WWJMRD 2017; 3(9): 157-164
www.wwjmrd.com
International Journal
Peer Reviewed Journal
Refereed Journal
Indexed Journal
UGC Approved Journal
Impact Factor MJIF: 4.25
e-ISSN: 2454-6615

Mokka Jagannadha Rao
Dept of Geology, Andhra University, Visakhapatnam, AP, India

G.Raja Rao
Dept of Geology, Andhra University, Visakhapatnam, AP, India

P.Rajesh
Dept of Geology, Andhra University, Visakhapatnam, AP, India

Correspondence:
Mokka Jagannadha Rao
Dept of Geology, Andhra University, Visakhapatnam, AP, India

Beach Placer Mineral Deposits of India, Their Distribution, Mineralogy and Possible Environmental Implications Due To Mining –With Special Reference to Placer Ilmenite

Mokka Jagannadha Rao, G.Raja Rao, P.Rajesh

Abstract
In recent years the importance of placer minerals in modern technology has been realized. Technological development is aimed at strategic and economic applications which are mostly dependent on titanium, zirconium and rare earths, in the form of their metals / compounds or alloys. The placer deposits are the treasure houses for ilmenite, rutile, leucoxene – all titanium minerals, zircon – ore for zirconium and hafnium, monazite – source for cerium, thorium and other light rare earths, garnet – the most preferred abrasive and sillimanite – an excellent refractory mineral. These minerals of economic importance have prompted the placer mineral deposits exploration and exploitation in this country. These deposits are identified along the East and West coasts of India and the total heavy mineral content (THM) of these placers ranges from 12% to 15% by weight. Out of these total heavy mineral content Ilmenite forms almost 40% of the THM. However, the abundance of other minerals varies from deposit to deposit. The details pertaining to mineralogy, industrial uses and production figures of placers in general and ilmenite in particular, compared to other countries have been presented.The scenario of placer ilmenite at world level compared to Indian potential has been reviewed. An attempt is made to present the possible environmental impacts to be considered on the sensitive coastal ecosystem, before initiating mining and processing of these placer sand deposits. It is suggested that environmentally friendly methods of mining and processing may be insisted to reduce the impact on the environment.

Keywords: Placers, ilmenite, mineralogy, environment, impact, beach, resources, THM

Introduction
India is blessed with a long coastline of over 6000 km combining east and west coasts. It is characterized by a variety of coastal landforms, including beaches, dunal belts, marshy environments, lagoons, deltas, estuaries and other coastal landforms. The incoming sediments brought by fluvial systems draining the hinterland are the main contributors of the economically important eavy minerals resulting beach placer deposts. The coastal land forms of east and west coasts of the Nation thus contain significantly important placer mineral deposits. The heavy minerals like ilmenite, rutile, garnet, zircon, monazite and sillimanite are occurring in these deposits. The controls, like source rock geology, coastal geomorphology effective drainage network and favorable climatic conditions favored the formation of rich placer deposits in coastal environments.

Formation of Beach Placers
These placers deposits are formed by the interacton of the terrestrial processes with the coastal hydrodynamics.The heavyminerals along with sediments which are derived mechanically from source rocksare contributed to the sea by various processes o transportationare selectively panned and sorted and then deposited at suitable locations,by the action of waves and currents.The factors controlling the formation of beach placers are source rocks, geomorphology of thea rea, climate, drainage pattern, coastal processes,neotectonicsetc.Theheavyminerals are concentrated by a combination of these

processes in the upper part of the beach,where the action of the wind may erode them and form heavy mineral rich coastal dune deposits (Kudrass,2000). The formation of beach placers has been shown (Fig-1). India has some of the largest placer deposits along its coasts.

