulting in award of 33 CBM blocks [including 2 blocks on Nomination and 1 block through Foreign Investment Promotion Board (FIPB) route]. Till date, most CBM exploration and production activities in India are pursued by domestic Indian companies. These CBM blocks are in the States of Andhra Pradesh, Assam, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu and West Bengal.

As per S.O. 1523(E) dated 06.04.2018 the Additional Director General, National Mission Head-II , Geological Survey of India has been notified as the "Administering Authority" for the purpose of the said Act by Clause (a) of Section (4) of the Offshore Area Mineral Development and Regulation Act, 2002 ,17 of 2003 and in supersession of the notification published in Gazzette of India, Extraordinary Part II Section 3, Subsection (ii) vide number S.O. 339(E) dated 11th February 2010.

Resources

As on 1.4.2017, the total balance recoverable reserves of crude oil were estimated at 604.10 million tonnes, out of which 324.24 million tonnes (54%) are in onshore and 279.86 million tonnes (46%) in offshore areas. ONGC (nomination) has the largest share of 72% in reserves of crude oil with OIL (nomination) and PSC regime contributing 13% and 15%, respectively.

The balance recoverable reserves of natural gas as on 01.04.2017 were placed at 1,289.81 billion cu m, out of which 479.71 billion cu m (37%) are in onshore and 810.10 billion cu m (63%) in offshore areas. PSC regime has the largest share of 49% in natural gas reserves with ONGC (nomination) and OIL (nomination) at 41% and 10%, respectively (Table-2).

Table – 2: Balance Recoverable Reserves of Crude Oil & Natural Gas in India including Offshore Areas (As on 1.4.2017)

(Crude oil in million tonnes)
(Natural Gas in billion cu m)

Area	Crude oil*	Natural gas*
India	**604.10**	**1289.81**
Onshore: Total	**324.24**	**479.71**
Offshore: Total	**279.86**	**810.10**
Western Offshore@	239.20	302.35
Eastern offshore	40.67	507.76

Source: *Indian Petroleum & Natural Gas Statistics 2015-16, Ministry of Petroleum & Natural Gas.*
** Proved and indicated balance recoverable reserves.*
@ Includes Gujarat Offshore.
Note: In case of Natural Gas, reserves includes Coal Bed Methane in Jharkhand, Madhya Pradesh and West Bengal.

EXPLORATION ACTIVITIES

Conventional Hydrocarbon

ONGC, GSI and other Public & Private Sector companies continued their efforts in respect of exploration for hydrocarbon in offshore region, both shallow and deep water, during 2016-17.

Private Companies/Joint Ventures

During 2016-17, a total of 19240.75 GLKM of 2D seismic data was acquired, mostly of which is in offshore region and were carried out by Private/JVs. A total of 13648.27 SQM of 3D seismic data was acquired, majority of which was carried out by ONGC in its offshore nomination areas. A total of 141 exploratory wells and 398 developments wells were drilled in 2016-17. Majority of the development wells were drilled by ONGC in its inland nomination areas (Table -3).

Marine & Coastal Survey

GSI continued its offshore geoscientific studies both in Exclusive Economic Zone (EEZ) and Territorial Waters (TW) of India. Survey in the near-shore zones, i.e., 0 m to 10 m isobaths were carried out using hired mechanical boats.

Table - 3: Exploratory & Development Efforts under Nomination & PSC Regime during 2016-17

Sl. No.	Subject	Parameter	ONGC (Nomination)	OIL (Nomination)	Pvt/JVs*	Total
1	2D seismic data acquired	Inland (GLKM)	262.7	196.96	4157.09	4616.75
		Offshore (GLKM)	-	-	146214	146214
		Total 2D Seismic	262.7	196.96	18781.09	19240.75
2	3D seismic data acquired	Inland (SKM)	2263.61	67.08	5494.60	7825.29
		Offshore (SKM)	5011.98	-	811	5822.98
		Total 3D Seismic	7275.59	67.08	6305.60	13648.27
3	Exploratory wells drilled	Inland	52	19	30	101
		Offshore	31	-	9	40
		Total Exploratory Wells	83	19	39	141
4	Exploratory Meterage drilled	Inland ('000)	131.99	63.88	78.37	274.24
		Offshore ('000)	92.69	-	25.39	118.07
		Total Exploratory Meterage	224.67	63.88	103.75	392.31
5	Development Wells drilled	Inland	266	37	9	321
		Offshore	86	-	-	86
		Total Development Wells	**352**	**37**	**9**	**398**
6	Development Meterage drilled	Inland ('000)	493.05	105.44	21.21	619.69
		Offshore ('000)	221.87	-	-	221.87
		Total Development Meterage	714.92	105.44	21.21	841.56

