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(Part- III : MINERAL REVIEWS)

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RARE EARTHS

(ADVANCE RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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24 Rare Earths

The term "rare earth" arises from the minerals from which they were first isolated, which are common oxide-type minerals (earths) found in Gadolinite extracted from one mine in the village of Ytterby, Sweden. However, with the exception of the highly-unstable promethium, rare-earth elements are found in relatively high concentrations in the earth's crust with cerium being 25th most abundant element in the earth's crust at 68 parts per million.

Rare Earths are a group of 17 elements starting with lanthanum in the periodic table of elements and include scandium and yttrium. They are moderately abundant in earth's crust but not concentrated enough to make them economically exploitable. The REEs find key applications in defence, electronics, energy systems etc. For instance, magnets made from rare earths are many times more powerful than conventional ones. Along with energy critical elements (ECE), such as, lithium which has become ubiquitous battery material, REEs have emerged as strategic elements essential for sustainable energy systems.

The Rare-earth Elements (REE) are a collection of 17 elements, namely, scandium, yttrium and lanthanides (15 elements in the periodic table with atomic numbers 57 to 71, namely, lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb) and lutetium (Lu).

Although these elements tend to occur together, the lanthanide elements are divided into two groups. The light elements are those with atomic numbers 57 to 63 (La, Ce, Pr, Nd, Pm, Sm and Eu) and the heavy elements are those with atomic numbers 64 to 71 (Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu).

REEs are characterised by high density, high melting point, high conductivity and high thermal conductance. A number of rare-earth minerals contain thorium and uranium in variable amounts, but they do not constitute essential components in the composition of the minerals.

The principal sources of REE are bastnaesite (a fluorocarbonate which occurs in carbonatites and related igneous rocks), xenotime (yttrium phosphate) commonly found in mineral sand deposits, loparite which occurs in alkaline igneous rocks and monazite (a phosphate). The rare earths occur in many other minerals and are recoverable as by-products from phosphate rock and from spent uranium leaching. In India, monazite is the principal source of rare earths and thorium. Monazite is a complex phosphate of thorium and Rare-earth minerals [(Ce, La,Nd, Th,Y) PO_4] and this is radio active in nature .

RESERVES/RESOURCES

The mineral monazite is a prescribed substance as per the Notification under the Atomic Energy Act, 1962. AMD has been carrying out its resource evaluation for over six decades. It occurs in association with other heavy minerals, such as, ilmenite, rutile, zircon, etc. in concentrations of 0.4 – 4.3% of total heavies in the beach and inland placer deposits of the country.

The resource estimates of monazite in the beach and inland placer deposits is 12.73 million tonnes as on March, 2021. The statewise breakup of 12.73 million tonnes was given in Table -1.

Table – 1: Resources of Monazite

(In million tonnes)

State	No. of Deposits	Resources*
All India	**130**	**12.73**
Andhra Pradesh	24	3.78
Gujarat	2	0.07
Jharkhand	1	0.21
Kerala	35	1.84
Maharashtra	5	0.004
Odisha	12	3.16
Tamil Nadu	50	2.47
West Bengal	1	1.20

**Inclusive of indicated, inferred and speculative categories.*
Source : *Reply of Parliament Question No. 2564 in Rajya Sabha, it was answered on 18.03.2021.*

Monazite contained in 130 deposits in the coastal beach placer sands in Kerala, Tamil Nadu, Odisha, Andhra Pradesh, Maharashtra & Gujarat and in the inland alluvium in parts of Jharkhand, West Bengal and Tamil Nadu. The major deposits which contain monazite (thorium and REE ore mineral) are :

1. Chavara barrier beach and Eastern Extension, Kollam district, Kerala
2. Manavalakurichi beach sand deposit, Kanyakumari district, Tamil Nadu
3. Sathankulam Teri sand deposit, Tamil Nadu
4. Ovari Manapadu Teri Sand deposit, Tamil Nadu
5. Navaladi-Ovari Teri Sand deposit, Tamil Nadu
6. Kuduraimoli Teri Sand deposit, Tamil Nadu
7. Bhimunipatnam beach sand deposit, Andhra Pradesh
8. Kandivalasa beach sand deposit, Andhra Pradesh
9. Kalingapatanam beach sand deposit, Andhra Pradesh
10. Srikurmam beach sand deposit, Andhra Pradesh
11. Bhavanapadu beach sand deposit, Andhra Pradesh
12. Gopalpur beach sand deposit, Odisha
13. Chhatrapur beach sand deposit, Odisha
14. Brahmagiri beach sand deposit, Odisha