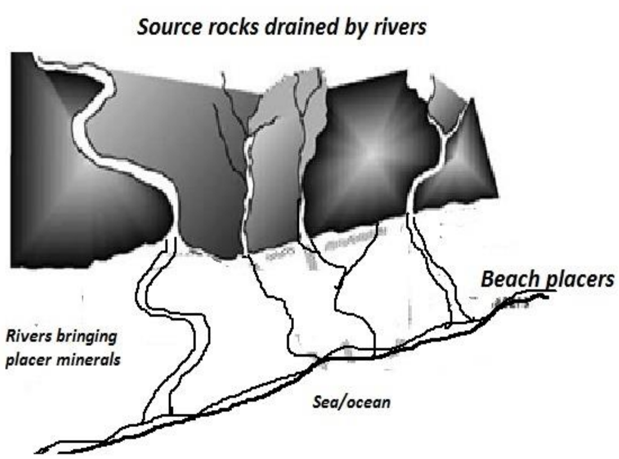

Fig.1: Process of Placer sand formation

Indian Placer deposits

Important deposits occur in the coastal environments of Kerala (Chavara), Tamil Nadu (Manavalakurichi, Midalam, Vayakallur), Andhra Pradesh (Kakinada, Pentakota, Bhimunipatnam, Konada – Kandivalasa – Mukumpeta – Bendi creek – Donkar), Orissa (Sanaekasangi – Gopalpur, Chatrapur, Bajarkot, Satpara and Puri) and Maharastra (Kalbadevi, Newre and Malgund). In Indian context the deposits are of variable grade (10-16%) of THM. The economic minerals commonly occur include ilmenite, rutile, leucoxene, zircon, monazite, garnet and sillimanite. The abundance percentage and reserves of heavy mineral pockets differ from deposit to deposit. Most important deposits of the country are Rushikulya, Chatrapur and Gopalpur in the state of Orissa; Bhavanapadu, Kalingapatnam, Srikurmam, Bhimunipatnam, Kakinada and Nizampatnam deposits in the state of Andhra Pradesh; The deposits in Tamil Nadu are Kudiraimozhi, Ovari and Manavalakurichi In Kerala; Chavara and Ratnagiri in Maharashtra. Nearly 40-55% of the global ilmenite recovery is from coastal deposits. India is in the top five countries having huge deposits of ilmenite. The detailed exploration programs conducted by AMD has resulted huge deposits of placer minerals on both East and West coasts (Fig.2)

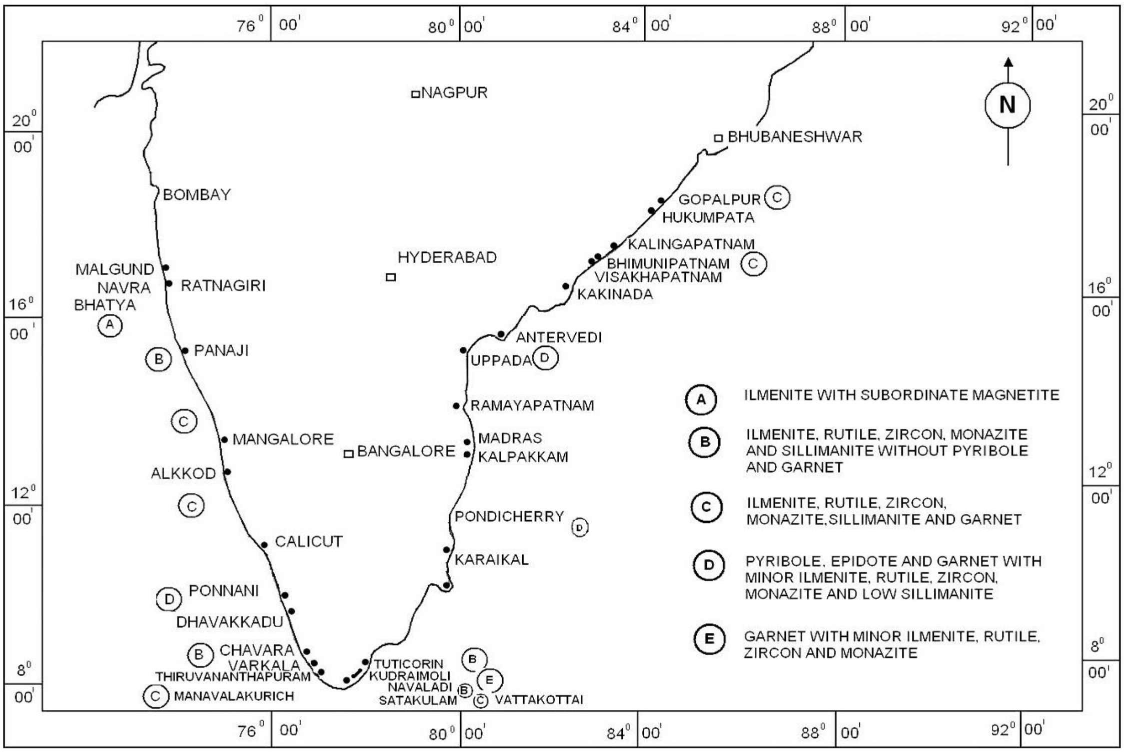

Fig.2: Beach placer deposits of India.

Earlier studies

Mahadevan and Sriramdas (1948) reported the black sand concentration along the Visakhapatnam-Bhimunipatnam coast, Andhra Pradesh for the first time. The other studies include Viswanathan (1957), gave an account of the beach sand placer deposits of Neendakara-Kayamkulam in Kollam district, Kerala and Manavalakurichi in Kanyakumari district, Tamil Nadu. The occurrence of monazite-bearing black sands along the southern and southwestern coast of India was discovered by Schomberg, a German chemist in 1909 (Overstreet, 1967).