Source: *India's Hydrocarbon Outlook: 2016-17 - A report on exploration & production activities, Directorate General of Hydrocarbon, Ministry of Petroleum & Natural Gas.*
** Includes 168.82 GLKM of 2D seismic data acquired by ONGC under PSC regime in 2016-17 in 21 exploratory wells.*

Marine and Coastal Survey Division (M&CSD) has completed seabed mapping of 1,37,520 sq.km out of 1,50,000 sq.km in 5 km × 2 km grid within Territorial Waters and 18,55,614 sq. km out of 18,64,900 sq. km in the Exclusive Economic Zone beyond Territorial Waters on reconnaissance scale. The total EEZ coverage including TW is 19,93,134 sq. km out of a total EEZ area of 20,14,900 sq. km. In addition, an area of 1,164 sq. km within the contiguous zone was mapped on reconnaissance scale with sampling grid of 5 km x 2 km.

During the field session, R.V. Samudra Ratnakar covered an area of 41,234 sq. km by high resolution seabed mapping by multi-beam bathymetry and covered 31,134 sq. km for mineral investigation. Under different themes, R.V. Samudra Ratnakar collected 12,549 LkM single beam bathymetry, 5,275 LkM magnetic, 16,550 LkM gravity, 2,538 LkM multichannel seismic, 15,587 LkM sub-bottom profile and 15 Conductivity-Temperature-Depth (CTD) profile data, 21 ROV data and also sediment samples and water samples from 262 stations. During 2016-17, a total of twenty-three cruises were undertaken using three vessels. i.e., 9 cruises of R.V. Samudra Ratnakar, 7 cruises of R.V. Samudra Kaustubh and 7 cruises of R.V. Samudra Shaudhikama.

The following marine geoscientific surveys were carried out during 2016-17 Field Season:

R.V. Samudra Ratnakar

1. SR-023: Study of morphology and tectonic set up of Northeast Andaman Sea within EEZ of India.

2. SR-023A: Special cruise mounted for Indian Navy in search of missing IAF_AN-32 Aircraft.

3. SR-019: Study of tectonic set up of Bay of Bengal and Andaman-Nicobar subduction complex within EEZ of India by systematic multi-channel seismic survey.

RV Samudra Kaustubh

1. ST-251: Study of Seabed Morphology by Seismic and Magnetic survey within Territorial Waters off Visakhapatnam - Pudimadaka, Andhra Pradesh coast, Bay of Bengal

2. ST-254: Systematic Magnetic Survey within Territorial Waters in the shelf area between Paradip and Shortt's Island, Odisha.

3. ST-256: Study of Seabed Morphology of the shelf off Palar river mouth, Tamil Nadu by Swath Bathymetric Survey.

4. ST-257: Study of Seabed Morphology by Seismic and Magnetic survey within Territorial Waters off Chennai-Point Pudi, Tamil Nadu Coast and Bay of Bengal.

RV Samudra Shaudhikama

1. SD-270: Seabed mapping off Mahuva, Gujarat (block-III) beyond Territorial Waters of India.

2. SD-271: Mapping of seabed off Diu, Gujarat beyond Territorial Waters of India.

3. SD-272: Mapping of seabed off Pipavav, Gujarat, beyond TW of India.

Airborne Survey

GSI pursued airborne geophysical survey for generating database by employing magnetic and gamma ray spectrometric techniques. The survey was followed by data processing, preparation of aerogeophysical maps and interpretations that help in ground evaluation and add information to geological maps and would aid prospecting and exploration for minerals. The data from the aerial surveys thus form an important backup for refining the geological understanding of an area, with focus on identification of favourable locales of mineralisation, crustal structure, etc.

