TECHNOLOGIES FOR NEW INDIA@75
आज़ादी का अमृत महोत्सव

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Unleashing Values

IREL (India) Limited

70 YEARS

Compendium on Rare Earths and Heavy Minerals



Released on the occasion of
37th DAE- Safety & Occupational Health Professionals Meet, 2021

TRUSTED PARTNER IN GROWTH FOR OVER SEVEN DECADES

- Products - enhancing industrial performance
- CSR beneficiaries - over 10,000
- Catalytic role in supporting more than 2,200 industries in value chain
- Employment Generation - over 2,00,000
- Green belt development - over 1,500 acres
- Area Decontaminated & made Radioactivity free - over 2,500 acres

Index

IREL (India) Limited

IREL (India) Limited, a Mini Ratna Category-I CPSE is a Govt. of India Undertaking under the administrative control of Department of Atomic Energy (DAE) with Registered Corporate Office in Mumbai, Maharashtra.

IREL's mineral production units are located at Chatrapur (Orissa Sands Complex (OSCOM)), in Odisha, Chavara in Kerala and Manavalakurichi (MK) in Tamil Nadu are engaged in extraction of Heavy Minerals like Ilmenite, Rutile, Zircon, Sillimanite, Garnet and Rare Earth Mineral.

The Rare Earth Extraction Plant (REEP) is located in Chatrapur (OSCOM), Odisha and High Pure Rare Earth Plant in Aluva, Kerala is engaged in refining of Rare Earth concentrate to produce separated High Pure Rare Earths.

IREL (India) Limited has its Corporate Research Centre (IRERC) at Kollam, Kerala

IREL (India) Limited is one of the key-players in the global Rare Earth and Heavy Mineral industry and has been the driving force behind the growth of hundreds of industries in country and has proven to be reliable global partner for end user industry.

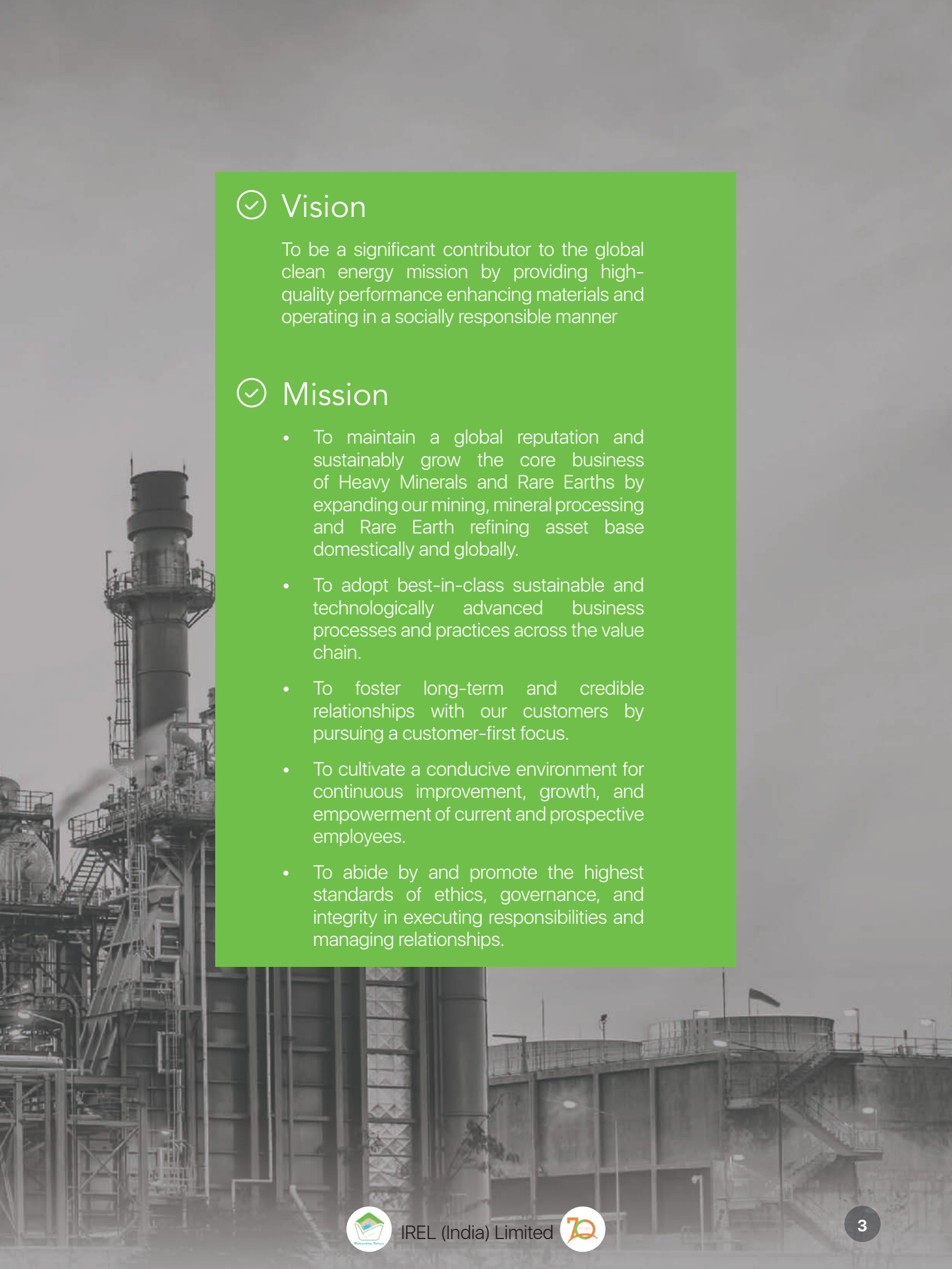
Our History

In 1909, German Chemist Mr. Herr Schomberg identified shining yellowish brown sand particles in the sand remnants of contaminants of coir imported from Kerala. This lead to discovery of moderate deposits of Rare Earth mineral (Monazite) and paved way for Rare Earth and Heavy mineral industry in India.

In 1950, IREL (India) Limited (formerly Indian Rare Earths Limited) was incorporated as a private limited company jointly owned by Govt. of India and erstwhile Govt. of Travancore - Cochin with operations in Udyogmandal, Aluva, Kerala. IREL (India) Limited became a full-fledged government undertaking under administrative control of Department of Atomic Energy (DAE) in 1963.

Products

Rare Earths	Chemicals	Heavy Minerals
Lanthanum Carbonate	Rare Earth Chloride	Ilmenite
Cerium Carbonate	Tri Sodium Phosphate	Rutile
Neodymium-Praseodymium Oxalate / Oxide	Thorium Nitrate	Zircon
Samarium Oxalate / Oxide		Garnet
Dysprosium Oxide		Sillimanite
Gadolinium Nitrate		



Vision

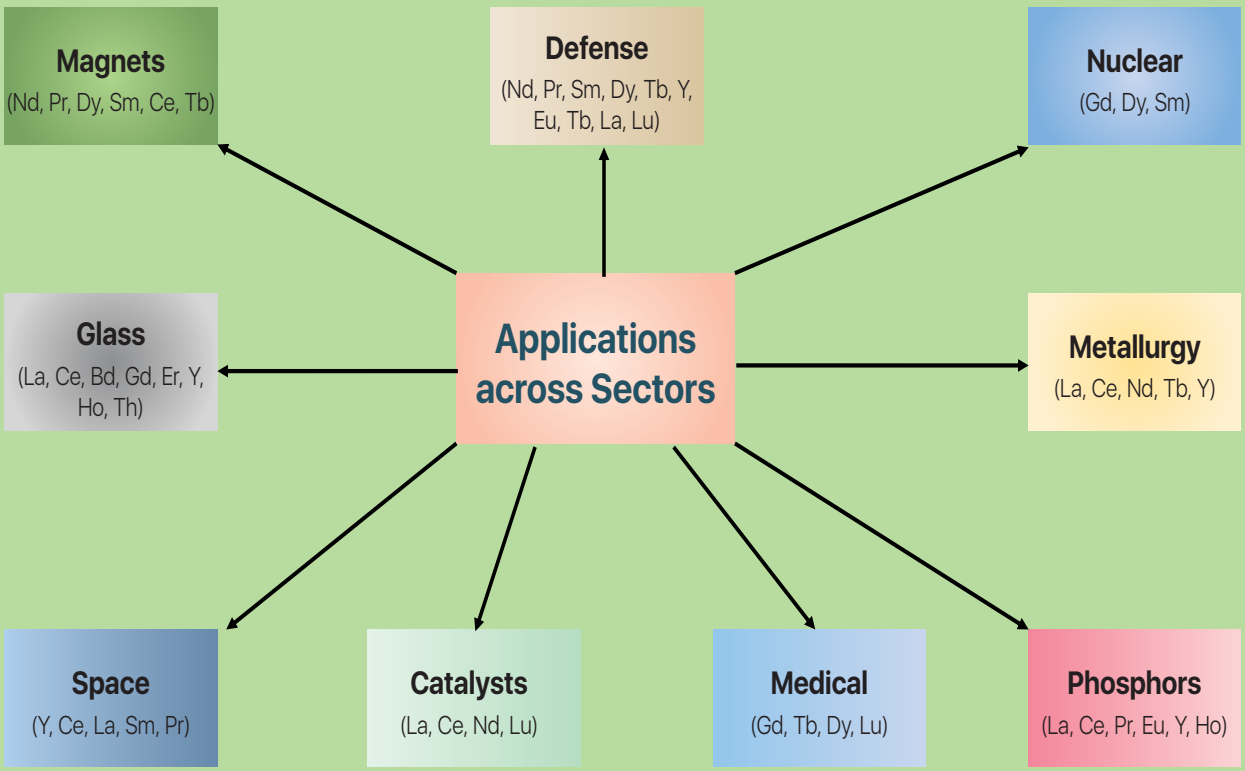
To be a significant contributor to the global clean energy mission by providing high-quality performance enhancing materials and operating in a socially responsible manner