Rao (1973, 1976, 1977) presented data on heavy mineral reserves of beach placers of Neendakara-Kayamkulam, Kerala, Manavalakurchi, Tamil Nadu and Chatrapur, Orissa. Rao et al. (1989) investigated the occurrences of placer minerals along the southern parts of Andhra coast between Ramayyapatnam (Nellore) and Vashista Godavari (Kakinada). Ali et al. (1989, 1998) researched the placer deposits of Ratnagiri district, Maharashtra and brought out the influence of geology, geomorphology and the Late Quaternary sea level oscillations in the derivation of inland and beach placer deposits of India. Rao et al. (1990) gave a comprehensive account of the heavy mineral concentration and reserves of deposits between Lawson's Bay and Bhimunipatnam-Konada (north of Visakhapatnam), Andhra Pradesh. Banerjee et al. (1996) discussed the role of placer minerals in the economy of India. Roy et al. (1998); Panda et al. (1998); Vishwanathan et al. (1998); Rao et al. (1998) and Murthy et al. (1998) presented the textural data, evolution of the coast and heavy mineral association in the sand deposits of Andhra Pradesh and Tamil Nadu. Exploration carried out by Atomic Minerals Directorate for Exploration and Research (AMD) during the past five decades has resulted in identifying placer deposits along the coastal stretches of Maharashtra, Kerala, Tamil Nadu (including inland placers), Andhra Pradesh and Orissa. Jagannadha Rao et.al., (2005), recorded based on the geochemical and ore mineralogical aspects, ilmenite of Visakhapatnam – Bhimunipatnam placer sand deposit, Andhra Pradesh has less TiO_2 and more total iron contents, as compared to its stoichiometric composition, the hematite phase in ilmenite incorporate excess iron in the structure of ilmenite.

Details of Processing

The Indian Rare Earths Limited (IREL) plants collect raw sand either by dry mining of beach washings or wet mining of inland deposits and this operation is followed by the wet concentration, to get 90% heavy mineral (HM) concentrate. This material is then fed into a plant called Concentrate Upgradation Plant (CUP) to make 97% grade concentrate which enters the dry mill for separation of the six minerals namely, ilmenite, rutile, zircon, monazite, garnet and sillimanite. Unlike Chavara and Manavalakurichi, OSCOM has the facility to chemically process the ilmenite to synthetic rutile and supply as feed stock for the pigment industry. Rutile primarily goes to the electrode industry. In the case of zircon, some kind of physical value addition is carried at Chavara by grinding to produce materials called Zirflour / Microzir for its use in ceramic industry. Some part of the zircon sand as such goes to the foundry and refractory industry as well. Chemical value addition to zircon takes place at Manavalakurichi in the form of zircon frit which is supplied to Nuclear Fuel Complex (NFC) in Hyderabad for the production of zirconium based alloys for our power reactors. As far as monazite is concerned, it is chemically processed to produce thorium concentrate and mixed rare earth for the production of catalysts and misch metal. The pure, rare earth oxides of Ce, Nd, Pr, etc., are also produced for their assorted applications in glass polishing and making magnets, batteries, etc. At present thorium concentrate is being used primarily for the production of mantle grade thorium nitrate and a small part of it is being used for the nuclear industry. Department of Atomic Energy (DAE) intends to use thorium oxide as the nuclear fuel for our future power program.

Industrial Uses

The major use of rutile and ilmenite is in the production of titanium dioxide pigment, for surface and paper coatings and in plastic industries. Rutile is also used in welding rod flux coatings. Titanium carbide is used in commercial cutting tools. Titanium metal and its alloys are use in aerospace applications, gas turbines etc.

In placer type deposits, ilmenite, rutile and leucoxene occur normally along with other valuable minerals such as zircon, monazite, garnet and sillimanite. All these constitute the heavy minerals, the amount of which is quite variable from deposit to deposit. Quartz and shells form the major gangue. Mining of these deposits is usually done by dredging, shoveling or drag-lining. These minerals occur in relatively coarse size and in fully liberated form, hence no size reduction is needed, unlike in the processing of other ores. Pre-concentration is usually carried out at the mining site itself, in order to reduce the bulk to be treated in the subsequent separation stages. Gravity separation using spirals and/or Reichert cones is invariably preferred all over the world for pre-concentration.

Out of the six minerals, namely ilmenite ($FeTiO_3$), rutile (TiO_2), zircon (Zr silicate), monazite (RE/Th.phosphate), garnet (iron-aluminium silicates) and sillimanite (aluminium silicates) having specific gravity higher than quartz, the first four are called prescribed or atomic minerals. So far the right of mining and separation of these four minerals are restricted to IREL and KMML- a state PSU of Kerala. When one compares such Indian deposits with respect to those of entire world (Table-3) one can realize that India can emerge as a dominant player having a huge resources of ilmenite.