During 2016-17, the airborne surveys by Twin Other Airborne Survey System (TOASS) were carried out in the Alwar-Neem Ka Thana area in parts of Rajasthan, Haryana & Uttar Pradesh and over the Marwar – Khetri area in parts of Rajasthan & Haryana. The surveys in both the areas were conducted by engaging magnetic and radiometric sensors. a) Alwar-Neem Ka Thana area in parts of Rajasthan, Haryana & Uttar Pradesh: Aerophysical survey has been conducted through TOASS over Alwar-Neem Ka Thana area in parts of Rajasthan, Haryana & Uttar Pradesh with the objective to identify potential areas for mineral investigation. The study area is surrounded by different blocks which were already covered by airborne surveys. The preliminary data of unprocessed aeromagnetic show high frequency anomalies which is indicative to causative sources of shallow nature as seen towards northern part of the area around Shahpur, Chomu and Dausa where several base metal prospects have been reported by GSI; b) Marwar-Khetri area in parts of Rajasthan & Haryana: A total of 37,645 line km of magnetic and radiometric data have been collected covering an area of 43,048 sq. km through TOASS.

The Magnetic anomalies of the area are significant as there are base metal occurrences reported from Biramsar area.

Heliborne Geophysical Survey

The heliborne survey was conducted over Shimoga area in Karnataka with an objective to delineate potential areas for gold occurrences and PGE mineralisation within Shimoga Schist belt. The surveyed area covered 2,683 lkm over an area of 593 sq. km. The radially averaged power spectrum analysis of magnetic anomaly has shown presence of two crustal magnetic interfaces at depths of about 320 and 1,460 m. Electromagnetic signal map shows possible zones of mineralisation.

ONGC & OIL

A number of new initiatives have been taken to promote exploration and production activities in the country. A multi-dimensional approach has been adopted for furthering the objective of enhancing energy security of the country through increased domestic production and improved investment climate in the country. Some of the policy initiatives taken by the Government for exploration and development of oil and gas in the country are as under:

The operator can explore and produce conventional as well as unconventional hydrocarbon, such as, Coal-bed Methane (CBM), Shale etc. under a single licence.

Opening up of India's sedimentary basins through open acreage policy will provide option for the companies for selection of Exploration blocks. They will also not be required to wait till the formal bid round is launched by the government as the open acreage area will be available throughout the year for bidding.

Exploration will be allowed through-out the contract period. One of the major restrictions under Production Sharing Contract (PSC) was regarding exploration after the completion of exploration phase. The Hydrocarbon Exploration Licencing Policy (HELP) addresses the same and allows exploration throughout the contract period.

Exploration Phase for onshore areas have been increased from 7 years to 8 years and for that of offshore from 8 years to 10 years.

As on 31.3.2016, there were in all 427 oil/gas fields under these companies in the country including offshore areas.As per policy guidelines, ONGC Ltd and Oil India Ltd would have to carry out Shale Gas and Oil exploration in 50 and 05 blocks respectively for assessment under Phase-I. ONGC has begun carrying out Shale Gas and Oil exploration activities in Cambay, Cauvery, Krishna-Godavari and Assam & Arakan Basins. ONGC has drilled 21 wells and 83 cores have been collected in 21 wells. During 2016- 17, ONGC has completed coring and other data collection programme in three wells in Cambay basin in different blocks. These data will help in assessment of shale gas and oil potential of respective blocks. Oil India Limited commenced carrying out Shale Gas and Oil exploration activities in Assam and Rajasthan basins. Oil India Ltd (OIL) has initially identified five Blocks viz. Dibrugarh, Chabua, Dumduma, Jaisalmer and Jairampur from its Nomination acreages and later on identified one more block (Deomali PEL) and started G&G evaluation. OIL has completed G&G evaluation of four Blocks, i.e, Dibrugarh PML, Chabua PML, Dumduma PML and Jaisalmer PML. Out of 55 blocks, 3 blocks operated by ONGC and 4 blocks operated by OIL are in Assam.

