Beach Sand Mineral Industry In Orissa

Mineral Industry

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Beach Sand Minerals like Ilmenite, Rutile, Zircon, Sillimanite, Monazite and Garnet called Heavy Minerals have wide ranging application in the Industrial World today, viz. Paint, Refractory, Ceramics, Pottery, Sanitaryware, Foundry Chemicals, Electronics and Nuclear Power Plants etc.

India has very rich deposits of Beach Sand Minerals along the East and West Coast. The average Heavy Mineral (H.M.) content in West Coast along Kerala is about 50 - 55% whereas the H.M. content along the East Coast deposits in Ganjam Coast as well as Puri Coast in Orissa, is only about 20 – 25%. The deposits are in the form of dunes with an average height of about 15 metres from M.S.L. and the mineral content that could be economically mineable extends upto a depth of about 1.5 metres below M.S.L.

Hence to mine the minerals and to upgrade the H.M. content from 20% to +90%, the economical method of dredge mining the deposits and state of the art technology for mineral upgradation and separation is adopted in these deposits.

About the Deposit :

Mineral Sands are obtained from disintegration of rocks and are washed down into the sea by rivers and also from erosion of coastal rocks by wave action. They are again transported to the coast by high tidal waves. Wave action has also led to formation of off shore islands found in Australia which are sand masses containing concentration of Heavy Minerals. Along the Coast/Beach it is found in big dunes and are Hence called Beach Sand Minerals.

> Since the steel industry is poised for a massive growth in India, the refractory industry will also grow proportionately. Hence there is an urgent need for development of Beach Sand Mining industry which has a direct contribution in the steel related refractory and ceramic units.

In India, the Beach Sand Minerals exist over a coast length of about 2400 Kms along both the East and West coast touching Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka and Maharastra.

Quartz or Silica is the most common mineral in Beach Sand which is a low density and commercially low value mineral. However along with quartz many other Minerals with densities much greater than quartz and of very high commercial value do exist in the Beach Sand. They are Ilmenite, Rutile, Monazite, Zircon, Sillimanite and Garnet which are known as Heavy Minerals. These minerals are used in applications as diverse as they are numerous.

Beach Sand Deposit along Orissa Coast :

The Heavy Mineral contents of Kerala and Tamil Nadu deposits as well as other deposits in the West Coast contain about 60 percent of the raw sand and such deposits do not exist else where in the country. Though Ilmenite and associated minerals occur in the Ratnagiri Coast of Maharastra and in some parts of Andhra Pradesh, both in terms of reserves and richness, the Orissa deposits in East Coast rank next to the Kerala and Tamil Nadu deposits.

Atomic Minerals Division of Government of India have done extensive investigation work during the sixties and proved the occurrence of large deposits of Beach Sand along the South Orissa Coast over a stretch of about 100 Kms. Of the several deposits located, the one close to Chatrapur Town in (Ganjam District) is the most extensive single deposit with the highest content of Heavy Minerals.

It runs over a coast length of nearly 18 Kms covering a total area of over 26 Square Kms between Gopalpur in the South and the Rushikulya River in the North. The total raw sand deposit is estimated to contain about 230 million tons with 20 to 25 percent Heavy Minerals such as Ilmenite, Garnet Sillimanite, Rutile, Zircon and Monazite. This deposit is the single largest and contiguous deposit in the world.

The interesting phenomenon in this deposit is that most of the reserves are in the dune form. The frontal dunes that are a little away from the high water line of the Sea (Bay of Bengal) are almost along the 18 Kms Coast Length. The rear dunes which is of same length is almost parallel to the frontal dunes. The approximate gap between the frontal and rear dunes is about ¾ Kms. The average height of the frontal dunes is as high as 15M from MSL where as the rear dunes are about 10M from MSL and the valley portion between the dunes will be about 3 to 4M above MSL. The approximate depth of mineal deposit exists 1.5M below water table.

Extensive deposits have also been found along Rambha Coast in (Ganjam District). Rich mineral deposits have also been identified along the Puri Coast near Satpada located between Chilika Lake and the Sea Coast. However, so far it is only the Chatrapur deposit that is being mined and beneficiated and individual minerals are produced since 1986 by M/s. Indian Rare Earths Ltd. A Central PSU.