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are furnished in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION AND PRICES

Indian Rare Earth Limited (IREL), a Mini Ratna Company, is a Government of India Undertaking under the Department of Atomic Energy (DAE) and KMML, a Kerala State Government Undertaking, are actively engaged in mining and processing of beach sand minerals from placer deposits. IREL is the only entity processing monazite to produce Rare-earth (RE) compounds. Some REE which are available in India such as Lanthanum, Cerium, Neodymium, Praseodymium, Samarium, etc. are in supply surplus while Dysprosium, Terbium, Europium which are classified as HREE are having supply constraint. These HREEs are not available in Indian deposits in extractable quantity. Government is actively engaged in capacity building for consumption of the LREE. The annual installed mining, production and processing capacities are as under:

(i) Mining: 10 million tonnes

(ii) Processing capacity in terms of rare-earth concentrate: 11,200 tonnes

(iii) Refining capacity in terms of Total Rare-earth Oxide (TREO): 5,000 tonnes

(iv) Rare-earth Concentrate Production: 5,040 tonnes

(v) Refining in terms of TREO: 2,000 tonnes (Both Government and Private sector)

As reported by KMML (The Kerala Minerals & Metals Ltd.) monazite is a strategic mineral and cannot be sold in commercial market. Therefore, the prices are not available.

MINING AND PROCESSING

Mining of beach sand is being carried out by IREL and KMML. The installed capacity of monazite (96% pure) separation plant of IREL at Manavalakurichi is 6,000 tpy while that of KMML at Chavara is 240 tpy. Details regarding mining and processing, etc., are provided in the Review on 'Ilmenite and Rutile'.

INDUSTRY

IREL has a plant at Udyogamandal, Aluva, located in Ernakulam district, Kerala, wherein the monazite obtained from Manavalakurichi is chemically treated to separate rare earths in its composite chloride form and thorium as hydroxide upgrade.

IREL has set up a Rare-Earth Extraction plant (REEP) producing mixed Rare-earth chloride (MRCL) Tri-sodium phosphate etc., at its unit in OSCOM Odisha. MRCL produced from the above plant is processed at IREL's plant at Rare Earth Division (RED) in Aluva, Kerala, for producing separated High Pure Rare Earth (HPRE) Oxides/Compounds.

IREL implemented flow sheet developed by BARC and has produced 50 kg Nuclear Grade Gadolinium Oxide (99.99%). Same can be converted into Gadolinium Nitrate which is used by NPCIL. The Company invited research projects pertaining to products in the value chain of Ilmenite, zircon and rare-earth compounds, improvement in recovery energy efficiency, etc.

IREL is actively pursuing setting up of greenfield operations in Kanyakumari district of Tamil Nadu and Bramhagiri district of Odisha. The proposal for harnessing the beach sand mineral deposits in Tamil Nadu by constituting a Joint Venture Company with the nominated State Government Agency, TAMIN, is under active consideration by the State Government.

Ambadungar RE Project has been initiated to harness the carbonatite deposit explored by AMD in the state of Gujarat. Initially, about 1.55 Ha of the deposit is proposed to be harnessed, which will be further extended based on the exploratory results of AMD. Action has been initiated to establish the technical feasibility and financial viability of the project.

POLICY

In order to safeguard the strategic interest of the nation it is expedient in larger national interest to prohibit the grant of operating rights in terms of any reconnaissance permit exploration licence or production lease of atomic minerals as defined in part-B of the first schedule of the MM(DR) Act, 1957.

A Notification No. S.O.2685 (E) dated 27.07.2019, was issued for reserving the prospecting and mining rights of offshore minerals under Offshore Areas Minerals (Development and Regulation) Act, 2002 exclusively to Government or a Government - owned company or a corporation owned or controlled by the Government.

As per MMDR Act, 1957, Minerals of the "rare earths" group not containing Uranium and Thorium are mentioned in Part D of First Schedule to the Act for Critical & Strategic minerals. As per PIB Press Release dated 28.11.2023 by Ministry of Mines, Critical minerals are essential for our country's economic development and national security. The lack of availability of these minerals or concentration of their extraction or processing in a few countries may lead to supply chain vulnerabilities.

Other minerals under Code 2617 are freely exportable, except those which have been notified as prescribed substances and controlled under Atomic Energy Act 1962.