Mineralogy of Placer Ilmenite

In almost all placer deposits of India, the total heavy mineral content (THM) varies between 12% by weight to up to 15% by weight, in this almost 50% as composed by ilmenite content. The ilmenite appears to occur mainly fine to very fine fractions of beach sand (from +120 ASTM mesh size to +230 ASTM mesh size 125 microns to 63 microns) respectively. When observed under the binocular microscope, the majority of ilmenite grains is well rounded and reflecting black in color (Fig-2). The reflected light microscopy of ilmenite indicate excellent exsolved phases which strongly suggest that their derivation from igneous parentage.

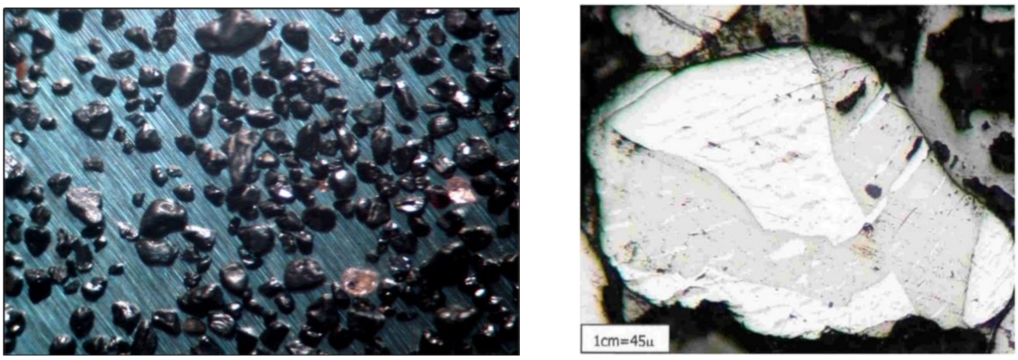

Fig.3: Ilmenite grains under binocular microscope and grain showing exolved phases under reflected light

Ilmenite Resources

A special mention of ilmenite has been taken up and presented, because of its abundance and economic significance.Ilmenite is the important constituent of beach sand deposits found right from Moti Daman-Umbrat coast (Gujarat) in the west to Odisha coast in the east. This mineral is concentrated in five well-defined zones along with rutile and other placer minerals.

* Over a stretch of 22 km between Neendakara and Kayamkulam, Kollam district, Kerala (known as 'Chavara' deposit after the main mining center).
* Over a stretch of 6 km from the mouth of River
* Valliyar to Colachal, Manavalakurichi and a little beyond in Kanyakumari district, Tamil Nadu (known as MK deposit).
* On Chatrapur coast stretching to about 18 km between Rushikulya river mouth and Gopalpur lighthouse with an average width of 1.4 km in
* Ganjam district, Odisha (known as 'OSCOM' deposit after IREL's Orissa Sands Complex).
* Brahmagiri deposit stretches for 30 km from
* Giralanala to Village Bhabunia with an average width of 1.91 km in Puri district, Odisha.
* Bhavanapadu coast between Nilarevu and
* Sandipeta with 25 km length and 700 m average width in Srikakulam district, Andhra Pradesh.

The AMD of the Department of Atomic Energy has been carrying out exploration of these mineral deposits. So far, about 3,890 km coastal tracts and 160.72 sq km inland areas in Tamil Nadu and West Bengal have been investigated for over six decades by AMD.

The ilmenite resources estimation of the areas explored up to 2012 has been completed. The most significant deposits which are proved and exploitable and that which could attract the attention of Industry for large-scale operations are listed out in Table – 1, and the total up from 520.38 million tonnes to 593.50 million tonnes (including leucoxene), inclusive of indicated, inferred and speculative categories. Resource estimation for the areas explored during 2012-15 is under progress (Table-2).

The average grade of total heavy minerals in these deposits is 10-25% of which 30-35% is ilmenite. The overall statewide reserves of ilmenite and rutile which occur together in beach sand deposits are furnished in Table - 2.

