

STATE REVIEWS



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(Part- I)

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**STATE REVIEWS
(Offshore Regions)**

(ADVANCE RELEASE)

**GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES**

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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 in spite of grant of Production Lease after successful completion of exploration operations.

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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 360 contracts under NELP (New Exploration and Licensing Policy) regime with National Oil Companies and Private (both Indian and foreign)/ Joint Venture companies. At present, 186 contracts are operational out of the total 541 contracts [(360 NELP, 110 (OALP), 71 (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 01.04.2021)**

Round	No. of blocks awarded	No. of blocks relinquished	No. of blocks active	Present Area (Sq. Km)
NELP-I	24	21	3	231527
NELP-II	23	22	1	267883
NELP-III	23	19	4	204596
NELP-IV	20	17	3	192810
NELP-V	20	16	4	115180
NELP-VI	52	44	8	306426
NELP-VII	41	33	8	112950
NELP-VIII	32	29	3	52573
NELP-IX	19	10	9	26431
Total	254	211	43	1510376
OALP-I	55	-	55	59283
OALP-II	14	-	14	29233
OALP-III	18	-	18	29765
OALP-IV	7	-	7	18510
OALP-V	11	-	11	19789
Total OALP	105	-	105	156580
DSF-I	30	11	19	777
DSF-II	24	5	19	3000
Total DSF	54	16	38	3777

Source: IPNG Statistics 2020-21, Ministry of petroleum and Natural Gas.

RESERVES/RESOURCES

As on 1.4.2021, balance recoverable reserves of crude oil were estimated at 587.33 million tonnes, out of which 325.73 million tonnes (55%) are in onshore and 261.61 million tonnes (45%) in offshore areas. ONGC (nomination) has the largest share of 71% in reserves of crude oil with OIL (nomination) and PSC regime contributing 13% and 16%, respectively.

The balance recoverable reserves of natural gas as on 01.04.2021 were placed at 1,372.64 billion cu. m, out of which 882.72 billion cu. m (64%) are in offshore and 492.91 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 40% and 10%, respectively (Table-2).

Table – 2: Balance Recoverable Reserves of Crude Oil & Natural Gas in India including Offshore Areas (As on 1.4.2021)

Area	(Crude oil in million tonnes; Natural gas in billion cu. m)	
	Crude oil*	Natural gas*
India	587.33	1372.64
Onshore	325.73	492.91
Offshore	261.61	882.72
Western offshore	219.27	325.65
Eastern offshore	42.34	557.07

Source: Indian Petroleum and Natural Gas Statistics, 2020-21, 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.

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 2020-21.

Private Companies/Joint Ventures

During 2020-21, cumulative 17,051.24 LKM 2D and 1,47,107 SKM 3D seismic data was acquired. Out of which approximately 16,806.42 LKM 2D and 7,281.69 SKM 3D data were acquired. This year 55% of 2D seismic and 68% of 3D seismic data acquisition have been carried out in the offshore basins. A total of 115 exploratory wells (including inland and offshore) amounting to a drilling meterage of 3,44,175 m were drilled. Details of exploratory activities in Nomination, PSC regime & RSC regime in the year 2020-21 are furnished in Table-3.

Table – 3 : Exploratory Efforts in Nomination, PSC and RSC Regime during 2020-21

Subject	Parameter	ONGC	OIL	PSC	RSC	Total
		(Nomination)	(Nomination)	(Pre-NELP & NELP)	(OALP & DSF)	
2D Seismic Data acquired	Onland (GLKM)	244.82	-	-	7502.89	7747.71
	Offshore (GLKM)		-	-	9303.53	9303.53
	Total	244.82	-	-	16806.415	17051.24
3D Seismic Data acquired	Onland (SKM)	433.05	124.61	250.05	2321.99	3129.71
	Offshore (SKM)	1,272.26			4959.69	6231.95
	Total	1,705.31	124.61	250.05	7281.69	9361.66
Exploratory well drilled	Onland	61	10	4	1	76
	Offshore	31		8		39
	Total	92	10	12	1	115
Exploratory Meterage drilled	Onland (1000 m)	176.266	42.811	13.25	1.4	233.744
	Offshore (1000 m)	83.177		27.25		110.31
	Total (1000 m)	259.443	42.811	40.5	1.4	344.175