Physical Properties of Beach Sand Minerals

Item	Bulk Density	Specific Gravity	Hardness (Moh's)	Electical Conductivity	Magntic Susceptability
Ilmenite ($FeTiO_3$)	2.69	4.54	5 to 6	Conducting	Magnetic
Garnet $R_3R_2(SiO_4)_3$	2.17	4.10	6.5 to 7.5	Non-conducting	Magnetic
Monazite (Ce,Y,La) PO_4	3.12	5.22	5.0 to 5.5	Non-conducting	Feebly Magnetic
Sillimanite (Al_2SiO_5)	1.79	3.24	6 to 6.5	Non-conducting	Non-Magnetic
Zircon ($ZrSiO_4$)	2.67	4.68	6 to 7.0	Non-conducting	Non-Magnetic
Rutile (TiO_2)	2.48	4.25	6 to 6.5	Conducting	Non-Magnetic
Quartz	1.40	2.60	6 to 6.5	Non-conducting	Non-Magnetic

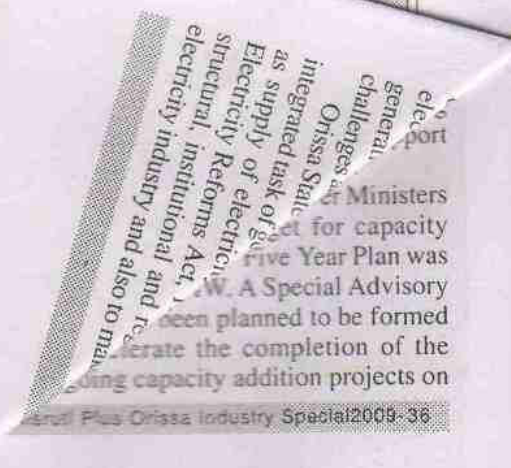
Government of Orissa has granted lease of the deposits of IREL.

Brief Procedure of Mining and Individual Separation of Minerals :

Beach sand can be bulk mined commercially using any of the following methods :
i Drag lining **ii** Dozing **iii** Bucket wheel excavator **iv** Suction dredging **v** Scrappers and **vi** Sluicing

For mining of Beach Sand, drag lining is high in capital as well as operating costs without any commensurate advantage. Dozing is even more expensive but has the advantage of comparatively lower dilution. Bucket wheel excavator is very high in capital cost and cannot operate satisfactorily below water table conditions. Suction dredging is comparatively lower in capital and operating costs, simple to operate and has no moving costs. This method leads to some what higher dilution. Scrapers are expensive and not reliable, also maintenance time and costs are high. Sluicing is comparable to dredging in capital cost but is higher in operating cost due to frequent moves, very large water consumption and pumping costs.

Since the Orissa deposit is clean without overburden; also, mineral values extend below water table to over 1.5M in very porous conditions and the subsequent pre-upgradation requires feed in slurry form. These factors, along with low capital and operating costs, favour adoption of



suction dredge along with Preconcentrator Unit moving along with mining.

As the deposit extends over a stretch of about 18 Kms, the mining operation will move along this area but the Mineral Separation Plant has to be stationary. This enables preconcentrate the raw sand at the mining site to discard bulk of the gangue materials and transport only heavy mineral concentrates to the stationary separation plant. The gangue material is refilled in the already mined areas.

The minerals being much heavier than the gangue (mainly quartz) and their size distribution being similar, the separation methods adopted for preconcentration are all based on gravity separation and the method generally adapted is spiralling.

The Present Cost of Minerals (as on 01.07.2009)	
Ilmenite	Rs 5,000/- per Ton
Rutile	Rs 41,000/- per Ton
Zircon	Rs 46,000/- per Ton
Sillimanite	Rs 11,000/- per Ton
Garnet	Rs 3,750/- per Ton

Industrial Application :

1. Ilmenite :

It contains approximately 50% TiO_2 and 50% Iron Oxide. This Iron Oxide exists as an impurity and by chemical process, if removed will enhance the TiO_2 content. By chloride route as well as sulphite route, technology is established to get 92% TiO_2 known as Synthetic Rutile. The Iron Oxide by-product has several uses in paint and red cement manufacture. The Synthetic Rutile is used as an input for Titanium Dioxide Pigment Plant.

