"Mineral Sands Deposits: their complexity and need for International reporting standards -Indian scenario"

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# Heavy Mineral Sand Deposits

- The term "Mineral Sands" refers to sands which contain suites of minerals with high specific gravity (> 4 Specific Gravity) known as heavy minerals.
- Heavy minerals occurs as disseminated, associated or concentrated deposits within the sands.
- > Found in an alluvial (old beach or river system) environment.
- These are derived from the weathering of pre-existing rocks, and accumulated due to the constant action of sea waves and wind near the shoreline.
- Typically, Ilmenite, Rutile, Zircon, Garnet and Sillimanite are the heavy minerals found in beach sands along with Monazite.

### **Mode of Occurrence of Heavy Mineral Sands**



**Replenish able Beach Sand Deposits** 



The washings on the beaches are mined by scraping

**Inland Teri Deposit** 



#### Inland Deposit



- The inland deposits are mined by digging in dry mining method
- In areas where the deposits extend below water table, the dredging method is adopted.

## Heavy Mineral Sand Deposits - Topography

- Deposit lies on a broad coastal plain with gentle sloping topography towards the ocean
- Form a gentle undulating topography and following the topography of the underlying bed rock i.e sand stone /calcareous sand stone.
- Low rounded sand dunes and flat terrains with elevation varying from 25m to 70m, lie parallel to sea coast at 1-2 km from shore line
- > Wind reworked aeolian sand deposits extend upto 15 km inland.

# A typical heavy mineral deposit – Mineral Assemblage



#### **Mineral Sands - Processing for mineral separation**



SEPERATION OF INDIVIDUAL MINERALS CARRIED OUT BY USING THEIR MAGNETIC & ELECTROSTATIC PROPERTIES AND DIFFERENCE IN SPECIFIC GRAVITY

# **Simultaneous Backfilling and Reclamation**

#### **Refilling of Mined out Land with Sand Tailings**



**Afforestation and Maintenance** 

#### **Recovering Water from Tails**



#### Afforested Mined out Land





# **Exploration Requirements**

As per Minerals(Evidence of Mineral Content)Rules, 2015 (MEMC 2015) and Atomic Minerals Concession Rules, 2016 (AMC 2016) :-

Particulars	UNFC	MEMC, 2015	AMC Rules, 2016
Method of Drilling	For beach sand minerals, sampling by auger or improvised version of drilling equipment	by auger or improvised version of drilling	Auger/Conrad/Bunka/Dorm er/Vibrocore/RCD drilling
(Detailed Exploration) G-1	at 200m x50m to 100m x25m in grid pattern.	100m <sup>*</sup> along the trend of the deposit and 50m across(100mx50m)	200m x 100m grid or closer.
(General Exploration) G-2	at 400mx100m grid	200m <sup>*</sup> along trend of the deposit and 100m across(200mx100m)	>200-1000m x100-200m grid

# **Geological Domains**

- > Three vertical geological domains.
  - Upper Sand :- An upper fine to medium grained homogeneous ore body that is brown in colour and that has possibly been reworked and re-deposited by coastal wind actions, commonly known as upper ore body having less slime content.
  - Lower Sand :- A coarse to fine grained homogeneous ore body that is brown in colour and is possibly an alluvial sediment from the most recent deltaic progradation, commonly known as lower ore body having high slime content.
  - Lagoonal Grey Clay : A fine grained homogeneous litho unit that is brown or dark grey in color and that has possibly an alluvial sediment deposited by deltaic progradation having meagre THM content and very high slime content.

# **Typical Geological Section**



Mineral Assemblege in Raw Sand %	Upper Sand	Lower Sand		
THM	31.76	15.98		
Slime	1.24	24.60		
Mineral Content				
Ilmenite	10.96	5.73		
Rutile	0.57	0.22		
Zircon	0.47	0.21		
Garnet	10.19	4.55		
Silimanite	8.88	4.56		
Others	0.69	0.71		
Total	31.76	15.98		

- Upper ore body thickness varies 1.0 to 11m, aveg 4.50m.
- Lower ore body thickness varies 1.0 to 9.5m, aveg.4.00m.
- > Mineral Assemblage for different ore body is varying.
- Slime content are very high in lower ore body which needs to be treated in a separate plant circuit.