Source: India's Hydrocarbon Outlook, 2020-21, Directorate General of Hydrocarbons

Marine and Costal Survey

Geological Survey of India

During, 2020-21, 27 no. of items were taken up by GSI under Marine & Coastal Survey.

SR-049 "Close grid geophysical surveys (GM) for studying the characteristics of subsurface geology, structure in the continental shelf/slope off Pondicherry, Tamil Nadu coast, Bay of Bengal". Magnetic (5000 lkm) and Gravity data (2304 lkm) along with bathymetry are collected. Study of magnetic anomaly map revealed a ENE-WSW broad magnetic trend associated with a long

wavelength between 11° 30'N and 12° 20'N in the central part of the study area. The significant change in the magnetic anomaly pattern at 12° 20'N gives a clear indication of the basin boundary. This zone may be spatially correlated to the E-W trending Moyar-Bhavani-Attur (MBA) lineament on land. The bathymetric data indicates continental shelf (77 to 1266 m), continental slope (1555 m and 2500 m), continental rise (2966 to 3200 m) and abyssal plain (3200 m to 3550 m). The SBP survey depicts the terrace/ridge-like features related to hard bottom are recorded around 900 to 1000m water depth. Sub-bottom record shows

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very thin or no sediment deposition resulting in the exposure of basement rock. This indicates a high energy condition in the area.

SR-054: "Preliminary Assessment of Lime Mud in the Continental Shelf off Pentakota-Bavanapadu, Andhra Pradesh". Preliminary assessment of lime mud over an area of 5000 sq km was taken up. The continental shelf in the study area is having a maximum width of 15 km in the central part and a minimum width of 1 km in the northern most part. In the northern part, shelf is very narrow beyond margin followed by deep submarine channels and gullies. The thickness of the lime mud in the recovered cores varies between 0.1m and 5.8m. Two zones of lime mud deposition is noticed in the 11.31m piston core collected from a depth of 151m. Lime sand/mud occurs in an area of 1440 sq km over a length of more than 170 km and a maximum width of 16 km in the study area.

SR-061: "Regional search of limemud/limesand in the continental shelf off Maharashtra Coast (Gap Area Block-2)". The mid-shelf is characterised by uneven, rugged erosional topography with ripple marks and pinnacles/buried coral reefs with a relief of 1 to 3 m. Sub-bottom profiles reveals the variation of sediment thickness between 20 m and 5 m. Major part of the survey area is covered by sand and silty sand. Silty clay occurs as a small patch in the survey area. Accordingly, three zones could be demarcated viz., high grade limesand zone, low grade limesand zone and impure limesand zone. The high grade limesand zone comprises of grey limesand with CaO content ranging from 50 to 52%. Low grade limesand zone is located in central part with CaO content varying from 44% to 50%. The impure limesand with intercalations of clay and limesand and carbonaceous clay zone is identified in the eastern part having less than 44% of CaO.

SR-066 "Regional exploration for Fe-Mn nodules off Lakshadweep Sea". An area of 6050 sq. km, within a depth range from 1649 to 3716 m off west of the Laccadive Ridge, in the Lakshadweep Sea, was surveyed by backscatter imaging/multi beam echo sounder system along with bathymetric, sub-bottom profiling, magnetic and gravity surveys. Thirty surface sediment samples (grab) in 10 km x 10 km grid and one gravity core (GC) were collected from the area. The major sedimentary units is sandy silt followed by silty sand and sand silt clay. Coarse fraction study reveals presence of frequent microfaunal remains with occasional detrital mineral grains and encrustations of Fe-Mn and Mn micronodules. The major microfauna noticed are foraminifera, followed by radiolaria,

ostracods and broken shells of pteropods and foraminifera.