Mission

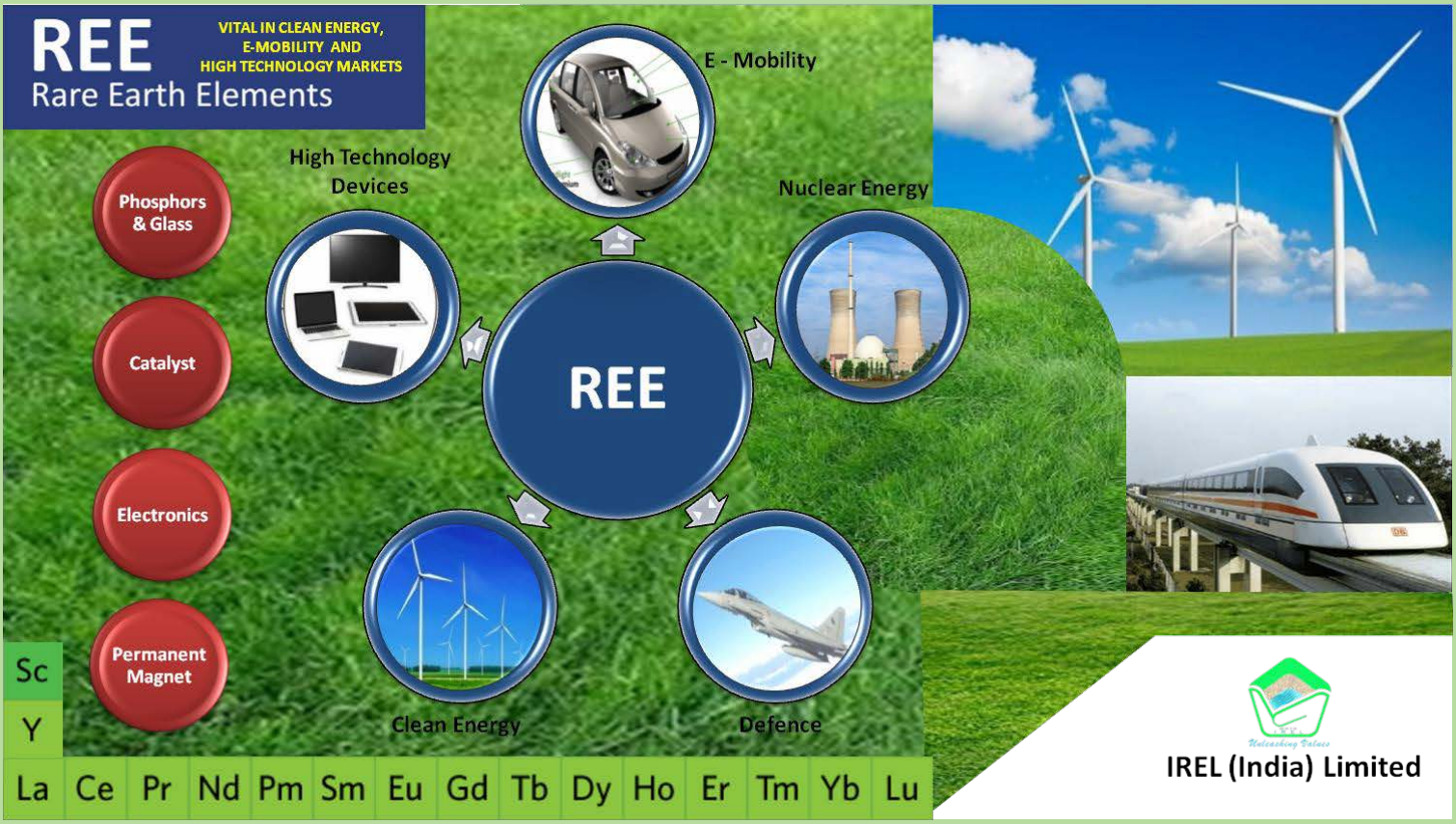
- To maintain a global reputation and sustainably grow the core business of Heavy Minerals and Rare Earths by expanding our mining, mineral processing and Rare Earth refining asset base domestically and globally.
- To adopt best-in-class sustainable and technologically advanced business processes and practices across the value chain.
- To foster long-term and credible relationships with our customers by pursuing a customer-first focus.
- To cultivate a conducive environment for continuous improvement, growth, and empowerment of current and prospective employees.
- To abide by and promote the highest standards of ethics, governance, and integrity in executing responsibilities and managing relationships.

What are Rare Earths ?

- Rare Earth Elements are a collection of 17 elements namely Scandium, Yttrium and Lanthanides (15 elements) in the periodic table with atomic numbers 57 to 71.
- Rare Earths have multiple applications and it is the vitamin of modern technology.
- Used in small quantities in variety of products in the field of e-mobility, green energy, catalysts, consumer electronics, defence, aerospace, etc. for:
  - Enhancing Performance
  - Technological Superiority
  - Incorporation of innovations to meet new challenges
  - Miniaturization



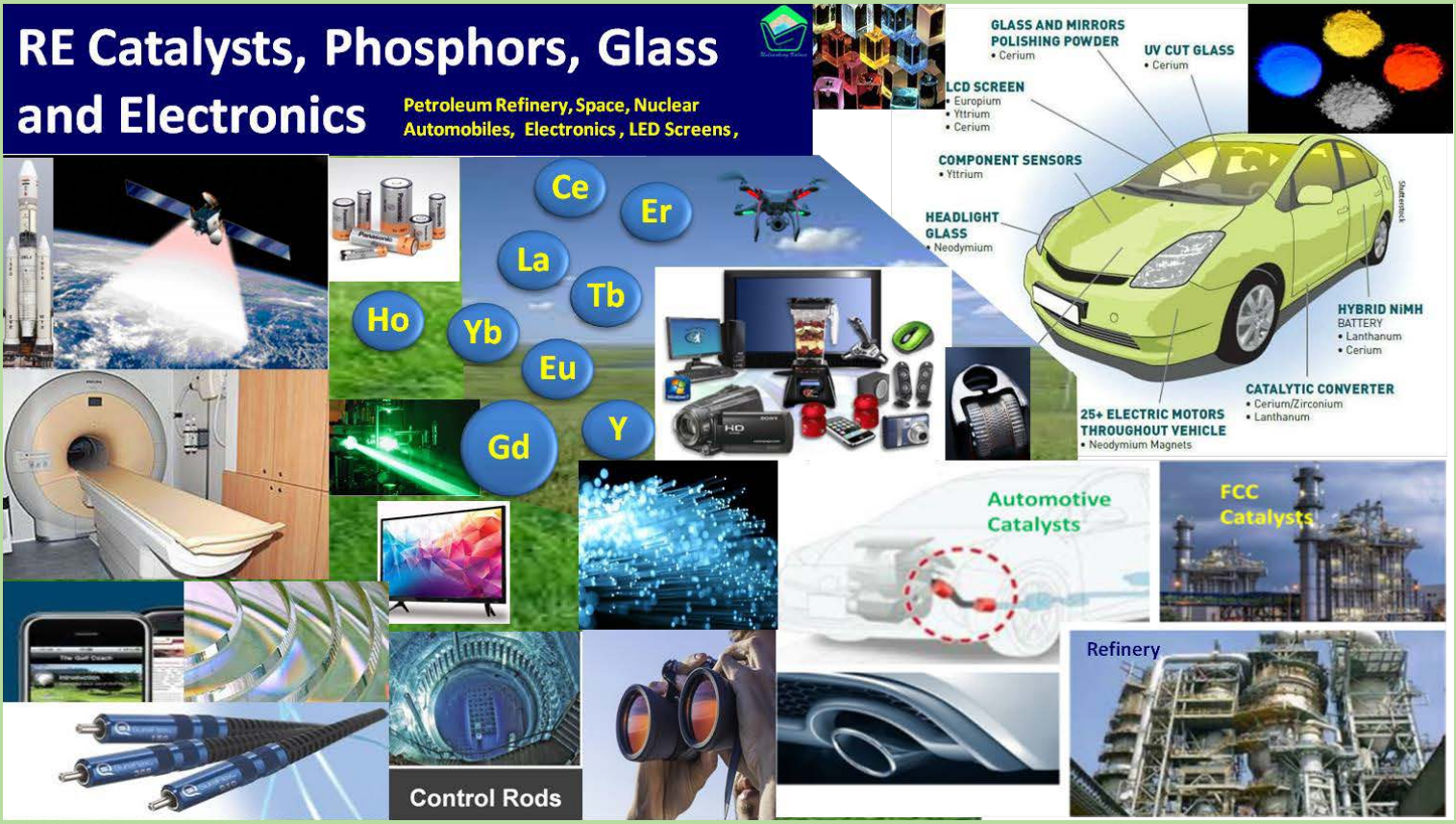
La-Lanthanum; Ce-Cerium; Pr-Praseodymium; Nd-Neodymium; Sm-Samarium; Gd-Gadolinium; Eu-Europium; Tb-Terbium; Dy-Dysprosium; Er-Erbium; Y-Yttrium; Ho-Holmium; Tm-Thulium; Yb-Ytterbium; Lu-Lutetium


REE
Rare Earth Elements
VITAL IN CLEAN ENERGY, E-MOBILITY AND HIGH TECHNOLOGY MARKETS
E - Mobility
High Technology Devices
Nuclear Energy
Phosphors & Glass
Catalyst
Electronics
Permanent Magnet
REE
Clean Energy
Defence
Sc
Y
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
IREL (India) Limited


Rare Earth Permanent Magnets
Defence, Clean Energy, Hi-Tech Electonics
Nuclear Energy, E- Mobility (EV)
Sm-Co (Samarium Cobalt)
Nd-Fe-B(Neodymium-Iron-Boron)
Dy
Pr
Nd
Sm

