# Indian Minerals Yearbook 2020

## (Part- I)

## 59th Edition

# STATE REVIEWS
## (Offshore Regions)

### (ADVANCE RELEASE)

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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 as 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 Act further states that 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 came 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 had notified the mineral-bearing offshore blocks available for grant of Exploration Licence. As per the attached Schedule to the said Notification, there were 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 was brought 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 overlapped with areas other than offshore area, to which the OAMDR Act did not apply.

The Central Government vide S.O.19 (E) dated 06.01.2011, published in the Official Gazette, declared the extent of the Coastal Regulation Zone (CRZ) and 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 also did state that CRZ shall 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 the 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 licence 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 could not 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 would stand rescinded.

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 Gazette of India, Extraordinary Part, II, Section 3, Sub-section (ii) vide S.O. 339(E) dated 11th February 2010.

The Government of India further signed 340 contracts under NELP regime with National Oil Companies and Private (both Indian and foreign)/ Joint Venture companies. At present, 131 contracts are operational out of the total 340 contracts [(254 NELP, 56 Pre-NELP (small & medium-sized discovered field)], 30 (DSF Round) 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. Details of exploration block awarded/ relinquished/operational are provided in Table -1.

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.

**Table - 1: Details of Exploration Block Awarded ( as on 01.04.2020)**

| Round | No. of blocks awarded | No. of blocks relinquished | No. of blocks active | Present Area |
|---|---|---|---|---|
| Pre NELP | 28 | 17 | 11 | 8824.18 |
| Pre NELP (small & medium sized discovered field) | 28 | 7 | 21 | 887.81 |
| NELP-I | 24 | 21 | 3 | 4372.85 |
| NELP-II | 23 | 22 | 1 | 657.05 |
| NELP-III | 23 | 19 | 4 | 4176.50 |
| NELP-IV | 20 | 17 | 3 | 1438.29 |
| NELP-V | 20 | 16 | 4 | 526.26 |
| NELP-VI | 52 | 44 | 8 | 7129.13 |
| NELP-VII | 41 | 32 | 9 | 14010.82 |
| NELP-VIII | 32 | 29 | 3 | 4217.00 |
| NELP-IX | 19 | 9 | 10 | 11904.00 |
| **Total** | **254** | **209** | **45** | **43242.44** |
| DSF Round-I | 30 | - | 30 | 776.75 |
| OAPL-I,II,III,IV | 94 | - | 94 | 136790 |
| DSF Round-II | 23 | - | 23 | 2999.68 |
| **Total** | **147** | **-** | **147** | **140566.43** |
| **G. Total** | **457** | **233** | **224** | **193520.86** |

***Source**:India's Hydrocarbon Outlook, 2019-20, Directorate General of Hydrocarbons.*

# RESERVES/RESOURCES

As on 1.4.2020, balance recoverable reserves of crude oil were estimated at 603.36 million tonnes, out of which 331.28 million tonnes (55%) are in onshore and 272.08 million tonnes (45%) in offshore areas. ONGC (nomination) has the largest share of 72% in reserves of crude oil with OIL (nomination) and PSC regime contributing 12% and 16%, respectively.

The balance recoverable reserves of natural gas as on 01.04.2020 were placed at 1,371.89 billion cu. m, out of which 880.92 billion cu. m (64%) are in offshore and 490.96 billion cu. m (36%) in onshore areas. PSC regime has the largest share of 50% in natural gas reserves followed by ONGC (nomination) and OIL (nomination) at 41% and 9%, respectively (Table-2).

**Table – 2: Balance Recoverable Reserves of Crude Oil & Natural Gas in India including Offshore Areas (As on 1.4.2020)**

(Crude oil in million tonnes; Natural gas in billion cu. m)

| Area | Crude oil* | Natural gas* |
|---|---|---|
| **India** | **603.36** | **1371.89** |
| **Onshore** | **331.28** | **490.96** |
| **Offshore** | **272.08** | **880.93** |
| Western offshore | 230.04 | 324.60 |
| Eastern offshore | 42.04 | 556.33 |

***Source:*** *Indian Petroleum and Natural Gas Statistics, 2019-20, Ministry of Petroleum and Natural Gas, Govt. of India.*

***Note:*** ** Proved and indicated balance recoverable reserves. 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 2019-20.