As per the Foreign Trade Policy, import policy under ITC(HS), 2022 Schedule 1, the import policy on the import of ores & concentrates of rare-earth metals (under HS Code 25309040) are permitted 'freely' whereas export policy under ITC(HS) 2018 Schedule 2, the export policy on the export of ores and concentrates of rare-earth metals (under HS Code 25309040) are permitted 'freely' .

Export of Beach Sand Minerals have been brought under STE and shall be canalised through Indian Rare Earths Limited (IREL). Beach sand minerals, permitted anywhere in the export policy, will now be regulated in terms of policy under at Sl. No. 98A of Chapter 26 of Schedule 2 of the Export Policy.

As per Gazette Notification No : GSR.134 (E) dated 20.2.2019, the particulars of threshold values for atomic minerals in respect of Beach Sand Minerals (BSM) shall be regulated as Schedule A [Rule 2(1)(m) and Rule 36] (Table-2).

Table - 2 : Particulars of Threshold Value for Atomic Minerals

[See Rule 2(1)(m) and Rule 36]

Uranium-bearing tailings left over from ores after extraction of copper and gold, ilmenite and other titanium ores.	60 ppm U_3O_8 and/or 250 ppm ThO_2.
Zirconium-bearing minerals and ores including zircon.	All cases of zirconium-bearing minerals occurring in Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e., the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade. In other cases, zircon containing less than 2000 ppm of hafnium.
Beach Sand Minerals, i.e., economic heavy minerals found in the teri or beach sand, which include ilmenite, rutile, leucoxene, garnet, monazite, zircon and sillimanite	All cases of Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e., the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade.

Many projects of IREL have been initiated, such as, capacity expansion of Mineral Separation Plant of OSCOM, Rare Earth Permanent Magnet Plant and Rare Earth Theme Park. Agencies to implement these projects are in place and the projects will be commissioned within the next 2-3 years. New areas of operations, such as, Rare Earths in Ambadungar, Gujarat or Atomic Minerals in Odisha and Tamil Nadu are also in advanced stage of development.

During the year 2020-21, Licence to Operate (LTO) office has been established for centralised monitoring & managing the regulatory compliances, required to achieve and sustain the targeted production plans. Centralised monitoring and control of statutory compliances is enabled through database dashboards. Units are sensitised for complying with the statutory requirements at regular intervals. Manavalakurichi and OSCOM units are continuing their operations in a sustainable manner. OSCOM has deposited the statutory fees as desired under Stage-I Forest Clearance towards obtaining the Stage-II Forest Clearance. Chavara Unit is in the final stage of receiving the environment clearances for its mining lease areas. LTO office establishes the processes & tools for proactive information gathering and structuring of regulatory requirements.

Rare Earth Permanent Magnet plant will be set up in BARC campus, Achitapuram, Vizag, for production of Samarium-Cobalt permanent magnet for use in Atomic Energy, Defence and Space sectors. Environment clearance and clearance from Design Safety Review Committee and Safety Committee, BARC for carrying out site activities have been received. Detailed engineering has been completed and appointment of contractor to commence site activities on Engineering Procurement Construction (EPC) model too has been done.

Subsidiary IREL- IDCOL Limited (IIL), the Joint Venture company has been established to harness the beach sand mineral deposit in the state which in turn will widen the footprint of the Company. Ground work towards declaration of the precise area is in the final stages at the State after completion of DGPS survey and preparation of cadastral map. DPR for the project has been prepared. Pre-project activities such as, obtaining environment clearance, preparation of mining plan, etc. necessary for execution of the mining lease deed will be taken up in 2021-22.

USES & CONSUMPTION

The Rare Earth Permanent Magnet (REPM) in Vizag and Rare Earth and Titanium Theme Park (RETTP) in Bhopal have kick started with the funding assistance of Government of India, which will enhance the visibility of IREL in the strategic and niche sector.

Environmental clearance for REPM project has been received from MoEF&CC and M/s MECON Limited, Bengaluru, has been appointed as consulting firm for detailed engineering. As regards RETTP project, lease deed execution towards land has been completed. A Letter of Understanding has been inked with BARC towards developing and transferring laboratory-scale technologies in the value chain of Rare Earths which will be suitably upscaled by IREL to pilot-scale and installed in the theme park.

In addition, IREL has been assigned the responsibility of carrying out civil construction works on behalf of BARC for the 5 million liters per day (MLD) hybrid seawater desalination plant at OSCOM. About 60% construction of plant building has been completed.