2. Ritile/Synthetic Rutile :

Rutile contains about 94 to 96 percent Titanium Dioxide. Synthetic Rutile is a Rutile like material containing about 90 to 92 percent Titanium Dioxide and is produced from Ilmenite, containing about 50 percent Titanium Dioxide. Rutile/Synthetic Rutile are used in the manufacture of Titanium Dioxide (TiO_2) Pigment, coating of welding electrodes and in manufacture of Titanium sponge and metal. TiO_2 Pigment is mainly used for paints, its other uses being for paper, plastics, rubber, printing ink, ceramics etc. Titanium metal which is a silver white light metal, a little heavier than aluminium but about half as heavy as alloy steel and having better corrosion resistance than stainless steel, is used where stainless steel is not suitable. Its main uses are in air crafts, missiles, chemical and desalination plants, marine equipments etc.

3. Sillimanite :

The theoretical composition of these minerals is about 60 percent Alumina (Al_2O_3) and 37 percent Silica (SiO_2). Its properties are similar to that of Kyanite and are widely used for light to medium temperature resisting refractory bricks, monolithics.

4. Zircon :

Zircon is a Silicate of Zirconium, containing about 65% Zirconia (ZrO_2)

and approximately 35% Silica. It is used in foundries, refractories, ceramics and porcelein. It also finds use in the manufacture of Zirconium compounds such as acetate, oxychloride, hydroxide, carbonate etc. Small quantities are also employed for the extraction of Zirconium metal, the alloys and compounds of which are used in nuclear energy plants.

5. Monazite :

Monazite is a phosphate of rare earths and thorium and contains about 60% rare earths expressed as oxide (Re_2O_3) and 27 to 29% phosphate expressed as phosphorus pentoxide (P_2O_5). It is used for production of rare earths chloride and other rare earths compounds, trisodium phosphate, thorium nitrate. These chemicals find extensive application in the incandescent gas mantle industry, in starters of fluorescent tubes, carbon are industry, optical glass composition, picture tubes of colour TV etc.

6. Garnet :

It is an Iron Aluminium Silicate, $Fe_3Al_2(SiO_4)_3$, with Al_2O_3 approx 21% by Wt, FeO 27% and Fe_2O_3 2.4%, SiO_2 38%. It is very hard and is used in grinding stones, Abrasive papers etc.

Possible Down Stream Industries :

The minerals have got wide range of industrial applications. Based on the utilities, the following major Industrial units can be set up:

1) Synthetic Rutile Plant or Titanium Dioxide Plant based on Ilmenite.

2) Paint Pigment Plant based on Titanium Dioxide (From Rutile or Ilmenite) and paint unit from the pigment.

3) Titanium metal/Titanium Sponge Unit, Ferro-Titanium Unit.

4) Welding Electrode Units.

5) Refractories based on Sillimanite and Zircon.

6) Zircon micronizing units to produce Zircon flour and Opacifier used in Ceramic Wall Tiles, Foundry Chemcials.

7) Zirconium Oxide and other Zirconium Chemicals Unit, partially stabilized and stabilized Zirconia Unit.

8) Silica Aluminium Unit.

9) Zirconium metal and Zirconium Alloy Plant.

10) Monazite processing unit to manufacture Rare Earths Chemicals as well as detergents based on Trisodium phosphate.

11) Garnet powder, graded garnet unit.

12) Separation of garnet and Sillimanite from reject sand of Heavies-Upgradation Plant.

13) Garnet Tile Unit.

14) Zircon frit making units which can supply to Nuclear Fuel complex, Hyderabad.

Orissa state not only possesses huge deposits of Iron, Coal, Bauxite, Chrome minerals but also has a substantial quantity of Beach Sand deposits. All these Beach Sand Minerals have diversified industrial application. Hence effective mining, beneficiation and conversion to value added products within Orissa will accelerate the industrial development of the state.

Since the steel industry is poised for a massive growth in India, the refractory industry will also grow proportionately. Hence there is an urgent need for development of Beach Sand Mining industry which has a direct contribution in the steel related refractory and ceramic units.

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