SD-297: "Close grid heavy mineral resource evaluation and study of sub-surface disposition of sand bodies in the inner shelf off Tuticorin in Gulf of Mannar (Area-I), Tamil Nadu coast". This program was taken up over an area of 50 sq km. Higher absorption of the seismic energy suggests the possibility of sand layer. The vertical extension of sand bodies varies from 2.2 m to 15.6 m. Total Heavy Mineral (THM) content in the seabed sediment varies from 1.33 wt.% to 21.95 wt.% with an average of 6.54 wt.%. The heavy minerals present in the samples are Garnet, Ilmenite, Sillimanite, Rutile, Zircon, Monazite, etc. in the decreasing order of abundance. The heavy mineral content is more in the medium sand than the fine/coarse sand unit. Further studies are in progress.

SD-298: "Preliminary resource evaluation of construction grade sand and search for heavy minerals in the contiguous zone off Mangalore, Karnataka". A total of 59 vibrocore samples were also collected in 2km X 2km grid. Sedimentological studies revealed that the area is mainly carpeted with clayey sediments. Sand sediments seen as patches are found to be associated either with the oxidised clay or the clay rich in organic materials (may be an indication of the presence of palaeo-strandline). Total Heavy Mineral (THM) content in sediment for 34 samples is not encouraging.

SD-299: "Close grid heavy mineral resource evaluation and subsurface disposition of sand bodies in the inner shelf off Vembar in Gulf of Mannar (Area-II), Tamil Nadu coast". The program was mounted over an area of 50 sq. km along with bathymetry, shallow seismic surveys and seabed sampling. Two channels are observed in the central part and north-eastern part of the survey area which are separated by a prominent ridge. The channel in the central part is one km wide and four km in length and shows a trend of N 10° W to S10°E. These channels may be the extensions of river Vembar and Mukaiyur respectively joining the gulf. Based on visual observation, surface sediments mainly consist of medium, coarse and fine sand. Coarse sand mainly occurs all along the channels. Medium and fine grained sediments occurs on the ridges. Heavy minerals are more concentrated in medium sand and fine sand. Total Heavy Mineral (THM) content in sediment varies between 0.8184 wt.% and 20.0674wt.% which averages to 5.8575 wt.%.

SD-300: "Preliminary resource evaluation of heavy mineral and sub-surface disposition of sand

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bodies in the inner shelf off Kuttapuli to Uvari sector in Gulf of Mannar, Tamil Nadu coast". Preliminary resource evaluation of heavy mineral over an area of 196 sq. km was carried out along with sensor surveys and sediment sampling at 2kmX2km grid interval. The total heavy mineral content in representative sample varies from 0.31 to 3.78 % in the bulk sample. Further studies are in progress.

SD-301: "Preliminary evaluation of heavy mineral resources and sub-surface disposition of sand bodies in the inner shelf sediments off Vizinjam-Poonthura sector, within territorial waters of west coast of India, Kerala coast". Preliminary evaluation of heavy minerals over an area of 183 sq. km. was carried out by vibrocoring at 2 X 2 grid pattern. The total heavy mineral percentage in the area varies from 0.34 wt.% to 4.62 wt.%. Concentration of heavies are higher in sediments having proximity to river mouths i.e, along the eastern side of the area. The major economic heavy minerals identified include ilmenite, garnet, sillimanite, zircon, monazite and rutile in the order of abundance.

SD-302: "Multi thematic mapping of Contiguous Zone beyond Territorial water in Arabian sea off Mt. Dilli, Kerala". A total area of 750 sq.km was covered within a depth range of 46.6 m and 76.8 m. A total of 71 nos. of grab samples were collected at 2 km x5 km interval. The seabed is mainly carpeted by fine to medium sand except along the eastern part where silty sand, sandy clay and clayey sand are present in shallow part of the area. The concentration of heavies in seabed sediment is not significant.