Table 1: Proved Ilmenite Resources/Deposits in India

State/Deposit	Ilmenite reserves in (million tonnes)
Andhra Pradesh	
1. BhavanapaduHukumpeta	10.18
2. Kakinada (Phase I-VIII)	13.84
3. Kalingapatnam	5.80
4. Narsapur	2.92
5. Nizampatnam	19.26
6. Srikumama (South)	8.60
7. Visakhapatnam (Bhimunipatnam)	2.88
8. Amalapuram (Phase I-III)	3.10
9. Pandurangapuram-Voderevu (Baptala-Chirala Coast)	10.39
10. Vetapalem Coast (Chirala Coast)	5.31
	82.28
Kerala	
1. Chavara Barrier beach	13.17
2. Chavara Eastern Extension (Phase-1)	17.02
3. Chavara Eastern Extension (Phase-II)	49.26
4. Trikkunnapuzha-Thotapally Beach and eastern Extension	9.50
5. Alapuzha-Kochi	5.88
	94.83
Maharashtra	
1. Ratnagiri	3.68
Gujarat	
1. Moti Daman-Umbrat coast	2.77
Odisha	
1. Brahmagiri (Phase-IV)	37.98
2. Chatrapur	26.72
3. Gopalpur (Phase I-IV)	6.39
	71.09
Tamilnadu	
1. Kudiraimozhi	22.86
2. Ovari-Periyatalai-Manapadu (Teri)	24.01
3. SattankulamTeris	41.26
4. Cuddalore-Pudupattuchavadi	4.67
5. Vayakallur (Block I-IV)	3.54
6. Manavalakurichi	2.04
7. Midalam	1.64
	100.02

(Source: Indian Minerals Yearbook (2015). Part-III (Mineral reviews), 54th edition, Ilmenite and Rutile, Government of India, Ministry of mines, Indian bureau of mines, Nagpur)

Table 2: Total Resources of Ilmenite (In million tonnes)

State	Total in situ
Andhra Pradesh	163.05
Jharkhand and Bihar	0.73
Gujarat	2.77
Kerala	145.70
Maharashtra	3.74
Odisha	96.44
Tamil Nadu	179.02
West Bengal	2.05
Total	**593.50**

(Source: Indian Minerals Yearbook (2015). Part-III (Mineral reviews), 54th edition, Ilmenite and Rutile, Government of India, Ministry of mines, Indian bureau of mines, Nagpur)

World Review

World resources of anatase, ilmenite and rutile are more than 2 billion tonnes. World reserves of ilmenite are estimated at 740 million tones in terms of TiO_2 content. Major reserves are in China (27%), Australia (19%), India (11%), South Africa (9%), Brazil and Madagascar (6% each), Norway (5%) and Mozambique (2%). The world reserves of rutile are located in Australia (41%), followed by South Africa (15%), India (14%) and Ukraine (5%).

World production of ilmenite and rutile concentrates was 12.58 million and 0.75 million tonnes, respectively, in 2014. Canada contributed 20% of ilmenite production, followed by Australia (12%) and South Africa (18%), Ukraine and China (about 9% each). Australia produced 40% of world rutile output, followed by South Africa (18%), Ukaraine (13%) and Sierra Leone (11%). World reserves and production of titanium minerals, viz, ilmenite and rutile, are furnished in the below tables. (Table-3, Table-4)

Table-3: World reserves of Ilmenite

Country	Reserves in '000 tonnes of contained TiO2
Australia	140000
Brazil	43000
Canada	31000
China P Rep.	200000
India	85000
Kenya	54000
Madagascar	40000
Mozambique	14000
Norway	37000
South Africa	63000
Ukraine	5900
USA	2000
Vietnam	1600
Other countries	26000

(Source: Indian Minerals Yearbook (2015). Part-III (Mineral reviews), 54th edition, Ilmenite and Rutile, Government of India, Ministry of mines, Indian bureau of mines, Nagpur)

Table- 4: World Production of Ilmenite
(By Principal countries)
(In '000 tonnes)

Country	2012	2013	2014
Australia	1572	1572	1570
Brazil	69	78	80
Canada	2700	2800	2500
China P Rep.	1100	1100	1100
India	739	740	740
Madagascar	562	562	334
Mozambique	575	720	855
Norway	831	826	864
Russia	125	150	178
Senegal	0	0	1005
South Africa	1203	1070	1105
USA	300	200	100
Ukraine	600	600	600
Vietnam	978	1088	1100
Sri Lanka	45	43	135
Kenya	0	0	282
Other countries	44	48	34
Total	11442	11548	12582

(Source: Indian Minerals Yearbook (2015). Part-III (Mineral reviews), 54th edition, Ilmenite and Rutile, Government of India, Ministry of mines, Indian bureau of mines, Nagpur)

In table 4, each country has been compared with others with respect to its ilmenite production. Government of India has therefore decided to open up this industry to all Indian companies. Even foreign equity participation is permitted provided the activity includes intermediate and final value addition to ilmenite.While IREL is presently exploits the deposits adjacent to their plants at Chavara, Manavalakurichi and OSCOM, large deposits in states like Kerala, Tamil Nadu and Andhra Pradesh have been identified for future joint venture projects