During the year 2016-17, ONGC has made 23 oil and gas discoveries in domestic fields (operated by ONGC). Out of the 23, 13 discoveries are in onshore areas and 10 in offshore areas. A total of 12 discoveries were made in the new prospects of which 11 were new pool discoveries. Of the above 23 discoveries, 4 discoveries have been made in NELP blocks. Nine of these discoveries have already been put to production. ONGC also drilled 100 exploratory wells with good Hydrocarbon exploration success. Notable among them is Jabera discovery. ONGC with this discovery has brought Vindhayan Basin into the oil & gas reserve map of India (Table-4).

Table – 4 : Details of Oil and Gas Discovery by ONGC in Offshore Areas during 2016-17

S.N.	Well No.	Basin/Sub-basin	Type of Hydro-carbon
1.	KGS092NA-SRI-1	KG (offshore-SW)	Oil & Gas
2.	B-34-2/B-34-B	Mumbai offshore	Oil & Gas
3.	B-157N-1/B-157N-1	Mumbai offshore	Oil & Gas
4.	GS-7-1/GS-71-AA	KG (offshore-SW)	Oil & Gas
5.	B-154N/ B-154N-A	Mumbai offshore	Oil & Gas
6.	D-30-2?D-30-A	Mumbai offshore	Oil & Gas
7.	G-1N-2/G-1-N-AB	KG (offshore-SW)	Oil & Gas
8.	GKS101NCA-1/ GKS101NCA-A	Kachchh	Oil & Gas
9.	MBSO51NAA-2/ NAA-B	Saurashtra	Gas & Cond.
10.	B-12C/B12C-/ B-12C-A	Mumbai offshore	Gas & Cond.

Source: *Hydrocarbon Exploration & Production Activities, India 2016-17.*

Table – 5: Mineral Production in Offshore Regions, 2014-15 to 2016-17 (Excluding Atomic Minerals)

Mineral	Unit	2014-15	2015-16	2016-17 (P)
		Quantity	Quantity	Quantity
Natural Gas (utilised)	m cu m	24861	23012	22038
Petroleum (crude)	'000t	18924	19089	18421

Production

Petroleum (crude) and natural gas (utilised) are the mineral items produced from Offshore region.

Offshore accounted for 51% production of petroleum (crude) and 69% of natural gas (utilised) in the country during 2016-17. In the region, production of petroleum (crude) increased by 3.5% while that of natural gas (utilised) decreased by 4.2% as compared to the previous year (Table - 5).

Coal-Bed Methane

Coal-bed Methane (CBM), an eco-friendly natural gas stored in coal seams, is generated during the process of coalification. The coal and lignite seams contain varying amounts of methane depending on the rank of the carbonaceous matter, the depth of burial and the geotectonic setting of basins. CBM exploration and exploitation has an important bearing on reducing the greenhouse effect. The extraction of CBM through degassing of the coal seams prior to mining of coal, is a cost-effective means of boosting coal production and maintaining safe methane level in working mines.

India has the fifth largest proven coal reserves in the world and thus, holds significant prospects for exploration and exploitation of CBM. The prognosticated CBM resources in the country are about 92 TCF (2600 BCM) in 12 states of India. In order to harness CBM potential in the country, the Government of India formulated CBM Policy in 1997, wherein CBM being Natural Gas is explored and exploited under the provisions of Oil Fields (Regulation and Development) Act, 1948 and Petroleum & Natural Gas Rules, 1959. With the announcement of said policy, CBM development gained momentum which laid the foundation of commercial exploitation of CBM in India. The said policy provided level playing platform for exploration and commercial exploitation of CBM by national and international entrepreneurs.

CBM blocks were offered through international competitive bidding for exploration and production of CBM in the country for the first time in May 2001. So far, under the CBM policy, the Government has awarded 33 CBM blocks [including 2 blocks on Nomination and 1 block through Foreign Investment Promotion Board (FIPB) route] in four rounds of bidding to National, Private & Joint Venture Companies. These 33 blocks covers 16,613 sq km out of the total available coal-bearing areas for CBM exploration of 26,000 sq km. These CBM blocks are in the States of Andhra Pradesh, Assam, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Telangana and West Bengal .

In India, most CBM exploration and production activities are pursued by domestic Indian companies. Total prognosticated CBM resources for the awarded 33 CBM blocks is estimated to be about 62.4 TCF (1767 BCM), of which, so far, 9.9 TCF (280.34 BCM) have been established as Gas in Place (GIP).