SD-303 "Multi thematic mapping of Contiguous Zone beyond Territorial Waters off Bekal, Kerala". Bathymetry data reveals that the depth increases progressively from east to west. A total of 75 surface sediment samples were collected at a 2x5 km grid and 3 core samples at a 5x10 km grid to generate 15 core samples. The THM content varies from 0.6 to 2.4% in the surface sediments and the carbonate content in the surface sample ranges from 6.8% to 31.7%.

ST-282: "Close Grid Mineral Exploration for Placer Minerals within the Territorial Waters off Bavanapadu- Nuvvalarevu, Andhra Pradesh (South Block)". Cruise: was taken-up over an area of 45 sq.km and the bathymetric survey reveals that the sea bottom is gently sloping in general from east to west within the water depth varying from 28.56m to 46.41m. The total non-magnetic heavy mineral wt% in the area varies from 1.92 to 10.73wt% with an average of 5.66wt% in 0-1 m level.

ST-283: Preliminary search for Placer Minerals and Sub-Surface Sand Body in the Territorial Waters off Karipeta, Andhra Pradesh". A total of 45 nos. of vibrocoring sediment samples were collected in 2km x 2 km grid by covering an area of 128 sq.km within water depths of 11.9 m to 40.7 m. A few concretions (carbonaceous?) of 3cm x 2cm and wood pieces were observed in few samples. Total Heavy Mineral (THM) content in sediment varies between 0.83 wt.% and 8.23 wt.% with an average of 3.93 wt.%.

ST-284: "Preliminary evaluation of placer mineral resource in the shelf area off between Port Novo and Karaikal, Tamil Nadu". The survey has been taken-up over an area of 70 sq.km, within the water depths of 28.8 to 59.7 m. Bathymetric survey carried out for 80 lkm reveals that the sea bottom is exhibiting gentle slope from west to east. Total Heavy Mineral (THM) content in sediment calculated for 34 samples varies between 2.3 wt.% and 6.5 wt.% with an average of 4.5 wt.%.

ST-285: "Geophysical (magnetic) survey within continental shelf off Kalingapatnam, Andhra Pradesh coast, Bay of Bengal". During the cruise, 905 lkm of magnetic and bathymetric surveys were carried out in an area of 3780 sq.km. A minor NE-SW trending negative anomaly has been observed in the northeastern part of the area. This low may be interpreted as southwestern continuity of the hinge zone passing through the Bengal basin. It extends up to the Kalingapatnam and further southwest falls in line with the main deep fault. This magnetic low is flanked by short-wavelength anomalies on the landward side. The elliptical closures having high frequency and high amplitude magnetic anomalies trending along NE-SW and ENE-WSW direction observed at the central, north-eastern and south-western part of the study area respectively, may be due to the presence of intrusive bodies within the continental crust. These intrusive bodies might have originated during the initial stage of rifting of the Eastern Continental Margin of India (ECMI).

ITEM NO.-127: "Preliminary search for placer mineral occurrence in the nearshore area between Taruvaikkulam and Chippikulam, Thoothukkudi District, Tamil Nadu". An area of 100 sq. km had been covered with systematic bathymetric survey and collection of seabed sediments in 2 km x 2 km grid. The concentration of CaCO_3 and P_2O_5 in the sediment from near shore domain is higher than the upper crustal continental values may be due to higher biological productivity in the study area. The average concentration of TiO_2 &

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Fe₂O₃ in the near shore seabed sediment samples are higher than the upper continental crustal values may be due to abundance of heavy minerals such as garnet and ilmenite. Trace elements such as Zirconium and Strontium are higher than its upper continental crustal values attributing towards abundance of heavy minerals such as Garnet, Ilmenite and Zircon. Total Heavy Mineral (THM) content in sediment calculated for 18 samples varies between 3.2 wt.% and 11.2 wt.% with an average of 6.2 wt.%.