Environmental implications

Mining and Processing: The most common mining methods employed to treat low-grade placer deposits are bulldozing, loosening with hydraulic jets and slurry pumping, draggling, bucket wheel excavating and suction dredging is most favored in view of the simplicity of operation and low unit cost. An artificial pond is crated in the mining area and the dredging and pre-concentrator units are mounted on pontoons and anchored in the mining pond. The mining is done by dredging arm moving from the base unit and the mined ore slurry is transported to the pre-concentrator plant by horses. The rejected gangue, consisting mainly of quartz is pumped to the rear side of the mining pond (dredging area) in order to reclaim the already dredged as mining progresses, the pond also advances in the mining direction. Periodically the dredging cum pre-concentrator units are moved to a different location for easy operation. At Manavalakurichi and OSCAM, mechanized mining by suction dredging is followed at and Chavara, the beach washings are mined by dry mining methods, where in the sand, after drying by furrowing, is mined and transported to mineral recovery plant (MRP) by country boats or tipping wagons. However, the mechanized mining is also in operation at Chavara using suction dredging. The present mining/concentration practice in the three plants. The pre-concentrate from the pre-concentrator is transported to the concentrate up gradation plant (CUP) for further concentration before transport to mineral separation plant (MSP). When the distance between water and dry mills is not much, the CUP, belt conveyors or slurry pumping to MSP transport concentrate. (MC Donald 1969, Palmer 1994).

As mentioned above mining and processing of the placer sands are being practiced at different deposits. Considering the potential of placer sand occurrences all along the coastal tracts of India, a suitable and scientific basis should be adopted for initiating a successful mining and processing of new deposits.

Possible Environmental Hazards: The coastal zone consists of many different sub- systems, viz beaches, mangroves, cliffs, coral reefs, sea grass beds. These are all interconnected such that impacts on one-sub system affects the entire system.

Sand mining and dredging, which is part and parcel of surface mining where in sand and gravel containing placer deposits in beach, fore dune and rear dune environments will be removed and scrapped up. This kind of dredging creates environmental problems in the coastal tracts. The east coast of India is known for rich and varied natural environment. The lakes, estuaries and beaches of the east coast were famous for their scenic beauty and support diverse fauna and flora. The mining of placer deposits which are taking place in these coastal tracts, are a subject of serious concern. The following paragraphs are devoted to making a preliminary assessment of the possible impact on the sensitive environments in these zones.

Coastal Morphology: Sand mining and dredging in the coastal areas cause severe beach erosion. It is well established that the size and shape of beaches are determined by a balance between the sand deposited and sand eroded. The sand mining will have a catastrophic impact on this balance. It causes instability on the beach and this result in beach erosion.

Water quality: All types of dredging create some type of sediment plume in the water. Such plumes have adverse effects on biological resources either through impairment of water quality or increased siltation. Another one of its harmful effects is its potential to decrease dissolved oxygen (DO). A decrease in DO can significantly affect biological resources. In addition, sediment plume can also alter the pH (acidity) levels in water. In altered pH levels, some of the existing organic life perishes.

Habitat

Bird Habitat: Marine and coastal birds make up a significant part of the biota of the coastal system. It is also well known that this part of the coast is known for many migratory birds which pass through this coastal stretch to reach lakes like Chilka etc. physical disturbance of habitat caused by dredging activities involves generation of noise, this interrupts migratory routes besides affecting the nesting/breeding activities or damage the local bird habitat. Other effects include changes in foraging and nesting of habitat and increased exposure to re-suspended toxicants.

Fish Habitat: Physical disturbance to this habitat includes disturbance of fish spawning.

The processing of placer sands at the mine site, involves discharge of huge quantities of effluents that are ultimately channeled into the open sea. These effluents are rich in toxic chemicals that have harmful effects on the fish population. The untreated effluents discharged into the open sea by the Indian Rare Earth's plant at Chatrapur, Orissa, resulted in massive deaths of fish population in the surrounding waters (Bakshi, 1992). This has long ranged ecological and socioeconomic impact on the local population. The people living in the coastal areas, mainly depend upon the profession of fishing. When the fish population in the coastal areas dwindles, due to environmental impact, the fisherman community is deprived of its daily catch and livelihood.

Turtle Habitat: Beach environment (beach profiles, grain size and type of sediments, temperature and moisture gradients) influences the reproductive behavior, nesting and hatching activity of olive Ridley sea turtle, Lepidochelysolivacea. Most of the nesting beaches of olive Ridley sea turtles are confined to fine sandy areas nearer to larger river mouths of the Godavari, Nagavali and Vamsadhara, lagoons and estuaries in north Andhra Coast.

Mining operations for the extraction of beach sands diminishes the profile of the beach disturbs vegetation and induces the beach erosion. All these will have detrimental effects to nesting habitats and eliminate the nesting process. This area is an important habitat for olive Ridley turtle nesting and also possesses a higher concentration of economically important heavy minerals. (Rajasekhar et al 2001).