The vast majority of the best prospective areas for CBM development are in Eastern India, situated in Damodar Koel valley and Son valley. CBM projects exist in Raniganj South, Raniganj East and Raniganj North areas in the Raniganj coalfield, the Parbatpur block in Jharia coalfield and the East and West Bokaro coalfields. Son valley includes the Sonhat North and Sohagpur East and West blocks.

Within the next few years, CBM is expected to emerge as a new source of natural gas production in the country. India has emerged as the fourth country in the world capable of producing CBM on commercial scale. Currently, commercial production has

commenced from Raniganj South CBM block operated by M/s GEECL since July 2007. As on March 2017, CBM production has been around 1.45 MMSCMD from 4 CBM blocks which include incidental production from 1 CBM block Jharia which is operated my M/s ONGC and commercial production from 3 CBM blocks namely, Raniganj South, Raniganj East and Sohagpur West. The projected CBM production is expected to be around 3.4 MMSCMD by 2018-19. Oil & gas discoveries made by ONGC & OIL during 2016-17 are furnished in Table-6.

Table - 6: Oil & Gas Discoveries made by ONGC and Oil India Ltd during 2016-17

Name of Basin	Well Name	Name of ML	Oil/Gas
A. ONGC			
Gujarat Kutch	GKS101NCA-1	GK-OSN-2010/1[NELP- IX]	Gas
Krishna Godavari	KGS092NASRI-1	KG-OSN-2009/2[NELP - VIII]	Oil
Saurashtra Offshore	MBS051NAA-2	MB-OSN-2005/1[NELP-VI]	Gas
Cambay Basin	NDDA (Nadiad # 4)	CB-ONN-2001/1[NELP-III])	Oil
Cambay Basin	Akholjuni-29	Akholjuni PML	Oil
Cambay Basin	Dahej-20	South Dahej PML	Gas
Cambay Basin	Olpad-47	Olpad-Dandi-Extn-I PML	Gas
Cambay Basin	Gandhar-724	Gandhar Ext-XII PML	Oil & Gas
KG Onshore	Kesanapalli West Deep-1	Adavipalem- Ponnamanda PML	Oil & Gas
KG Onshore	Thurupu Vipparu-1	Godavari Onland PML	Gas
KG Offshore (SW)	GS-71-1	GS-15 & 23 PML	Oil & Gas
KG Offshore (SW)	G-1-N-2	Vasishta PML	Oil & Gas
Mumbai Offshore	B-34-2	South & East Bassein PML	Oil
Mumbai Offshore	B-154N-1	BOFF PML	Oil & Gas
Mumbai Offshore	B-157N-1	BOFF PML	Oil & Gas
Mumbai Offshore	D-30-2	BOFF PML	Oil & Gas
Western Offshore	B-12C-2	C' Series ML	Gas
Vindhyan Basin	Jabera-4	Nohta-Damoh-Jabera PML	Gas
A &AA Basin (South Assam Shelf)	Suphayam-2	Golaghat District PEL	Oil
A &AA Basin (South Assam Shelf)	Dayalpur-1	Kasomarigaon (Additional) PML	Oil & Gas
A &AA Basin (South Assam Shelf)	Nambar-12	Nambar PML	Gas
A &AA Basin (South Assam Shelf)	(KHBB_Z) Khoraghat-38_Z	Nambar PML	Oil & Gas
A &AA Basin (North Assam Shelf)	Geleki-390	Namati PML	Oil &Gas
B. Oil India Ltd.			
Upper Assam Onshore	HJN055	Hugrijan PML	Oil
Upper Assam Onshore	NHK606	Hugrijan PML	Oil
Upper Assam Onshore	HJN062	27 Hugrijan PML	Oil & Gas
Upper Assam Onshore	NHK595	Nahorkatiya Extension PML	Oil
Upper Assam Basin	HJN067	Dumduma PML	Gas
Upper Assam Basin	NHK637	Hugrijan PML	Gas
Upper Assam Basin	KRJ001	Tinsukia PML	Oil
Upper Assam Basin	BHB001	Hugrijan PML	Oil
Upper Assam Basin	MKM043	Hugrijan PML	Gas

Source: Director General of Gas & Hydrocarbons, Annual Report 2016-17.