RE Catalysts, Phosphors, Glass and Electronics

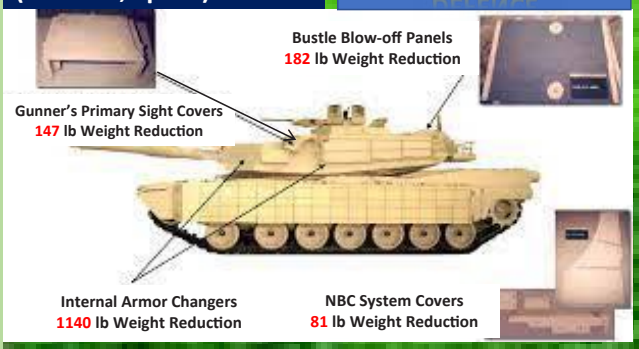
Petroleum Refinery, Space, Nuclear
Automobiles, Electronics, LED Screens,



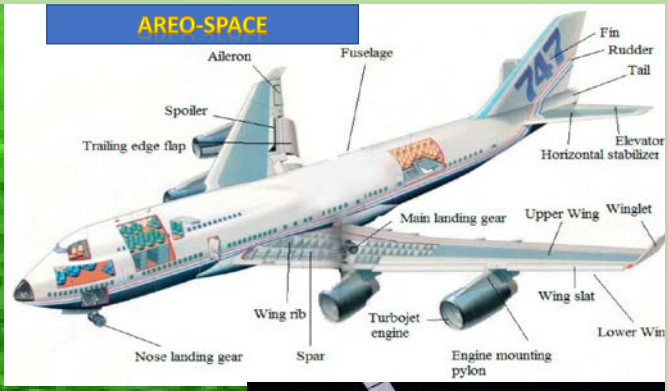
Titanium Applications (Automotive, Daily Life, Industry, Medical)

Titanium Applications (Defence, Space)

DEFENCE



AREO-SPACE



OSCOM Rare Earth Extraction Plant

IREL has set up a Rare Earth Extraction Plant (REEP) for producing Mixed Rare Earth Chloride (MRCL), Trisodium phosphate, Thorium Nitrate and other compounds of strategic interest at its unit OSCOM Odisha. MRCL produced from the above plant is refined at IREL's plant at Rare Earth Division (RED) in Aluva Kerala for producing separated High Pure Rare Earths.

The Rare Earth oxide content in the ore is 0.06 % and it undergoes several stages of concentration to make it amenable for extraction.

The installed capacity of REEP is 11200 tpa mixed Rare Earth Chlorides / Concentrate.

Rare Earths Division Aluva

Rare Earths Division (RED), Udyogamandal, Aluva is located on the banks of river Periyar in Kerala at a distance of 12 kms from the port city of Kochi and 15 kms from Kochi International Airport. RED is an exclusive value adding chemical plant, wherein Rare Earths concentrate produce from REEP is refined to produce high pure individual rare earth compounds. This plant, the first Unit of IREL, was made operational way back in 1952 for processing of 1400 tons per annum (tpa) of monazite, which subsequently increased to 3600 tpa.

The plant was refurbished to process mixed Rare Earth Chloride. It produces high pure individual rare earth compounds of Lanthanum and Cerium in carbonate form, and that of Neodymium-Praseodymium, Samarium, Dysprosium, Gadolinium and Yttrium in oxalate form (with more than 99% purity). RED also produces strategic material for the Department of Atomic Energy, Government of India, which are available in the ore in ppm level.

Orissa Sands Complex (OSCOM)

Orissa Sands Complex (OSCOM) is IREL's flagship unit located at Chatrapur in the district of Ganjam, which is about 150 kilometers from Bhubaneswar, the Capital of Odisha. All-weather Gopalpur port is situated beside the OSCOM plant complex. The nearest airport is in Bhubaneswar. At present, heavy mineral mining and mineral separation activity are carried out to produce Ilmenite and other associated minerals such as Rutile, Zircon, Sillimanite and Garnet.

Chavara Mineral Division

Chavara mineral separation plant is located 10 kms north of Kollam and 85 kms from Thiruvananthapuram the Capital of Kerala. It is about 135 kms from Kochi, the major port in Kerala. The nearest airport is at Thiruvananthapuram. The adjacent area of Chavara is blessed with one of the best mineral sand deposits in the country – the renowned "Q" Grade minerals.

Manavalakurichi Mineral Division

Manavalakurichi unit (MK) is located at a distance of 25 kms North of Kanyakumari (erstwhile Cape Comorin) in Tamil Nadu. All weather major seaport 'Thoothukudi' is located at a distance of 100kms and the nearest Airport at Thiruvananthapuram is located at a distance of 65 kms from the MK plant. Nagercoil, the district headquarter located at a distance of 18 kms from the plant is the closest major Railway station.

Research and Development

IRERC

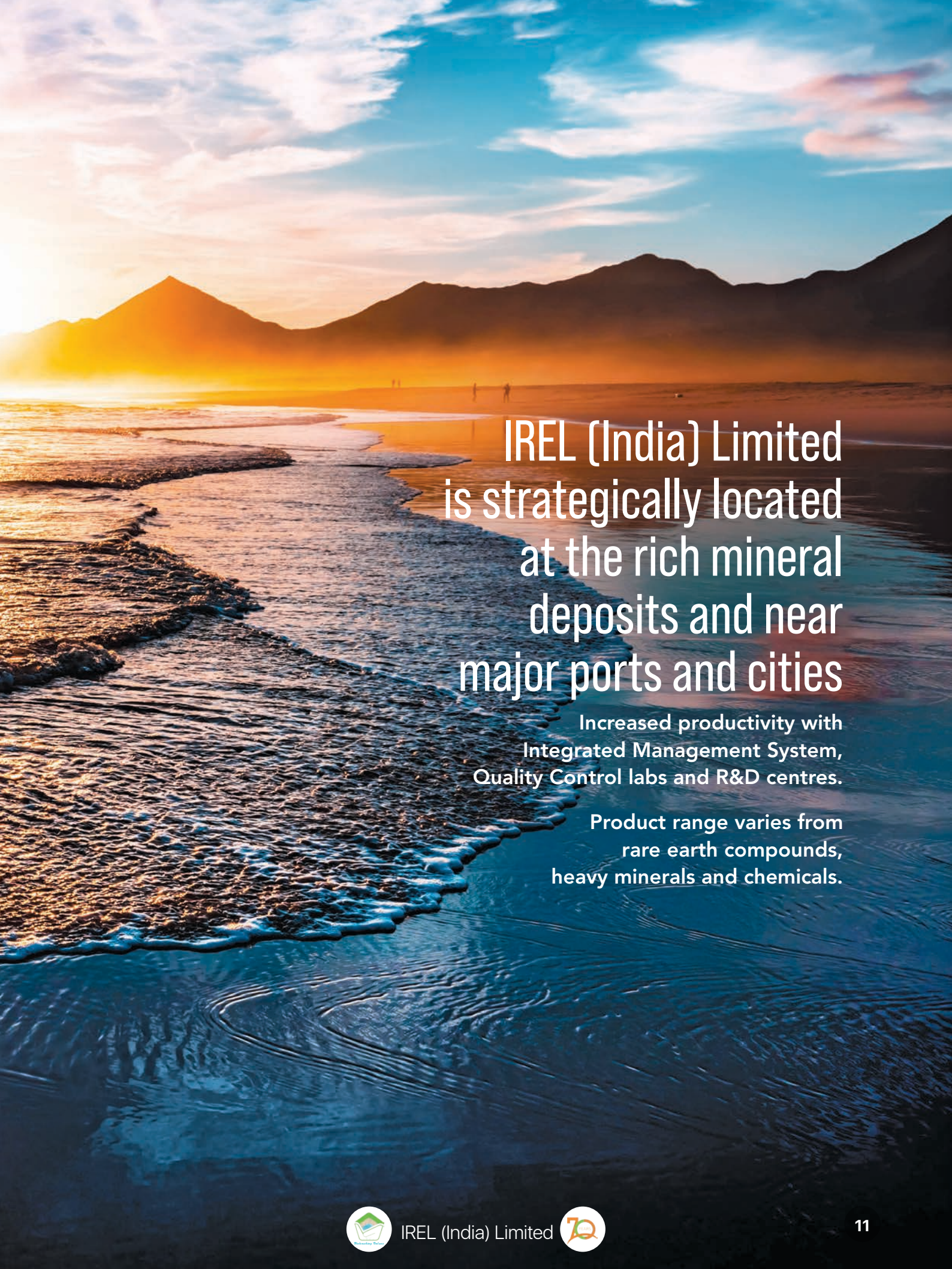
Corporate Research Centre is located at Kollam, Kerala and carries out research in the value chain of heavy minerals, undertakes projects on mineral separation and flow-sheet development, carries out mineral analysis and caters to the needs of internal and external customers. It is engaged in various R&D activities such as processing of Rare Earth mineral by alternate route, processing of nano rare earth materials etc. with the ultimate objective of commercialization of R&D outcomes. The Research centre also coordinates the research activities of RED, Aluva and Technical Services Division at OSCOM, Chatrapur, Orissa. This Research Centre was earlier known as Mineral Research and Development Centre since 1991 and later renamed as Indian Rare Earths Research Centre from July 2003. This Centre along with all QC laboratories is NABL 17025/2017 accredited and recognised by DST, GoI.

The Research Centre is equipped with various equipments and instruments like magnetic, gravity, electrostatic separators, floatation cells, grinding mills, vacuum filters, mixer settlers, ion exchange columns, particle size analyzer, XRD/XRF, thermal analyzer, ICP atomic absorption spectrometers, UV spectrometers, petrological microscopes, etc. for various analytical and research purposes.

IRELTDC

IREL Technology Development Council (IRELTDC) is formed with an objective of promoting industrial scale R&D that would be beneficial to the overall programme of DAE in both strategic and non-strategic fields utilizing mineral & value-added products of IREL.

It was constituted in 2006 by the Secretary, DAE with members from BARC, IGCAR, IITs and other leading R&D Institutions. Council invites funds and monitors R&D project proposals from CSIR, IITs, State & Central laboratories, for large scale application & exploitation on the areas of technology of mutual interest.



IREL (India) Limited is strategically located at the rich mineral deposits and near major ports and cities

Increased productivity with Integrated Management System, Quality Control labs and R&D centres.

Product range varies from rare earth compounds, heavy minerals and chemicals.