Aquatic organisms: Decrease in marine species: Significant reduction in the average number of species has been observed in a number of places in the world. Although the natural process of recolonization immediately occurs after the cessation of dredging, the post dredging, marine community differs substantially from its preodredging state. In the face of these observed and hypothetical adverse effects of offshore sand mining, particularly dredging, there is a need to evaluate or reevaluate offshore mining operations in the present context.

Due consideration must be given to the fact that the marine environment is in a fragile state. Moreover, a considerable population depends on the coastal environment for its livelihood and daily existence. It is at this juncture, that the government should adopt precautionary measures.

Mangrove Environment: Mangrove ecosystems are self-perpetuating coastal/estuarine landscape biotic entities that have resulted due to long term interaction between geo-meteorological factors. Mangroves are the plant species that depend on tides and inhabited only the intertidal belt, which is alternately covered and uncovered by coastal water mixed with a greater or lesser extent with water from land runoff. No other association of plants can live in intertidal belt, nor can mangrove plants grow well above or below this zone. However, the composition of plant species and also the associated animals varies with tidal amplitude, nature of soil, land profile, quality of fresh water input and salinity, duration of exposure between tides, temperature, cloud cover, wind and wave action.

The mangrove ecosystem is a sensitive interface between the land and the sea and forms a significant part of the coastal environment along the East coast of India. The extensive river systems of the east coast, namely Godavari, Mahanadi and Ganges are extensively supported mangroves plantation. Besides the major rivers, a number of small estuaries also support the growth of mangroves on a different scale and magnitude. Significantly, many of these sand deposits are near these mangrove ecosystems. The proposed mining activity is a further blow to the mangrove ecosystem which is already damaged by a number of land based industries discharging effluents into the fluviatile systems that support the mangrove survival and hinder their growth. The impact of mining on the drainage will also indirectly affect the mangrove habitat.

Coral reefs: Coral reefs are an important natural resources, which provide an important marine habitat for fish and other species. They serve as a tourist attraction and provide protection for the coast and beaches.

The proposed dredging activity will cause a serious threat to the coral reef environment due to the removal of beach and dune sedimentation.

Prehistoric resources: The areas under proposed mining activity are famous sites of prehistoric and cultural importance which are having lengthy history. These are mainly located in the districts of Visakhapatnam, Vizianagaram, Srikakulam in A. P, and Ganjam in Orissa. A number of temples and monuments of historical importance can be seen along the coast. It is obvious that the present day dunes might have covered a number of prehistoric monuments and many of them might have buried under them during the dune migration. The proposed mining and dredging activity may damage these sites. The companies and organizations involved in mining should be properly instructed for a preliminary survey to ensure that no such sites of historical/cultural importance are located in the proposed mining area.

Remedial measures: It is well established that a set of remedial measures to minimize the environmental impact due to activities like mining etc. are in place. The primary environmental impact due to dredging will be mainly in the coastal environment, especially affects the littoral zone habitat.

In recent times the concept of "Environmental Windows" is introduced to minimize the environmental impact especially due to operations like dredging. This concept is based on the fact that the sensitive biological resources, and their habitats may be protected from potentially detrimental effects by way of conducting the operations in selective months of the year to avoid the month in which these biological resources are some sensitive to disturbance.
In addition, the following minimizing techniques can be adopted.

- Imposition of dredging performance standards to meet environmental conditions and design controls.
- Monitoring and observance of water quality conditions and standards.
- Selection of dredging equipment to minimize impact, such as the use of environmental buckets, where appropriate, to trap contaminated sediments.
- Use of silt curtains where appropriate.
- Monitoring of blasting operations to control impacts to adjacent structures of historic significance.
- Coordination of all dredging activities with the Coast Guard and other organizations.
- The equirement for the dredging contractor or the organization to file and follow a contingent plan to cover the spills and accidents.

Similar steps can be taken to replenish the dredged material back to the original place. While doing so the following mitigation measures can be initiated towards beach nourishment, habitat creation and shoreline protection.

- Habitat development, including wetlands, up-land, island, aquatic
- Beaches and beach nourishment.
- Aqua Culture.
- Parks and Recreation.
- Agriculture, horticulture and forestry.
- Strip mine reclamation and solid waste landfill.
- Multipurpose uses and other land-use concepts.
- Construction and industrial/commercial uses