## Private Companies/Joint Ventures

During 2019-20, cumulative 3,787.71 LKM 2D seismic data was acquired. Majority of the Data acquisition was carried out under RSC regime (in OALP Blocks) which was approximately 3,599.50 LKM. Cumulative 3D seismic data acquired in FY 19-20 was 7,018.24 SKM out of which approximately 4,166.89 SKM data was acquired by NOCs/JVs/Pvt Companies under OALP. A total of 121 exploratory wells and 526 developments wells were drilled in 2019-20 (Table -3).

**Table - 3: Exploratory & Development Efforts under Nomination & PSC Regime during 2019-20**

| Sl. No. | Subject | Parameter | ONGC (Nomination) | OIL (Nomination) | Pvt/JVs | Total |
|---|---|---|---|---|---|---|
| 1 | 2D seismic data acquired | Onland (GLKM) | 152.43 | 33.68 | 2176.2 | 2362.31 |
| | | Offshore (GLKM) | - | - | 1425.40 | 1425.40 |
| | | **Total 2D Seismic** | **152.43** | **33.68** | **3601.6** | **3787.71** |
| 2 | 3D seismic data acquired | Onland (SKM) | 978.49 | 122.10 | 671.88 | 1772.47 |
| | | Offshore (SKM) | 1744.41 | - | 3501.36 | 5245.77 |
| | | **Total 3D Seismic** | **2722.90** | **122.10** | **4173.24** | **7018.24** |
| 3 | Exploratory wells drilled | Onland | 71 | 11 | 2 | 84 |
| | | Offshore | 27 | - | 10 | 37 |
| | | **Total Exploratory Wells** | **98** | **11** | **12** | **121** |
| 4 | Exploratory Meterage drilled | Onland (‘000 m) | 204.46 | 30.79 | 6.70 | 241.95 |
| | | Offshore (‘000 m) | 74.73 | - | 23.46 | 98.19 |
| | | **Total Exploratory Meterage** | **279.19** | **30.79** | **30.16** | **340.13** |
| 5 | Development Wells drilled | Onland | 273 | 25 | 129 | 427 |
| | | Offshore | 79 | - | 20 | 99 |
| | | **Total Development Wells** | **352** | **25** | **149** | **526** |
| 6 | Development Meterage drilled | Onland (‘000 m) | 515.76 | 65.04 | 253.12 | 833.93 |
| | | Offshore (‘000 m) | 176.82 | - | 53.91 | 230.73 |
| | | **Total Development Meterage** | **692.58** | **65.04** | **307.03** | **1064.66** |

***Source:*** *India's Hydrocarbon Outlook: 2019-20 — Directorate General of Hydrocarbon.*

## Marine and Costal Survey

### Marine Survey

Detailed exploration for polymetals (Co, REE, Ni and Zn etc.) in the Fe-Mn crust/nodules in the An.

During regional exploration for polymetallic nodules off Lakshadweep Sea, an area of 4,185 $km^2$ off Lakshadweep Sea was surveyed by backscatter imaging/multi-beam echosounder system along with magnetic and gravity surveys and sediment sampling to identify the seabed morphology and tectonic set up favourable for augmenting offshore marine resources off Lakshadweep Sea. Forty-four surface sediment samples (grab) in 10 km x 10 km grid and two gravity core (GC) were collected from the investigation area. Geochemical studies of surface and sub-surface samples show that there is an enrichment of manganese content in the sediment along with slight enrichment of Cu, Ni, Co elements in the sediments. High geochemical affinity between $CaCO_3$ and Strontium (Sr) is evident from the chemical data of sediments.