The Indispensable Rare Earths & Heavy Minerals

Application Of Rare Earths & Heavy Minerals

- All electronic items commonly used like mobile phone, computers and smart TVs are containing Rare Earths.
- Petrol and diesel used in two-wheelers, cars, boats, buses and trains are separated in refineries with the help of Rare Earth catalysts.

Dependence Of Micro Small & Medium Enterprises

- Heavy Minerals are largely supplied to Micro, Small & Medium Enterprises.
- Millions of people are employed in MSME sector.

Dependence Of Various Other Industries

- Rare Earths & Heavy Minerals are used as performance ingredients in Consumer electronics, Automotive, Renewable Wind and Solar energy, Ceramic, Refractories, Welding Electrode, Foundries, Glass industry, Telecommunication, Aerospace, Paint and pigments, Gas mantle, Petroleum, Pharmaceuticals, Satellite, Aerospace, Defence applications etc.

Employment

- Thousands of direct and indirect employees and their families are dependent on IREL for their livelihood.

Reduced Radiation

- Beaches have moderate reserves of minerals which are naturally radioactive & through sustained mining of such important and strategic minerals; the area is made safer for local inhabitants where the background radiation is significantly reduced after mining.

Betterment Of Mankind With Sustainable Development

Mining may well have been the second of humankind's earliest endeavours - granted that agriculture was the first. From prehistoric times to the present, mining has played an important part in human existence.

Basic purpose of extracting those valuable heavy minerals from beach sand naturally available in the earth to be used for the betterment of the Mankind with sustainable development as the objective, which would otherwise find their way back to sea if not harnessed

Essential For Renewable Energy

The greatest risk facing humankind is global warming due to climate change. One of the most important drivers in propelling green technologies to mitigate global warming is Rare Earths.

All 'renewable' forms of energy generation, including solar, wind, bio - energy, forestry and agricultural production, ultimately depend on end products of these Heavy Minerals.

Strategic Sector

Rare Earths & Heavy Minerals are used in space research, aerospace, nuclear power, electronics, R&D & defence.

Welfare Of People

The mineral sector plays a crucial role in the industrial development of the country. The mineral sector contributes to the exchequer which is further utilized for the welfare of the people.

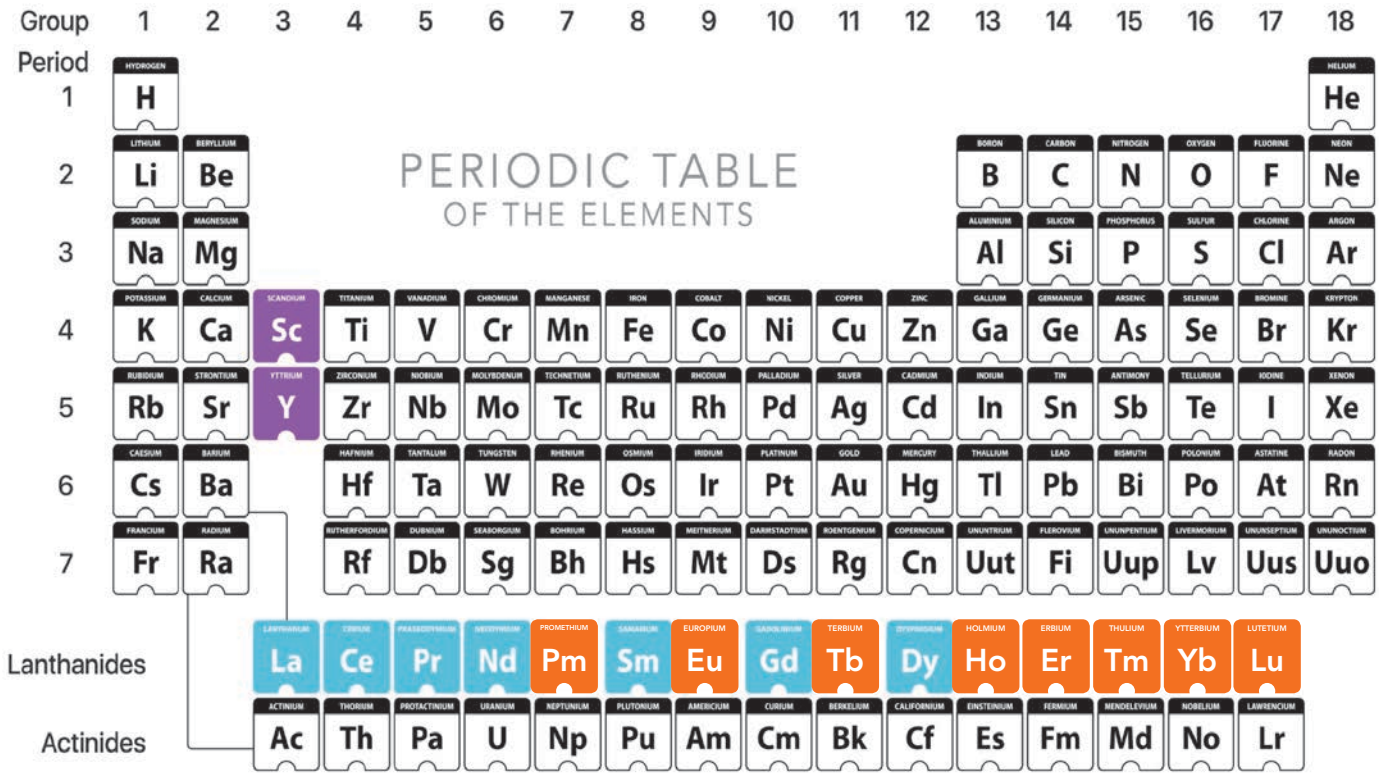
Common uses of Rare Earths & Heavy Minerals

- Neodymium is used in manufacture of permanent magnets in industries along with boron and iron. It is also employed in the laser industry for the manufacturing crystals such as yttrium aluminum garnet. It can absorb the glare in the flame; it is utilized for the purpose of coloring glasses.
- Praseodymium is used in the aircraft engines in the form of alloying agent and for the purpose of creating high field strengths. It is also utilized in the permanent magnets present in the wind turbines and motors. The carbon electrodes used in the arc lightning lamps make use of the oxides of Praseodymium.
- The most important application of Samarium is Samarium-Cobalt magnets which can withstand high temperature. These magnets are used in strategic sectors like defence, space and atomic energy. This element is also used in the manufacture of solar-powered electric aircrafts. Samarium can be used in the production of superconducting materials, and samarium-doped iron superconductors are among the highest-temperature superconductors known
- Gadolinium finds its uses in the field of atomic energy, microwave application and also used in color television sets in the form of phosphorous. The alloys of gadolinium are utilized in the manufacture of magnetic and electronic gadgets such as video recorder, etc. The isotope of gadolinium Gd is widely employed in curing tumors and neutron therapy
- Lanthanum is found in modern television sets, the energy saving lamps, fluorescent tubes, etc. It is also used in the field of optics as lenses and radiation absorbing glasses. One of the most important applications is as catalysis in the field of petroleum refineries.
- Cerium is the key component of mischmetal alloy which is used in flints for cigarette lighters. The reason for it is cerium produces sparks when struck. It is also used in almost all color televisions and energy-saving lamps.
- Illmenite is used to produce synthetic rutile, a form of titanium dioxide used to produce white, highly reflective pigments. Illmenite is also used in the manufacture of aircraft parts, artificial joints for humans, and sporting equipment such as bicycle frames. About 5% of the ilmenite extraxcted is used to produce titanium metal.
- Rutile is a main constituent in the production of welding electrodes giving about 100% weld metal recovery are easy to strike and use. Finely powdered Rutile is a brilliant white pigment and is used in paints, plastics, paper, foods, and other applications that call for a bright white color.
- Zircon is used as an opacifier, whitening agent, and pigment in glazes and stains used on ceramics and pottery. Yttria-stabilized zirconia is used to manufacture cubic zirconia, fiber optic components, refractory coatings, ceramics, dentures and other dental products. Zircon serves as the primary ore of zirconium metal and is also used to manufacture zirconium alloy tubes for housing nuclear fuel.
- Garnet has been used since the Bronze Age as gemstones and abrasives. They are used in waterjet cutting, "sand" blasting, sandpaper, water filtration, and a number of other uses. Almandine is the hardest garnet and also the most abundant.
- Sillimanite mineral is utilized in the production of mullet or high-alumina refractories. 95% of the world's consumption of these minerals is used for this purpose in the manufacture of metals, glass, ceramics and cement.

IREL (India) Limited harvest heavy minerals and extract rare earths for the benefit of the society and nation

Rare Earths

La	Lanthanum	Eu	Europium	Tm	Thulium
Ce	Cerium	Gd	Gadolinium	Yb	Ytterbium
Pr	Praseodymium	Tb	Terbium	Lu	Lutetium
Nd	Neodymium	Dy	Dysprosium	Sc	Scandium
Pm	Promethium	Ho	Holmium	Y	Yttrium
Sm	Samarium	Er	Erbium		



Available in Indian resources

Not available in Indian resources

Lanthanum

La

Basics

Atomic Number	57	Year Discovery	1839
Atomic Weight	138.91	Discoverer	Carl Mosander
Colour	Silvery White	Name Origin	From the Greek word lanthaneis (to lie hidden)

Interesting Facts

- Lanthanum is used in hydrogen sponge alloys, which takes upto 400 times their own volume of hydrogen gas.
- Lanthanum Chromite is used in manufacturing high temperature heating elements.

Major Applications

- **Energy Batteries:** An inter-metallic component of Nickel Metal Hybride (NiMH) batteries used by electric automobiles.
- **Glass and ceramics:** As doping agent in camera and telescope lenses.
- In making special optical glasses, such as infrared absorbing glass.
- Improves the alkali resistance of glass.
- **Alloys:** Alloying elements used in High Strength Low Alloy (HSLA) steels for automobiles and cold weather applications.
- Added to iron to produce nodular cast iron for automotive rear ends, transmissions and transfer cases.
- **Medicine:** As a phosphate binder for the treatment of hyperphosphatemia.
- In Hydrogen storage fuel cell materials for stationary and automotive.
- **Other uses:** In petroleum cracking and chemical industry catalysts.