Gas Hydrates

Gas hydrates are formed when gas and water mixtures are subjected to high pressure and low temperature conditions in the sea, usually in water depths of more than 800 m, within sediments just below the sea bottom. They are also formed in some permafrost region of the world. The gas hydrates also act as a cap under which natural gas can get accumulated. Gas Hydrates can be an unconventional future energy source world over. World over production of gas from gas hydrate is in research & development stage. USA, Japan, Russia, China, Germany and Korea are deeply involved in developing viable technology to exploit these proved gas hydrates reserves.

In India, gas hydrate research and exploratory activities are being steered by the Ministry of Petroleum & Natural Gas under National Gas Hydrate Programme (NGHP). The presence of gas hydrate has been established in Krishna-Godavari, Mahanadi, Gulf of Mannar and Andaman Basin.

Under National Gas Hydrate Programme (NGHP), technically coordinated by Directorate General of Hydrocarbons (DGH), various R&D studies are in progress to develop vast resources of gas hydrates in western and eastern offshore and Andaman offshore areas. It is a consortium of National E & P Companies, namely, ONGC, GAIL, OIL and national research institutions NIO, NIOT and NGRI. There are numerous potential offshore areas of gas hydrates in KG, Mahanadi and Andaman deepwaters which are under different stages of development.

NGHP-Expedition-01 exploration programme was carried out in 2006 for mapping gas hydrates zones in Krishna-Godavari, Kerala Konkan, Mahanadi and Andaman offshore regios. A total of 39 holes at 21 sites were drilled and physical presence of gas hydrate in Krishna-Godavari, Mahanadi and Andaman Basin in clay dominated complex geological settings have been established.

NGHP-02 that commenced on 3rd March 2015 was completed on 28th July 2015. A total of 42 wells were drilled at 25 sites in Krishna-Godavari and Mahanadi area in sand reservoirs for gas hydrates. LWD was completed in 25 wells in 4 areas A, B C & E. Coring and wire line logging was carried out in 17 wells in areas 'B' 'C' & 'E'. NGHP-02 has discovered significant gas-hydrate-bearing sand reservoir system in the Krishna-Godavari B, C and E areas. Area A, which is in the Mahanadi deep water basin, has several sand zones devoid of gas hydrates. Two distinct gas hydrate accumulations have been identified in Krishna-Godavari Basin, one is approximately 20 to 100 m thick, layer-type at depths of 400 m and the other accumulation is a fracture-type unit of variable thickness at shallow levels.

NGHP Expedition-02 results have been encouraging and further extensive studies are to be carried out to assess the gas hydrate resource potential, reservoir characterisation, reservoir delineation and geo-mechanical modelling for seafloor along with wellbore stability and identification of sites for pilot production for testing. KG deep offshore Area 'B' & 'C' contain gas hydrate accumulations and these areas could become suitable sites for future gas hydrate production testing under NGHP Exp-03. NGHP-3 aims at carrying out pilot production testing of at least one site in Indian deepwater environment.

Two NGHP R&D projects under direct funding by OIDB were approved in 15th steering committee. The first NGHP R&D project of KDMIPE, ONGC with IIT-Kanpur entitled "Modelling and Simulation of Methane Extraction from Gas Hydrates via Simultaneous Depressurisation and CO_2 Injection" was taken up with an aim to design a simulator with all dynamic variables and estimate methane release per unit time. The second project of NGRI entitled, "Carbon Dioxide & Methane Hydrate Phase Stability in Sandy and Clay Environment: Laboratory Studies" approved under NGHP funding was formulated to carry out the CO_2 phase stability experiments using synthetic sand & clay particles and to find out the rate of methane yield due to depressurisation.

The challenges faced for commercial exploitation of gas from gas hydrates are more or less similar all over the world. Extracting methane from gas hydrate in marine environments is relatively a new path. Japan has taken a lead in this direction. From the progress being made by the Indian NGHP, steps are under way to mitigate anticipated challenges in the Indian context. The NGHP expeditions are an appropriate line of research investigation which could help the country move forward by harnessing this yet elusive resource.