An area of 6,000 $km^2$ was surveyed by backscatter imaging/multi-beam echosounder system along with magnetic and gravity surveys and sediment sampling to identify the seabed morphology and tectonic set up off Lakshadweep Sea in search of Fe-Mn nodules in the abyssal plains as a part of National Programme on High Resolution Seabed Mapping and Natural Resource evaluation in EEZ of India and beyond.The geophysical survey by gravity and magnetic methods brought out three dominant anomaly zones in the area, i.e, a low free air (FA) gravity (Zone-I)-cum-moderate magnetic anomaly (Zone-III) in the eastern side; a high value of FA gravity (Zone-II)-cum-high magnetic anomaly (Zone-II) in the central part; and a moderate free air (FA) gravity (Zone-III)-cum-low magnetic anomaly (Zone-III) in the north-western side of the area. Geochemical studies reveal that sediments having high $CaCO_3$ show high Sr content. There is an enrichment of Mn content in surface sediments. Manganese (Mn) is a redox-sensitive element accelerating the growth of Mn micronodules. Mn/Al ratio varies from 0.03 to 0.06 (average 0.04) indicating that the sediments are derived from Mn-rich (in offshore) areas. The Total REE concentration in surface sediments varies from 90.31 to 155.22 (avg. 120.75) ppm. Sparsely distributed Mn micronodules are there in the investigated area as infillings and encrustations. The chemical data showed that there is enrichment of Mn content in the sediments but the formation of macro-nodule is hindered by factors like the sediments from the Indus Fan, bioturbation, under water currents, proximity to continents etc.

An area of 1,600 sq. km in the continental shelf off Point Calimere in Tamil Nadu-coast was taken up for preliminary assessment of phosphorite in the East Coast Margin of India. Surface sediments collected from shelf area are marked by the presence of glauconite and phosphatic materials. The phosphatic material in the survey area mainly occurs in form of concretions, peloid/pellets, sand-sized phosphatic grains, micro-concretions, steinkerns, ferruginous rock pieces and phosphatised fish bones. The phosphatic material is confined within the water depths of 174 m to 370 m and associated mainly with silty sand and sandy clay sediments. At two locations, it was observed that phosphatic material exist within the ferruginous rock.The size and shape of the phosphatic concretions vary widely in the study area. Size of phosphatic nodules showed variations from 0.5 cm x 0.5 cm to as big as 6 cm x 3 cm. An area of 550 sq. km was delineated in the surveyed area based on the concentration of $P_2O_5$ in the recovered phosphatic concretions and nodules. It was observed that $P_2O_5$ enriched phosphatic nodules/concretions could be recovered from the terrace like features on the outer shelf zone. About 60% of the phosphatic materials recovered were of fertilizer grade (>16%). The average $P_2O_5$ content in these samples was reported as 16% while its maximum value went up to 23% at places.

During preliminary search for heavy mineral resource in the inner shelf area off Anjengo, South Kerala, a total of 67 vibrocore samples were collected within a water depth of 45.9 m to 63.5 m in 2 km x 2 km grid. The maximum core recovery was 4.2 m (VC-04) and minimum core recovery was 0.29 m (VC-42). Presence of heavy minerals were observed in the finer fractions of top sediments. Heavy mineral occurrence was noticed in the fine fractions of the sandy sediments in the bottom.The total heavy mineral (THM) in the top one meter of the sediment column ranged between 0.45 and 4.31 wt. % with an average value of 2.19 wt. %. THM content concentration was maximum in +120 and +230 fractions. Preliminary assessment of heavy mineral resources in the offshore sediments off Paravur, south Kerala over an area of 57 sq. km was taken up. Shallow seismic survey of 98 lkm and single beambathymetric survey of 98 lkm were also carried out to study the disposition of sediment on and below seabed. A total of 64 vibrocore samples were collected during the cruise at 1 km x 1 km grid pattern. The minimum and maximum length of cores recovered was 0.30 m and 3.88 m respectively and average length of cores recovered was 2.35 m.