Cerium

Ce

Basics

Atomic Number	58	Year Discovery	1803
Atomic Weight	140.12	Discoverer	W Von Hisinger
Colour	Silvery White	Name Origin	Ceres (asteroid)

Interesting Facts

- Cerium Sulphide (Ce_2S_3) is likely to replace cadmium in red pigments for containers, toys, household wares and caters, since cadmium is now considered as environmentally undesirable.
- Flammacerium (cerium nitrate - silver sulphadiazine) is a cream to treat and prevent infections in extensive burn wounds.

Major Applications

- **Glass and Ceramics:** Polish glass surfaces.
- Manufacture of glass both as component and decolorizer. LEDs to turn blue light into white light.
- In combination with Tin Oxide (SnO) is used for UV absorption for solar panels.
- **Catalysts:** As a catalyst converter to reduce carbon monoxide emission in the exhaust gases from motor vehicles.
- Used as Petroleum cracking catalyst in petroleum refineries. As additives to diesel fuel to burn more cleanly. In organic synthesis as catalyst.
- **Energy:** As a solid electrolyte in intermediate temperature in solid oxide fuel cells.
- **Alloys and Metals:** Alloy with iron to make nodular iron to improve machinability of automotive power-train components.
- Added to magnesium alloys as a grain boundary modifier in magnesium to improve thermal resistance. As a precipitation hardening agent in stainless steel.
- **Other uses:** Used to make carbon arc lights, which are used in the motion pictures industry for projector lights. In incandescent gas mantles combined with thorium.

Praseodymium

Pr

Basics

Atomic Number	59	Year Discovery	1885
Atomic Weight	140.91	Discoverer	C F Aver Von Welsbach
Colour	Silvery white, Yellowish tinge	Name Origin	From the Greek words prasios (green) and didymos (twin).

Interesting Facts

- Praseodymium Carbonate is one of the ingredients in electrolytes used in Solid Oxide Fuel Cell.
- Praseodymium is used to colour cubic zirconia yellow-green, to simulate the mineral peridot.

Major Applications

- **Magnets:** Substitute for neodymium in super magnets.
- **Glass and Ceramics:** A doping agent in optic cables where the cable is used as a signal amplifier.
- Compounds are used to give yellow colour in ceramics, glass and enamels.
- Components of didymium to make certain types of welder's and glass blower's goggles and other UV protective glasses.
- **Materials:** An alloying agent with magnesium to create high-strength metals used in aircrafts engines.
- PR_2O_3 , like other rare earth oxides, is among the most refractory substances known and is also used in automotive exhaust catalytic converters.
- As a catalyst to make the most widely used plastic, polyethylene, for soda bottles, bubble wrap, food plastic wrap, sandwich bags and milk cartons.
- Forms the core of carbon arc lights, which are used in motion picture industry for studio lightening and projector lights.

Neodymium

Nd

Basics

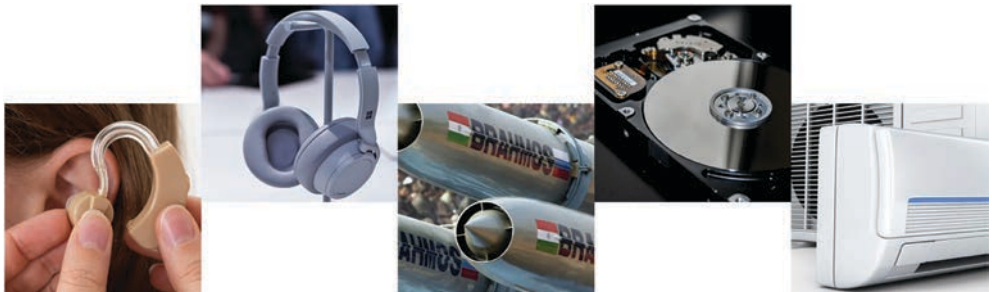
Atomic Number	60	Year Discovery	1925
Atomic Weight	144.24	Discoverer	Carl Aver Von Welsbach
Colour	Silvery white, Yellowish tinge	Name Origin	From the Greek words neos (new) and didymos (twin).

Interesting Facts

- A small, high strength Neodymium magnet made with Iron and Boron is so strong that when placed on a refrigerator it can't be removed by hand.
- NdFeB magnet causes cell phones to vibrate when a call is received. In high-end audio devices NdFeB mag

Major Applications

- **Rare Earth Magnets:** Neodymium magnets ($Nd_2Fe_{14}B$) or 'neo-magnets' are the strongest permanent magnet known.
- Neo-magnets are used in consumer electronic products (microphones, loudspeakers in ear and head phones, hearing aids, computer hard drives). Neo-magnets are used in hybrid cars, industrial motors, air conditioners, elevators, industrial tools, wind and tidal energy turbine generators.
- **Glass and Ceramics:** Neodymium glass is becoming widely used in incandescent light bulbs to provide more 'natural' light. To stop green coloration caused by iron contamination in the glass melt.
- Neodymium specialty glass is used in automobile rear-view mirrors to reduce glare at night. Compounds are used as colourisers or enamel and glass. Neodymium colours glass in delicate shades ranging from pure violet through wine-red and warm grey.
- In Cathode Ray Tubes (CRTs), Neodymium enhances the contrast between red and green colours.
- **Material:** Neodymium makes up about 18% of Misch metal, a material that is used to make flints for lighters.
- A component of didymium glass, which is used to make certain types of welder's and glass blower's goggles.
- **Medical and Science:** A dopant in yttrium-aluminum-garnet (YAG) lasers for medical applications.



Samarium

Sm

Basics

Atomic Number	62	Year Discovery	1879
Atomic Weight	150.36	Discoverer	Paul Emile Lecoq de Boisbaudran
Colour	Silvery White	Name Origin	Smarskite (mineral)

Interesting Facts

- Samarium-cobalt permanent magnets have high resistance to demagnetization and they keep their magnetism at temperatures up to 700°C
- Today, the samarium isotope, Sm-153, used to treat rheumatoid arthritis of the knee and other joints.

Major Applications

- **Magnets and Electronics:** In making 'Samarium-cobalt' permanent magnets which has a high resistance to demagnetization when compared to other permanent magnet materials.
- Samarium-cobalt magnets are used in high-end magnetic pick-ups for guitars and related electronic musical instruments, headphones magnets and automotive accessories.
- Samarium inform of titanates has a high dielectric property useful in capacitors at microwave frequencies and because of its spectral absorption properties it is used in neodymium-yttrium-aluminum garnet laser glass.
- **Defence:** Crucial for building 'smart' missiles.
- **Medicine:** Samarium-153, a radioisotope of samarium, is used in medicine to treat the severe pain associated with cancers that have spread into bone tissues.
- **Other Uses:** Compounds are used as sensitizers for phosphors excited in the infrared
- Added to glass to absorb infrared radiations.
- A catalyst for the dehydration and dehydrogenation of ethanol and as a chemical reagent in organic synthesis.
- As a neutron absorber in nuclear reactors.

Gadolinium

Gd

Basics

Atomic Number	64	Year Discovery	1880
Atomic Weight	157.25	Discoverer	Jean De Maarignac
Colour	Silvery White	Name Origin	Gadolinite (mineral)

Interesting Facts

- Using gadolinium alloy $Gd_5(Si_2Ge_2)$ in magnetic refrigeration has the potential to cut electrical heating and cooling costs by as much as 80%.

Major Applications

- **Materials & Electronics:** In making gadolinium yttrium garnets, which have microwave applications.
- Phosphors for colour TV tubes.
- Yttrium gadolinium garnet or yttrium gallium garnets (YGG) are used in various electronic components for communication and radar.
- **Energy:** In nuclear marine propulsion systems area burnable nuclear poison and as a secondary, emergency shut-down measure in some nuclear, particularly CANDU type reactors.
- **Specialty Glasses:** Gadolinium gallium garnet ($Gd_3Ga_5O_{12}$) is used in fabrication of various optical components and as substrate material for magneto-optical firms.
- **Alloy:** $Gd_5(Si_2Ge_2)$ is used in magnetic refrigeration.
- **Medical:** X-ray imaging where terbium-doped, gadolinium oxysulfide as a phosphor converts the X-ray released from a source into light.
- Solutions of organic gadolinium complexes and compounds are used as intravenously administrated, contrasting agents to enhance images in medical Magnetic Resonance Imaging (MRI).
- Cerium - doped gadolinium oxyortho-silicate is single crystal used as a scintillator in medical imaging such as Positron Emission Tomography (PET).

Europium

Eu

Basics

Atomic Number	63	Year Discovery	1901
Atomic Weight	151.96	Discoverer	Eugene Demarcay
Colour	Silvery White	Name Origin	Europe

Interesting Facts

- In 1964, the development of new phosphor Eu:Y_2O_3, allowed the first true red in colour television.
- A typical 19 inch (48 CM) CRT television screen can contain 0.5g of Europium Oxide.

Major Applications

- Used as a red phosphor in television sets and fluorescent lamps and as an activator for yttrium-based phosphors. Whereas trivalent europium gives red phosphors, the luminescence of divalent europium emits light on the blue side of visible spectrum.
- These two europium phosphors, combined with yellow/green terbium phosphors give "white" light; the colour of which can be varied by altering the proportion or composition of the individual phosphors.
- Coming the same three phosphors is one way to make tri-chromatic systems in TV and computer screens and pilot display screens.
- **Science and Medical:** Screening for Down's syndrome and some other genetic disorders.
- Ceramics and Specialty Glasses: Used to dope some types of glass to make lasers and it also used as an agent in the manufacture of fluorescent glass.
- **Other uses:** Europium is commonly included in trace element studies in geochemistry and petrology to understand the process that from igneous rocks, i.e. these rocks that have formed from magmas or lava
- As a phosphor in Euro banknotes to detect their production by counterfeiting.