ITEM NO-130 “Preliminary Investigation of Placer Mineral Resource in the Near Shore area off Baruva sector, North Andhra Pradesh Coast”. An area of 35 sq. km from the low water line (LWL) to 10m isobath was surveyed towards carrying out bathymetry by portable single beam echo sounder and sediment sampling with portable grab, manual auger core and vibrocorer Total heavy mineral (THM) concentration (Magnetite free) in the grab samples ranges from 2.39 wt% to 24.98wt% with an average of 10.57wt%. The vibro core samples ranges from 5.08 wt% (VC/2/1) to 10.38 wt% (VC/3/1) with an average of 7.93 wt%. The sediment wise THM wt% reveals that, the concentration of HM is more in the very fine sand followed by sandy clay, fine sand and medium sand.

SR-059: “ Preliminary assessment for polymetals in the Fe-Mn crust/nodules in the southern part of West Sewell Ridge with close grid sampling and Preliminary search for Fe-Mn crust/nodules in the northern Part of the Sewell Rise, Andaman Sea”. The survey was carried out over an area of 1510 sq km. Most Fe-Mn crusts and nodules were recovered from the near flat seamounts and ridges of the study area. The surface of the nodules having either a combination of botryoidal and gritty texture or a completely botryoidal texture, although some nodules have smooth surface. Recovered crusts are usually tabular and mainly pebble size fragments. They are usually laminated or layered having thickness of 2-3 cm.

ST-277: “Close Grid Exploration for Placer Mineral Resources in the Territorial Waters off Malud Odisha Coast”. The programme was taken up over an area of 48 sq.km and total of 64 nos. of vibrocore samples and 3 water samples were collected from water depth of 19.60 to 32.15m. Heavy minerals are mostly concentrated in the fine to medium grained sand. The bulk economic Heavy Mineral content in the study area varies from 1.78 to 13.47 wt%. The heavy mineral suite with ilmenite, garnet and sillimanite as major constituents followed by zircon, pyroxenes, epidote, monazite and kyanite.

ST-279: “Close grid exploration for placer mineral resources in the territorial waters off Gopalpur-Chatrapur, Odisha coast”. Cruise was mounted over an area of 45 sq.km. Geostatistical studies show an area of 42.98 sq.km consist of potential heavy mineral bearing sand for the top 1.0 sediment column. Preliminary study indicates heavy mineral suite with garnet, ilmenite and sillimanite as major constituents followed by zircon, pyroxenes, epidote, monazite and kyanite.

ITEM 129: “Study of Shoreline changes, coastal zone management and bathymetry study in the inner shelf (0-10m water depth) of Rasulpur River mouth to Subarnarekha River mouth”. This study was taken up along 60 km long coastal stretch located between Rasulpur and Subarnarekha estuarine complex and the study reveals prograde and retrograde shoreline changes due to erosion and accretion of sediments by tides and waves. The study shows dynamic behaviour of erosion and accretion processes which are resulting both by natural and anthropogenic activities. The bathymetric survey was carried out in 64 sq. km area of nearshore domain falling within 0 to 10m isobaths. The bathymetric contour map reveals that the depth of the nearshore seabed varies from -0.7m to -9.5m isobaths. The predominant sediment type is grey-brown, fine to very fine sand rich in shell fragments, mica and heavy minerals with mud, loose clay with sticky sandy clay balls. Very fine sand with admixture of mud etc.

Production

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

Table – 4: Mineral Production in Offshore Regions, 2018-19 to 2020-21 (Excluding Atomic Minerals)

Mineral	Unit	2017-18	2018-19	2019-20 (P)
		Quantity	Quantity	Quantity
Natural Gas (ut.)	m cu m	22117	20635	18429
Petroleum (crude)	'000t	16867	16003	15391

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

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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.