An area of 52 sq. km within the continental shelf domain off Paravur (Block-III), in Kerala was covered for preliminary assessment of heavy mineral resource. Thick sedimentation was observed in the eastern part of the area where water depth was found to vary from 26 to 34 m. Bottom sample consisted of medium to coarse sand/ compact oxidised clay. Fining upward sequence was observed in most of the cores. Heavies were mainly observed in the fine sand.The concentration of bulk heavy mineral observed in analysed samples varied from 0.8 to 3.7 wt. % with an average of 1.95 wt. %. Major heavy minerals present were sillimanite and ilmenite.

A preliminary assessment of heavy mineral resources in the offshore sediments off Kollam (Block-II), South Kerala; was carried out covering an area of 50 sq. km. During the cruise, the area had been covered with 110 lkm of bathymetric and 212 lkm shallow seismic surveys. A total of 55 VC samples were collected in 1 km x 1 km grid pattern in the exploration area. Coarse fraction studies indicated that the sediment was dominated by terrigenous content with only 10-12% biogenic content. A large number of carbonate ooids (white and brown colour) were also observed in the sediments. The sandy sediments also reported by contained considerable amount of heavies, mostly in finer fraction. The heavy mineral assemblage in the sediment included Ilmenite, magnetite, garnet, rutile, pyroxenes, amphiboles, epidote etc.

A preliminary assessment off Kollam (Block-I), South Kerala was taken up to augment the resources of economic heavy minerals in the offshore area of 55 sq. km which is just adjacent to nearshore domain off kollam. Bathymetric survey was carried out along 60l km. The heavy mineral content was found to range from 0.5 wt. % to 7.38 wt. %. VC-36 yielded maximum heavy mineral content of 7.38 wt. %.

To evaluate placer mineral resources in the territorial waters east off Bhimunipatnam, Andhra Pradesh, 77 vibrocore samples were collected in 1 km x 1 km grid covering an area of 60 sq. km within water depth ranging from 21.64 to 42.43 m. The analysis revealed that the garnets were of almandine variety, $TiO_2$ content in rutile was seen to range from 99.63% to 99.71%. The Total Heavy Mineral (THM) and Total Economic Heavy Mineral (TEHM) concentration in sub-surface level from 0-1 m were observed to be decreasing with increase depth and also decreased with fraction size. In sub-surface level (0-1 m), the TEHM ranges from 0.096 to 9.301 wt % with an average value of 2.805 wt %. In sub-surface level of 1-2 m, the TEHM ranged from 0.356 to 12.494 wt % with an average value of 1.858 wt %. In sub-surface level of 2-3 m, the TEHM ranged from 0.741 to 6.885 wt % with an average value of 2.114 wt % and in sub-surface level of 3-4 m, the TEHM ranged from 0.743 to 10.245 wt % with an average value of 3.393 wt %.

During preliminary assessment of placer mineral resources in the territorial waters off Rajapuram (South of Bavanapadu), North Andhra Pradesh Coast, an area of 60 sq. km was covered with 96 lkm of bathymetric survey and of 77 vibrocores were collected. All the surface sediments were found enriched with considerable amount of heavy minerals. Bulk heavy mineral concentration in sediment showed variations from 2.04 wt % to 21 wt % up to 4 m below seafloor.

A preliminary assessment of placer mineral resource in the shelf area off Vizhunthamavadi, Nagapattinam district, Tamil Nadu; was taken-up over an area of 70 sq. km. During the cruise, a total of 80 vibrocore sediment samples were collected in 1 km x 1 km grid covering an area of 70 sq. km within water depths of 14.8 to 37.8 m.

A preliminary search for placer mineral resource was taken up in the nearshore area off Bavanapadu Sector, north Andhra Pradesh

coast. During the investigation, survey of 50 sq. km area in the nearshore stretch off Bavanapadu was carried out to assess the heavy mineral placers resource potential and characterisation of heavy minerals up to 10 m of water depth. The heavy mineral study of the seabed sediments indicated that the bulk weight percentage of total heavy minerals varies from 0.43 wt% to 29.08 wt% with an average of 6.81 wt%.