Pm Promethium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
61	145	Metallic	1945	J A Marinsy	From the god Prometheus (who stole fire of sky and gave it to man)

Major Applications

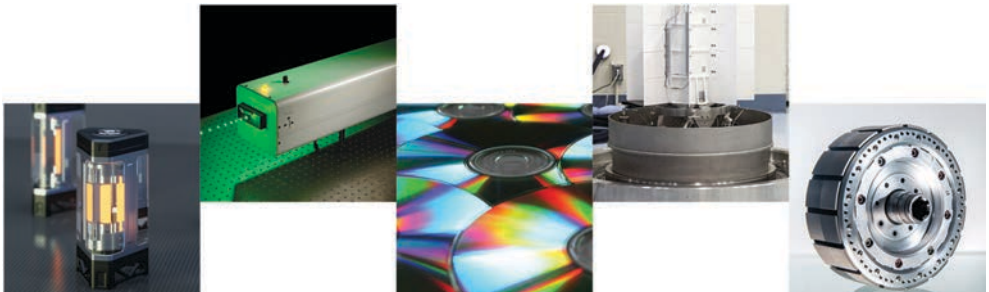
- To make a nuclear powered battery.
- As a thermo electric generator.
- Using in luminous paint applications.
- As a portable x-ray source and as a source of radio activity for gauges that measure thickness.
- As a starter switch in energy-efficient CFL
- In the targeting sights of shoulder-fired missiles.
- To measure the thickness of materials

Tb Terbium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
65	158.92	Silvery White	1843	Carl Mosander	Ytterby (a town in Sweden)

Major Applications

- Used in green phosphors in fluorescent lamps and colour TV tubes.
- As crystal stabilizer in fuel cells that operate at high temperatures.
- Used as doping agent in solid-state devices.
- Used to make special lasers.
- Used on CDs and DVDs for data storage.
- As alloy that expands or contracts to a high degree in the presence of a magnetic field.
- As an additive in hybrid and electric vehicle motor magnets



Dy Dysprosium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
66	162.50	Silvery White	1886	Paul Emile Lecoq de Boisbaudran	From the Greek word dysprositos (hard to get at)

Major Applications

- Used in magnets to raise the coercivity or strength, for demanding applications.
- Used in various data storage applications.
- As a sources of infrared radiation used in the study of chemical reactions.
- Used in making of laser materials.
- As neutron-absorbing control rods in nuclear reactors.
- Used in dosimeters for measuring ionizing radiation.

Ho Holmium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
67	164.93	Silvery White	1878	J L Soret	From the Latin word Holmia (Stockholm)

Major Applications

- Used as a yellow and red glass colouriser.
- As colourants for cubic zirconia for use in jewellery
- Used to create the strongest artificially generated magnetic fields
- Used laser in medical surgical procedures.
- Used for eye-safe medical and dental technologies.
- Holmium - containing glass has been used as a calibration standard for ultra violet and visible light spectrophotometers.
- Used in nuclear control rods.

Er Erbium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
68	167.26	Silvery White	1843	Carl Mosander	Ytterby (a town In Sweden)

Major Applications

- Used as a doping agent in optical fibres.
- As a colourant for glass and porcelain.
- Used in sunglasses and less expensive jewellery.
- Used in a wide variety of dermatology and dental applications.
- For cosmetic procedures and mild to medium depth skin resurfacing.
- Used in cryocoolers.
- Used as a photographic filter.

Tm Thulium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
69	168.93	Silvery White	1879	Per Theodor Cleve	From Thule (ancient name of Scandinavia)

Major Applications

- It has been used to create laser lights.
- Used in high temperature super conductors.
- Used as a radiation source substitute for portable x-ray machines where electricity is not available
- Used in surgery, dentistry, atmospheric testing and remote sensing.
- Used in metal halide lamps.

Yb Ytterbium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
70	173.04	Silvery White	1878	Jean De Marignac	Ytterby (a town In Sweden)

Major Applications

- Used as a radiation source substitute for portable x-ray machines where electricity is not available.
- Used to improve the grain refinement, strength, and other mechanical properties of stainless steel.
- Used to convert infrared energy into electricity in solar cells.
- Used as a doping material for high power and wavelength -tunable solid-state lasers.
- Used in optical glasses, crystals and ceramics.
- Ytterbium lasers are used to drill into diamonds to remove imperfections.
- Ytterbium alloys have been used in dentistry.

Lu Lutetium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
71	174.97	Silvery White	1907	Georges Urbain	From Lutetia (ancient name of Paris)

Major Applications

- Used in magnetic bubble memory devices.
- Used in x-ray phosphors.
- Used in immersion lithography for manufacturing high-tech integrated circuits.
- Used to measure wind speed and direction, pollution and moisture.
- Used for Positron Emission Tomography.
- Used as a catalyst in petroleum refining, hydrogenation and polymerisation processes, and in OLED.
- When exposed to neutron activation, is used as a pure beta emitter.

Sc Scandium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
21	44.956	Silvery White	1879	Lars Nilson	From Scandinavia

Major Applications

- Used in alloys for minor aerospace industry components.
- Used to limits an excessive grain growth in heat-affected zone of welded aluminum components.
- Used in making of sports equipment.
- Used in bicycle frames.
- Used in the materials, have been production of high made with scandium- intensity "stadium" lights.
- Used in mercury vapour lamps.

Y Yttrium

At. No.	At. Wt.	Colour	Year	Discoverer	Name Origin
39	88.906	Silvery White	1794	Johann Gadolin	After Yetterby (a town in Sweden)

Major Applications

- Used as thermal barrier to withstand extreme heat in fighter jet engines.
- To reduce the grain size and to increase strength of alloys.
- Used to to make white LEDs.
- Used to simulate diamond gemstones.
- Used as a de-oxidizer for non-ferrous metals.
- Used in some ceramic and glass formulas.
- Used in television cathode ray tubes and in LEDs.
- In fabrication of needles that are used to sever pain- transmitting nerves in the spinal cord.

Rare Earth Chloride

General Information

Rare Earth Chloride ($RECl_3 \bullet 6H_2O$) is a mixture of all Rare Earths. This mixture contains various Rare Earths Elements in the same general proportions found in the deposit. It is pink lump, highly soluble in water.

Major Applications

- Feed material for the separation of individual rare earths elements and its high pure compounds, oxides and metals.
- Rare Earths are used as fertilizers in agriculture and as feed additives in animal production.
- **Textiles:** Waterproofing, mildew proofing, mordant dyeing, corrosion resistance treatment of filter clothes.
- **Paper:** Treatment of paper mill effluents.
- **Paints:** For manufacture of paint driers, metallic soaps.
- **Metallurgical:** In the manufacture of mischmetal for lighter steel industry and other metal industries.
- **Oil Refinery:** In preparation of the zeolite molecular sieve catalysts for petroleum refining.
- Defence and aerospace

Trisodium Phosphate

General Information

Trisodium phosphate (Na_3PO_4) is a cleaning agent, stain remover and degreaser. It is a white, granular or crystalline solid, highly soluble in water producing an alkaline solution.

Major Applications

- **Paper:** In cleansing the felts of the calendering machine and in the dissolution in the manufacture of paper.
- **Detergents:** As filler in the manufacture of soap and detergent powders.
- **Sugar:** To improve clarification of sugar cane juice, for reduction of scaling in evaporators and to decrease the quantity of molasses.
- **Boilers:** In softening of boiler feed water and remove scale deposits.
- Food: For bottle cleaning, metallic equipment & pipeline washing of dishes, ceramics, glass etc.
- Textiles: Pressure boiling of goods and J-Box alkali boiling, open with alkali boiling, open boiling of coloured goods, boiling of yarn before use and desizing.

Ilmenite

General Information

Chemical Formula	$FeTiO_3$
Occurrence	Accessory component in igneous & metamorphic rocks.
Introduction	Ilmenite is a Titaniferrous mineral. Mineral produced at various mineral separation plants form specific grades in terms of TiO_2 content ranging from 50% to about 60%. The FeO and Fe_2O_3 content also varies between 10 ~ 20 % and 12 ~ 27% respectively.

Interesting Facts

- Titanium is light weight, non - corrosive, able to withstand temperature extremes (especially its high melting point, 1800 degrees C) and it has good strength as strong as steel and twice as strong as aluminum.

Major Applications

- Titanium pigment is a basic critical ingredient in a wide range of industrial and consumer products including paints, plastics, cosmetics, ceramics, paper, rubber, textiles, ink sunscreens and even candy.
- Titanium is a standard material for medical devices such as hip joints, bone screws, knee joints, bone plates, dental implants & surgical devices.
- Titanium applications are the most significant in jet engine and airframe components that are subject to temperatures up to 1100°F and for other critical structural parts.
- Titanium and titanium compounds have found uses in desalination plants, electrical components, glass products, artificial gem stones, jeweler and even as smoke screens.
- Titanium - based alloys are currently utilized in gas turbine engines, fan blades, compressor blades, discs, hubs and numerous non - rotor parts.

Rutile

General Information

Chemical Formula	TiO_2
Occurrence	Accessory mineral in generous igneous rocks pegmatites metamorphed lime stones & veins.
Introduction	Rutile is a Titanium bearing mineral. The TiO_2 content in rutile produced by all the three mineral separation plants is over 92%.

Interesting Facts

- Titanium is resistant to salt water, perspiration and acids.
- Titanium does not become magnetized.
- Titanium has a "low magnetic signature" reducing visibility to metal detectors.

Major Applications

- Rutile is a major ore of titanium, a metal used for hi-tech alloys, manufacture of refractory ceramics and in sunscreens protect against UV - induced skin damage.
- Manufacturing of titanium metal, similar to ilmenite and leucoxene.
- A major constituent in welding electrode.

Sillimanite

General Information

Chemical Formula	Al_2SiO_5
Occurrence	Metamorphosed peri - aluminous sedimentary rocks.
Introduction	Sillimanite is Alumino-Silicate mineral. Mineral produced at two mineral separation plants has guaranteed Al_2O_3 content of 58%.