References

1. Ali, Mir Azam. Naidu, P.V.S. and Manjunath, Y.S. (1989). Studies on the beach placers of Ratnagiri district, Maharastra, India. Expl. Res. Atomic Min., Vol.2, pp. 167-175.
2. Ali, Mir. Azam. Viswanathan, G. and Krishnan, S. (1998). Beach and inland sand placer deposits of India – influence of geology, geomorphology and late Quaternary sea level oscillations in their formation, The National Symposium on Late Quaternary Geology and Sea Level Changes and The Annual Convention of The Geological Society of India, held at Cochin University of Science and Technology, Cochin, India, pp. 53 (abs).
3. Bakshi, A. K., (1992). Mineral processing Consultant, USA, Personal communication.
4. Banerjee, D.C., Ali, Mir Azam. And Dwivedy, K.K. (1996). Placer Minerals in the Economy of India, Spl. Vol., Indian Institute of Engineers, Bangalore, February, 1996.
5. Indian Minerals Yearbook (2015). Part-III (Mineral reviews), 54th edition, Ilmenite and Rutile, Government of India, Ministry of mines, Indian bureau of mines, Nagpur.
6. Mahadevan, C. and Sriramdas, A. (1948). Monazite in the beach sands of Vizagpatnam district, Proc. Indian. Sci, Vol.27, Cong. Section A, pp. 275-278.
7. MC Donald, E. H., (1968). Manual of beach mining practice, exploration and evaluation. Prepared for department of external affairs, Canberra, Australia.
8. Murthy, P.V.V.S.S., Anil Kumar, V., Ravi, G.S. and Ali, Mir Azam (1998). Studies on Heavy Mineral Resources of Koyyam Coast, Srikakulam district, Andhra Pradesh, Proceedings on Late Quaternary Geology and Sea level changes and annual Convention of Geol. Soc. India, Cochin, Abstract, Vol. P.63. Presented in: National Symposium on Late Quaternary Geology and Sea Level Changes. Cochin, November 4-6.
9. Overstreet, W.C. (1967). Geologic occurrences of Monazite. U.S.G.S. Prof. Paper 530. p. 327.
10. Palmer, G. L., (1994). The discovery and delineation of the Heavy mineral sand ore bodies at Graauwduimen, Namaqualand, Republic of South Africa. Explore. Mining Geol., Vol. 3, No. 4, pp. 399-405.
11. Panda, N.K., Murthy, P.V.V.S.S., Sahoo, P., Ravi, G.S. and Ali, Mir Azam. (1998). Evolution of Kalingapatanam Coast and its influence on Placer mineral concentration, East Coast of India. Presented in: National symposium on Late Quaternary Geology and Sea Level Changes. Cochin, November 4-6.
12. Rajasekhar, P. S, and Rajasekhar Reddy, D., (2001). Impact of beach sand mining on nesting habitats and reproductive success of Olive Ridley sea turtle, North Andhra Coast. Presented in National Seminar on Mineral based industries, present status future prospects, Visakhapatnam, India.
13. Rao, G.P. (1977). Evaluation of beach placer reserves of Chatrapur Deposit, Ganjam District, Orissa, Unpublished AMD Report.
14. Rao, G.P. (1973). Evaluation of Heavy Mineral reserves of IRE Mining lease areas, Chavara, Quilon district, Kerala. Unpublished AMD Report.
15. Rao, G.P. (1976). Evaluation of beach placer reserves of KMML Mining lease areas, Chavara, Quilon district, Kerala. Unpublished AMD Report.
16. Rao, B.R., and Narasayya, B.L (1989). Nonliving resources in the seabed within the Territorial water. A view from the coastal states of Andhra Pradesh and Tamil Nadu. Marine Wing Newsletter, Geol. Sur. India, Vol.V.2, pp. 3-4.
17. Rao, R.G., Rao, G.D., Rami Naidu, Ch. and Hussain Zaffar. (1990). Evaluation of a Heavy Mineral Reserves – Bhimunipatnam Sand Deposit, Visakhapatnam, Vizianagaram districts, Andhra Pradesh. Unpublished AMD Report.
18. Rao, A.Y., Rao, A. P., Ravi. G.S. and Ali, Mir Azam. (1998). Placer ilmenite deposits of Bhavanapadu coast, Srikakulam district, Andhra Pradesh. The National symposium on Late Quaternary Geology and Sea Level Changes. The Annual Convention of the Geol. Soc. India, held at Cochin University of Science and Technology, Cochin, India. P.62 (abs).
19. Roy, A.K., Ravi, G.S. and Ali, Mir Azam (1998). Textural characteristics and heavy mineral content of shelf sediments off Chilka Lake, Orissa. Presented in: National symposium on Late Quaternary Geology and Sea Level changes. Cochin, November 4-6.

20. Vishwanathan, P. (1957). Studies on Travancore Beach Sands. India Mining J. Spl. Issue, pp. 109-122.
21. Vishwanathan, G., Chandrasekharan, S., Tippeswamy, S., Murugan, C., Ratna Reddy, N., Krishnan, S. and Ali, Mir Azam. (1998). Heavy mineral assemblage in the beach placer sand of Pillaithoppu-Rajakkamangalam area of Kanyakumari district, Tamilnadu. Presented in: National Symposium on Late Quaternary Geology and Sea Level changes. Cochin, November 4 – 6.