### **Ilmenite Resources in India**

- India's heavy mineral sand resources are not only extremely large, but they are also one amongst the highest grades in the world.
- According to the Atomic Minerals Directorate for Exploration and Research (AMD), Department of Atomic Energy, Govt. of India, ilmenite reserve estimated is one of the largest deposits in the world with about 30% of world reserve.
- Despite such extensive resources, the production to reserve ratio (PRR) in India is 0.002 as compared with world PRR which is from 0.003 to 0.275 in 2010. This is insignificant compared to countries having similar or even less resources.
- It is obvious that India's resources are not being optimally utilised; only state owned organizations like Indian Rare Earths Limited (IREL) and Kerala Minerals and Metals Limited (KMML) were in the production of beach sand minerals till very recently.

## **Beach Sand Mineral Policy in India**

- The Government of India in Oct 1998, had notified a policy on exploitation of beach sand minerals in the country, which inter alia allows participation of private sector with or without foreign companies subject to conditions stipulated.
- This is to encourage the exploitation of mineral deposits through a judicious mix of public and private sector participation including foreign collaboration.
- The minerals ilmenite and rutile were grouped as 'Prescribed Substances' as per notifications issued under the Atomic Energy Act, 1962.
- Department of Atomic Energy vide S.O. No.61 (E), dated 20.01.2006, the titanium ore minerals like ilmenite, rutile and leucoxene have been delisted as prescribed substances by the Department of Atomic Energy.
- Again as per MMDR Act 2015 amended and Atomic Mineral Concession Rules, 2016, less than threshold value treated as Non Atomic mineral and above threshold value treated as Atomic mineral.

# **Statutory Requirements**

- Heavy Mineral Mining comes under the management of both the State and the Central Government for the purpose of grant of lease and involves all the clearances and permissions required for mining of Coal or Iron ore etc.
- > Additionally clearances are required from the,
  - Coastal Regulatory Zone Authority for CRZ clearances
  - Department of Atomic Energy (DAE) for storage of Monazite
  - Atomic Energy Regulatory Board (AERB) license for handling Monazite Mineral
  - Atomic Minerals Directorate for Exploration and Research (AMD) for Approval of Mining Plan if the monazite content in THM is above threshold value or otherwise mining plan approval from Indian Bureau of Mines.
  - Wild life Conservation Plan for Sea Turtle on the coast.

#### **Resources to Reserves Conversion**

As per the Environmental and CRZ clearances there following are the mining constrains :

- > No mining shall be carried out in the inter-tidal zone
- > No mining shall be carried out within 100 M from HTL towards landward side.
- > No mining shall be carried out in sand dune areas
- > Adverse impacts on the Sea Turtle nesting due to mining activity
- > Barrier zone from forest and village boundaries
- > Other safety zones
- Land availability social issues

Mining & Mineral Separation

- Disposal of huge volumes of slimes (below 63 microns)
- > Disposal/Storage of radioactive minerals like monazite

Ilmenite Upgradation

Generation of huge amounts of iron oxide waste and acid wastes disposal of which assumes importance

# FDI in Mineral Sands Industry

- > As per FDI Policy for mining of titanium bearing Minerals & Ores
  - FDI up to 100% will be allowed with prior Government approval in mining and mineral separation of titanium bearing minerals & ores, its value addition and integrated activities subject to sectoral regulations and the Mines and Minerals (Development and Regulation Act 1957).
  - FDI for separation of titanium bearing minerals & ores will be subject to the following additional conditions viz.:
    - value addition facilities are set up within India along with transfer of technology;
    - disposal of tailings during the mineral separation shall be carried out in accordance with disposal of tailings during the mineral separation shall be carried out in accordance with regulations framed by the Atomic Energy Regulatory Board such as Atomic Energy (Radiation Protection) Rules, 2004 and the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987.

## **Pre-requisites for a Global Player**



# **Issues - Need for International Reporting Standards**



Land acquisition is an uphill task **D** Though mining lease is granted, access to the lands is prevented by social issues



# Best wishes for Indian Mineral Industry Guideline