Major Applications

- As a raw material for high alumina refractories which are cut into various shapes and sizes or made out of bonded particles. It is very resistant to glass slag and hence widely used as lining material in glass melting furnace.
- Sillimanite powder mixed with high-grade china-clay is used in the manufacture of spark plugs and other insulating materials required at high voltage.
- For the manufacture of the Si-Al alloy "silumine" used in the manufacture of crankcases, cylinder heads and similar components engine manufacturing.
- These are used industries like cement, ceramics, glass-making, metal smelting, electrical, refinery and treatment, tar distillation, coal carbonisation, chemicals manufacture, and iron foundries.
- In the non-ferrous industry (lining of electric smelting furnaces for the smelting of aluminum, copper-rich bronze, brass and Cu-Ni alloys, in zinc smelting and gold refining.

Zircon

General Information

Chemical Formula	$ZrSiO_4$
Occurrence	Magmatic, metamorphic, pegmatitic, and alluvial rocks.
Introduction	Zircon is Zirconium Silicate. Mineral produced at various mineral separation plants form specific grades in terms of ZrO_2 content ranging from 64.5% to about 65.5% with SiO_2 content of little over 32%.

Major Applications

- Zirconium alloy is used to house nuclear fuel, in surgical appliances, in photo-flash bulbs, as a getter in vacuum tubes, an alloying agent in steel, explosive primers, lamp filaments, rayon spinnerets, and much more.
- Mainly consumed as an opacifier in the decorative ceramic industry also used as cladding fuel elements in nuclear power industry.
- Extensively used in the glass and ceramic industry for opacifying it enamels, porcelain and glazes. In the ceramic industry, for the manufacture of sanitaryware, tableware, floor and wall tiles.
- Human tissues can easily tolerate this metal which makes it suitable for artificial joints and limbs.
- The high grade zircon sand is largely used in found as mould.
- Marketed as a natural gemstone used in jeweler, and its oxide is processed to produce the diamond stimulant.
- Bonded into bricks are refractory required also used in large while zirconia refractories quantities as refractory are considered to be bricks glass and basic.
- Finely powdered zircon and zirconia are used as an abrasive in polishing optical glasses.

Garnet (Almandite)

General Information

Chemical Formula	$Fe_3Al_2Si_3O_{12}$
Occurrence	Metamorphic and pegmatitic rocks.
Introduction	Garnets are a Silicate group of minerals. Garnet produced at two mineral separation plants is Almandine Garnet [$Fe_3Al_2(SiO_4)_3$].

Interesting Facts

- Garnet lasts longer and provides excellent bonding in anti-skid paints and surfaces.
- Used in Industrial Flooring as Garnet withstands more wear & tear and provides better grip.

Major Applications

- As abrasives for sand blasting of plane components, bridges, containers, on offshore-platforms, ship building (removal of salt, rust, algae and shell incrustations), the petrochemical industry for pipeline, tank and boiler cleaning (removal of rubber, paint, adhesives, bitumen and grease).
- For finishing jeans (gentle removal of the dyestuff).
- Many ancient pieces of garnet jewellery are studded with tiny red stones that do look a lot like cluster of pomegranate seeds.
- Garnet abrasives are and common used mostly for wood polishing.
- Finer grains of micron sizes are used as tumbling chemicals, grits for optical glass polishing and also ceramics and glasses.
- To make a number of similar products, including sanding belts, discs, and strips.
- As a water purifier

Safety

- IREL is committed to provide a safe and healthy environment for the protection and well being of the employees and the general public by means of safe and healthy system of work. Safety is given paramount consideration right from the conceptual stage of all the projects, modification / expansions and day-to day operations. The company is of the firm belief that accidents are preventable and the creation of safe and healthy working conditions is as important as production.
- IREL, recognises the need for developing a safety culture in the organization to enhance the awareness and commitment of all employees to safety. Decision making of Safety is guided by the following:

1. Establish and maintain safe work environment with appropriate facilities, equipment, procedures and trained personnel to ensure health and safety of workers.
2. Identify, assess and control occupational, public health and environmental hazards arising from operations including handling, transport of raw-materials and products.
3. Adopt an inter-disciplinary approach to land management making use of best available scientific information.
4. Comply with all applicable statutory provisions for the protection of health, safety and environment. These include relevant stipulations made by Atomic Energy Regulatory Board, Directorate General of Mines Safety, Department of Environment and State Pollution Control Boards.

Environment

- Heavy mineral mining and mineral separation operation is naturally environment friendly. There are no blasting and drilling operations involved for extraction of Heavy Minerals from the deposit.
- The mined out areas are simultaneously backfilled with tailings generated during the up gradation process. The background radiation of the area on account of extraction of monazite mineral is taken out.

CSR Policy

- Corporate Social Responsibility (CSR) and sustainability is fundamentally a philosophy or vision about the relationship of business and society. It is the continuing commitment of business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large. The concept of CSR and Sustainability go beyond charity and requires the company to act beyond its legal obligations and to integrate social, environmental and ethical concerns into company's business process.
- IREL has been a major partner in the development of the community living near its units, especially near its mining areas by its CSR initiatives. This CSR initiative has been taken by the company earlier to the formal notification by Government bringing out the guidelines and its implementation of CSR activities. Thus, IREL has been conscious of its CSR and Sustainability obligations and has been striving towards fulfillment of the same.
- IREL has been undertaking and implementing CSR and Sustainability activities for the welfare of the people and development falling within the periphery and close vicinity of its operational area.

Dignitary Visit

Shri K. N. Vyas, Chairman, AEC launching the new Logo of IREL

Visit of Dr. Sekhar Basu, Chairman, AEC to Corporate Office, Mumbai

Visit of Dr. Sekhar Basu, Chairman, AEC to RE Extraction plant, OSCOM

Automated Operations of Weighbridge in OSCOM inaugurated by Dr. A.K.Mohanty, Director, BARC

Dr. M. R. Srinivasan, Chairman AEC along with Board of Directors and Employees at Chavara Plant

Dr. P. K. Iyengar, Chairman, AEC laying the foundation for the Light Rare Earths Extraction Project at RED, Aluva

AWARDS

Leading Director Award 2021

CMD, IREL Shri D.Singh conferred with "Leading Director Award 2021" during Leading Directors' conclave conducted by Greentech Foundation on 27th August 2021.

Raj Bhasha Award

IREL (India) Limited awarded the Third prize for the year 2020-21 for "Excellent Official Language Implementation"

CEO of the Year Award

CMD, IREL Shri D.Singh conferred with "CEO of the Year Award" during National Feather Award Ceremony conducted by The Economic Times as Media Partner held in April 2021

Greentech Safety Award 2020

RE Division, IREL received " Greentech Safety Award 2020 for outstanding achievements in Safety Excellence Award 2019 in industry sector safety excellence category " in 19th Annual Awards by Greentech Foundation

FIEO "Export Excellence Award"

IREL conferred with FIEO "Export Excellence Award" for outstanding export performance in the category of Two Star Export House 2016-17" from Shri Nitin Gadkari Hon'ble Union Minister for Road Transport & Highway, MSME

Gold Medal for Quality Circle

IREL (India) Limited, OSCOM awarded the Gold Medal for Quality Circle at the 29th QCFI Koraput Chapter Conclave.

PSE Excellence Award, October 2020

National award for excellence in PSU for reskilling of employees, October 2020

Corporate Governance & Sustainability Vision Award 2020

ICC Corporate Governance & Sustainability Vision Award 2020 by Dr. Bhaskar Chatterjee, former Secretary DPE in presence of Dr. V. K. Saraswat Hon'ble Member of NITI Aayog, Govt of India

International Leadership Innovation Excellence Award 2019

International Leadership Innovation Excellence Award 2019 by Institute of Economic Studies during "Indo-Sri Lanka Economic Co-operation" at Colombo - Shri A. Mishra, DGM (TS) receiving award on behalf of CMD, IREL Shri D. Singh.

Atomic Energy Official Language Implementation Runner up Award for the year 2018-19

Director (Technical) receiving Atomic Energy Official Language Implementation Runner up Award from Joint Secretary (A & A) for the year 2018-19.

Best Community Development Award

IREL conferred with the "Best Community Development Award"
in the National CSR Leadership Congress

CAPEXIL "Top Export Award for the Year 2015-16 & 2016-17

CAPEXIL "Top Export Award for the Year 2015-16 & 2016-17 by
Hon'ble Shri Piyush Goyal, Minister of Commerce & Industry and Railways.

India's Most Trusted Company Award by IBC

IREL conferred with India's Most Trusted Company Award by IBC

The National Best Employer Brands Award 2018

IREL conferred with "The National Best Employer Brands Award 2018"
by the Global Employer Branding Institute

India's Best Company of the Year Award 2018 to IREL by Berkshire Media Pvt.Ltd

India's Best Company of the Year Award 2018 to IREL by Berkshire Media Pvt.Ltd

Rajbhasha Shield (Runner-up) 2017-18

CMD, IREL receiving the Rajbhasha Shield (Runner-up) for the year 2017-18

Industrial Safety Award 2017

IREL Received "Industrial Safety Award 2017" from Shri S A Bhardwaj, Chairman, AERB

ICC PSE Excellence Award 2017

CMD, IREL conferred with PSE Excellence Award for his "Outstanding contribution to the Indian Public Sector Industry". Director(Technical) receiving the Award on his behalf.