During regional search for placer mineral occurrence in the nearshore area off coastal stretch between Vaippar and Vembar, Thoothukkudi District, Tamil Nadu, an area of 120 sq. km in nearshore domain lying within 10 m water depth off coastal stretch extending from Vaippar to Vembar of Thoothukkudi district, Tamil Nadup; was explored with systematic bathymetric survey and 1 km x 2 km gridded seabed sediment sampling to study the spatial distribution of major placer minerals and to demarcate the zones of higher concentration of heavy minerals. A total of 60 seabed sediment samples were collected with Van Veen grab sampler at the grid interval of 1 km x 2 km to evaluate the heavy mineral concentration in the near shore area in the coastal stretch between Vaippar and Vembar within the maximum water depth of 11 m. Along the shoreline, 12 sediment samples were collected within the swash zone in the coastal stretch between Vaippar and Vembar.

A preliminary investigation was taken up for polymetals in the Fe-Mn Crust/Nodules in the southern part of West Sewell Ridge and regional search for polymetallic nodules in Sewell Rise, Andaman Sea. A total area of 2000 sq. km including the summit area of West Sewell Ridge (WSR) and Sewell Rise (SWR) of Andaman Sea-bed were surveyed for polymetallic Fe-Mn crust/ nodules. Fe-Mn nodules are rich in Co, Cu, Ni, Zn, Li, REE & PGE. The Fe-Mn nodules, crusts and encrustations were found to occur embedded in calcareous sand within basaltic rock pieces and their size and shape varied from place to place.

The nodules showed variations in size from 2 cm x 2 cm to 20 cm x 20 cm and were black to brown in colour. One polynodule was recovered from West Sewell Ridge (WSR). Nodules were massive to multi-layered in nature. Layer thickness was found vary from a few mm to 3.5 mm. The Fe-Mn crusts were layered masses of Fe-Mn with a thickness of 1 to 3 cm. The Fe-Mn encrustations were observed as amorphous.

During preliminary assessment of placer mineral resources in the territorial water off Chilka- Nuapara, Odisha Coast, an area of 47 sq. km was covered with vibrocore grid sampling in 1 km x 1 km grid pattern. A total of 52 vibrocore samples were collected with core length varying from 0.26 m to 1.78 m with an average of 0.63 m.Placer mineral content in the explored area varies from 3.35 to 19.02 wt %. Placer minerals identified were ilmenite, garnet, sillimanite, zircon, monazite, rutile besides other non-economic minerals, such as, hornblende and pyroxene.

## Production

Petroleum (Crude) and Natural Gas (utilised) are also produced from Offshore region. (Table - 4).

**Table – 4: Mineral Production in Offshore Regions, 2017-18 to 2019-20 (Excluding Atomic Minerals)**

| Mineral | Unit | 2017-18 | 2018-19 | 2019-20 (P) |
|---|---|---|---|---|
| | | Quantity | Quantity | Quantity |
| Natural Gas (ut.) | m cu m | 22010 | 22117 | 20634 |
| Petroleum (crude) | '000t | 18144 | 16867 | 16002 |

**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 energy source of the future.

In India, gas hydrate research and exploratory activities are being steered under National Gas Hydrate Programme (NGHP). Under 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.

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

NGHP-02 was conducted successfully in Eastern offshore from 09.03.2015 to 31.07.2015. A total of 42 wells were drilled at 25 sites in Krishna-Godavari and Mahanadi areas in sand reservoirs for gas hydrates. NGHP-02 has discovered two world class gas hydrate reservoirs, namely, Block KG-DWN-98/5 and Block KG-DWN-98/3. Based on the post-expedition studies and review by international experts, the site located in KG-DWN-98/5 has been found suitable for pilot production test during NGHP-03 expedition for which various studies like sand control measures, well design, reservoir and production simulation modelling as prerequisite for the pilot production have been completed.

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 underway 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.