ICC PSE Excellence Award for HRM 2017

IREL bestowed with "PSE Excellence Award 2017" for Human Resource Management by ICC

FCCI Quality System Excellence Award 2018

IREL received Certificate of Appreciation for Good Practices in Quality System by FICCI

ICC PSE Excellence Award 2016

CMD receiving ICC PSE Excellence Award 2016 for
Corporate Governance in Mini Ratna and other CPSEs category

SCOPE Award 2017

CMD receiving SCOPE Corporate Communication Excellence Award 2017 for Crisis Handling from Shri Rajyavardhan Singh Rathore, Hon'ble Minister for Youth affairs and I&B, Govt. of India

CMD receiving CAPEXIL Export Award 2014-15

CMD receiving CAPEXIL Export Award for the year 2014-15

CEO with HR orientation

CMD receiving CEO with HR orientation, A Tribute from CIMA

National Safety Award (Mines)

Head, MK receiving National Safety Award (Mines) from Hon'ble President of India Shri Ram Nath Kovind in presence of Hon'ble Minister for Labour and Employment, Shri Bandaru Dattatreya, Govt. of India

Head, MK unit receiving National Safety Award (Mines) from Hon'ble Vice President of India Shri M. Venkaiah Naidu in presence of Hon'ble Minister MoS for Labour and Employment, Shri Santosh Kumar Gangwar, Govt. of India

State Export Award

Shri A K Mohapatra, Director (Technical) with State Export Award by Government of Odisha

Odisha State Export Award

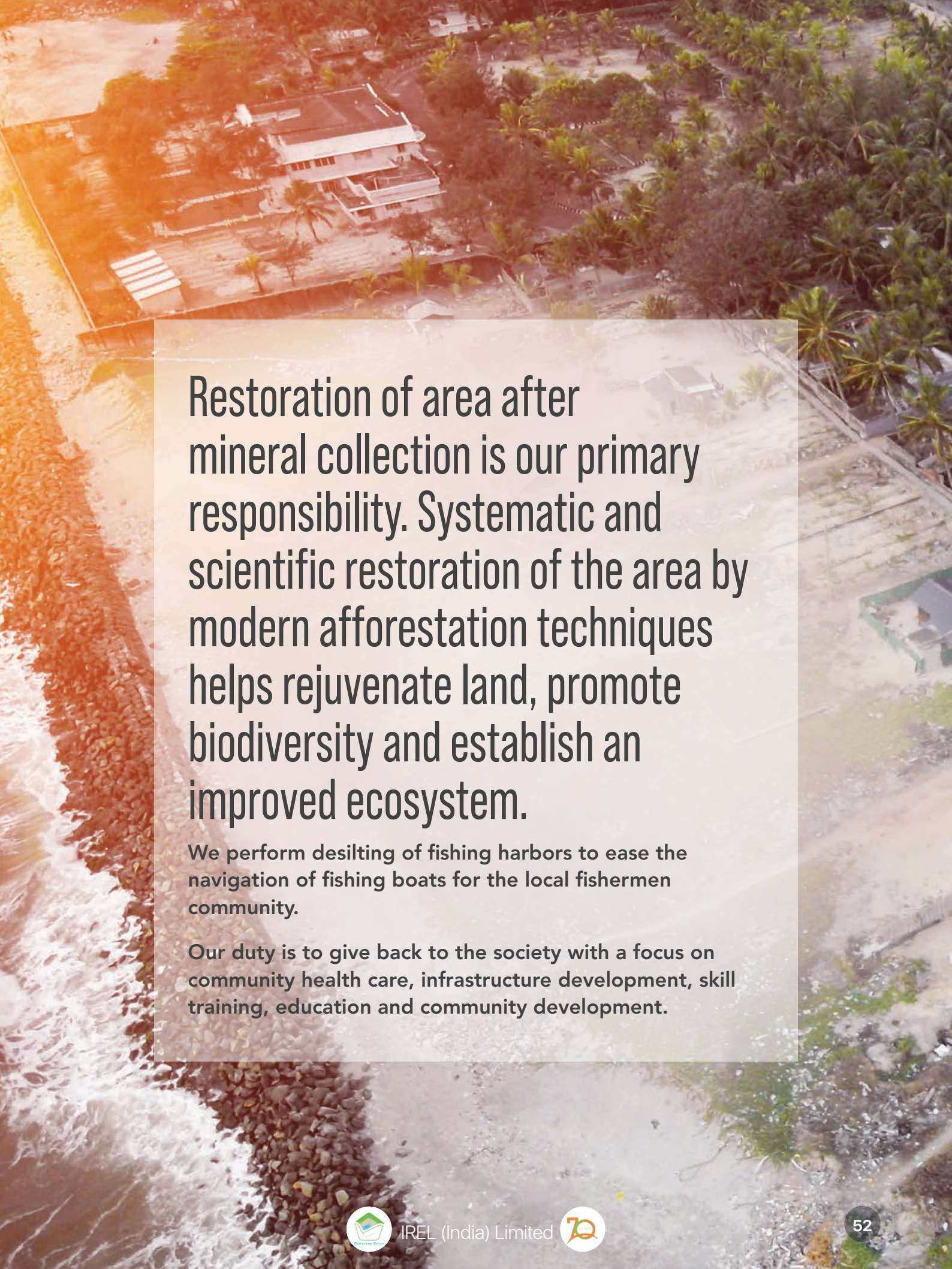
OSCOM Unit of IREL conferred with Odisha State Export Award for the year 2017-18 & 2018-19

Do You Know These Facts about Indian Rare Earth and Heavy Minerals (HM) Sector?

Sr. No.	Narrative	Facts
1	Large reserves of HM is available in the country.	Mineable reserves are limited due to CRZ regulations, Mangroves, Forest and uncontrolled inhabitation. In addition, mining of these resources is carried out since almost a century. Thus, historical status of reserves needs to be revisited.
2	Large reserves of Monazite is available in India.	The average grade of Monazite in the country is about 0.10% in HM Ore. Besides there is limited mineability due to inhabitation, forest and coastal regulatory zones. Extraction is subjected to grain size, geology, dispersion of deposit and concentration required to have a meaningful deliverable.
3	REE resources are abundant in the country.	Monazite is the primary source for REE in the country. From moderate grade HM deposits, one needs to mine about 24000 tons of HM ore to extract one ton of Nd, an important element for magnet. High volume and unregulated mining for too high tonnage of Nd will have to bear huge environmental case load implications. This should not outweigh the advantage of e-mobility towards the environment.
4	REE extraction is a simple process.	REE extraction is a complex and expensive process requiring high level of skills as its content in Indian resource is to the extent of only 0.06% (REO). The issue of economy of scale adds to further complication. REE resources are available in many countries but only a few (3 to 4) have processing facility on account of such reasons.
5	REEs are low value raw material (value addition).	As per globally acclaimed views, in the value chain from mine to magnet; highest value addition takes place in REE extraction from ore and its refining.
6	REEs are basic raw material for various RE based value added products.	REEs are the material added to functional material for providing catalytic improvement of their performance, which is manifested by its content varying from 0.5 % to 6.0 % in majority of cases and as high as 27 % in limited products. Due to this reason, the global consumption of REE is only in few hundred thousand tonnes.
7	Availability of REE resources is the key requirement for manufacturing REE based value added product i.e. magnet, catalyst etc.	Manufacturing of value added products having REE as one of the ingredients is done through interdisciplinary science and engineering, therefore all such value chain is long and complex. A number of intermediate industries are required to convert ore to end-product operating in different segments viz mining, processing & refining; metal & alloy and magnet manufacturing; BLDC motors and OEMs getting such products from their vendors under strict technical specification. These industries need to be connected in a chain link, ecosystem wherein absence of any link will make the whole system paralyzed.

Sr. No.	Narrative	Facts
8	Downstream value added industry could not be established since the sector was under Govt control.	Downstream industry using REE, Ilmenite or any other mineral product of HM sector have remained open for all including private sector. The Ore of all such products are radioactive in nature due to presence of U & Th, therefore the processes requiring for handling of these radioactive elements or prescribed substance containing them or mixture of minerals with such substance are under the control of Govt. The Govt or PSUs extract the radioactivity in terms of U & Th for strategic applications and Ilmenite etc. mineral products & REEs free from radioactivity is provided to industry; thus reducing the burden of liberation of radioactivity to the industry. About 2200 industries are operating in the sector using Ilmenite, Rutile, Zircon, Sillimanite and REEs in the country manifesting that the material is adequately available to all. The presence of Government PSUs ensured technology and skill development in the sector.
9	Downstream RE industry is not established by private players due to non-availability of raw material.	Abundant raw material in terms of RE is available in IREL warehouses, there is no taker. Recently concluded exercise of identification of industry partner for Magnet making does not ensure immediate consumption, since setting up of unit will take few years with policy intervention.
10	Blessed with abundant resources, Mining volume need to be increased.	Due to limited global consumption unlike other bulk minerals, unregulated increase in mining would have unfavorable implications on supply-demand balance leading to supply surplus situation besides environmental concerns.
11	RE products find application in wind energy generation. Hence RE production to be increased for increasing renewable energy generation.	Production of RE is associated with environmental case load. It may need a tight rope balance between generation of renewable energy and REE production, so that generation of renewable energy should not be outweighed by excessive environmental case load due to Rare Earth production.
12	Resources are open to all elsewhere in the world.	Resources declared as strategic are normally under Government control elsewhere globally. India being non-signatory of NPT has its own obligations to safety and security of radioactive resources.
13	Having REE resources, India did not develop its REE portfolio.	India is among 2-3 countries, which has developed its REE portfolio other than China; though REE resources are available in many other countries. Before entering into interdisciplinary area, REO and RE metals are almost at the end of RE value chain. Out of them REO have better marketability due to inherent nature of this sector and India is in global map having capability to provide REO.

Sr. No.	Narrative	Facts
14	REE are critical and scarce	REE consists of 17 elements and all of them are not critical. In fact Neodymium (Nd), Praseodymium (Pr), Terbium (Tb), Dysprosium (Dy) and few HREE are the scarce & critical materials, while Lanthanum (La) and Cerium (Ce) are abundantly available in earth crust and are not critical or scarce.
15	To meet magnet requirement Nd production need to be increased multifold.	Due to composition of element specific content in RE minerals, Nd production is associated with more than 3 times the volume of Cerium and Lanthanum. On account of limited consumption of these elements, they create impediments in production of Nd. Enhancement of Nd production would need continuous and consistent evacuation of Ce and La.
16	Dependence of India on China for REE	In India, Rare Earths are produced in surplus than domestic demand. Indian deposits have only LREE, which includes Ce, La, Nd, Pr, and Sm.



Restoration of area after mineral collection is our primary responsibility. Systematic and scientific restoration of the area by modern afforestation techniques helps rejuvenate land, promote biodiversity and establish an improved ecosystem.

We perform desilting of fishing harbors to ease the navigation of fishing boats for the local fishermen community.

Our duty is to give back to the society with a focus on community health care, infrastructure development, skill training, education and community development.

IREL (India) Limited

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