Execution of Supplimentary Mining Lease deed for OSCOM Mines till a period up to the year 2047 has been completed under the provisions of AMCR 2016. Communication on precise area of the Bramhagiri Mineral Sands Deposit in Puri district under AMCR, 2016 is in the final stages of issuance by the Government of Odisha.

Rare-earth materials are utilised in a wide range of critical products enabling many emerging green energy technologies, high-tech applications and defence systems, such as, hybrid cars, plug-in-hybrid electric-vehicles (PHEVs), the latest generation of efficient wind power turbines, computer disc drives, missile guidance systems, etc. The lanthanide elements as a group have magnetic, chemical and spectroscopic properties that have led to their application in a wide range of end-uses. Cerium finds application in polishing of glass items like lenses & display screens of cathode-ray tubes, liquid-crystal displays & plasma-display panels, in petrol & diesel fuels as fuel additive and along with lanthanum for replacement of cadmium in red pigments. Mixed salts of the cerium group of

elements, other than fluorides are used in medicine, non-irritating antiseptic dressings, waterproofing agents and fungicides in textile manufacture. The principal uses of commercially pure cerium compounds that are in the form of nitrate is in the manufacture of incandescent gas mantles and cerium compounds as oxide. It also finds usage as a polishing agent of glass. Cerium compounds are also used in ceramic and glass as colouring pigments and also as catalysts in Chemical Industry.

Department of Atomic Energy (DAE), has accorded in principle approval for futuristic proposal of IREL towards setting up of rare earth theme park which inter alia includes setting up of pilot plants in the value chain of rare earths, skill-cum-enterpreneur development center. This will be a first of its kind theme park in the country.

To produce samarium-cobalt (Sm-Co) magnet for meeting national objectives, a Special Purpose Vehicle (SPV) has been formed. Production of Sm-Co metal and magnet is based on technologies developed by BARC, Mumbai & DMRL, Hyderabad. Activities for firming up the investment, plant location etc., are under progress.

Supply of Nuclear Grade Ammonium diuranate (NGADU) from new source, i.e, the newly commissioned monazite processing plant at OSCOM, Odisha has commenced.

Subsequent to identification and development of conditions for dissolution of Rare Earths (REE) from fly ash generated at lignite coal fired thermal power plant at Neyveli, Tamil Nadu, studies were taken up to understand the overall process efficiency and precipitate dissolved rare earths in purified form.

Cerium, lanthanum and neodymium are used as glass additives in optical lenses and display screens, as catalysts in automobiles to reduce sulphur dioxide emission, in multilayer capacitors and along with yttrium in magnesium, aluminium and hydrogen storage alloys. Mischmetal which is an alloy of cerium with small amounts of other rare-earth metals is used in lighter flints, for desulphurisation in steel and foundry, and with lanthanum alloys, in batteries and hydrogen storage systems meant for electronics and hybrid cars. Cerium oxide is used in glass polishing industries.

Lanthanum oxide and neodymium compounds are used in special glass manufacture. Lanthanum finds application in X-ray films as phosphors; yttrium in advanced ceramics like nitrides,Y-stabilised ceramics, etc., and gadolinium in magnet alloys. Yttrium, europium and terbium are used as phosphors in displays of computers, TV, etc. and with lanthanum, cerium & gadolinium as phosphors in fluorescent and halogen lamps. Neodymium, samarium, dysprosium, praseodymium and terbium have application as high intensity magnets in electronics, electric motors and audio equipment. Lanthanum, erbium and ytterbium have application in fibre optics and lasers. Lanthanum and yttrium find application in solid oxide fuel cells. Scandium is used mainly in aluminium alloys for sporting goods. Scandium in minor amounts is used in semiconductors and special lighting, including halogen bulbs. Mixed rare-earth products are used as catalysts in petroleum refining and fluid cracking. Neodymium is used in welding in heavy industries and also in MRI scanners. Praseodymium is not a primary element for any specific use, but finds use as a substitute for neodymium in magnets.

Samarium is used essentially for the Sm-Co magnets. Europium is a primary component of phosphorus and is responsible for white light in compact fluoroscent lamps when used with terbium compounds.

Erbium used as fibre optic has emerged in the nineties as a remarkable tool for communication technology through which high quality rapid data in tight pulses can be transferred in speed unthinkable in the past.

The main application for neodymium-iron-boron (Nd-Fe-B) magnets are in automobiles for anti-lock brakes, and in computer hard disk drives, videos, CD-ROMs used in many small-size electronic consumer products, such as, digital cameras, where major advantage is their small sizes. Nickel metal hydride (Ni MH) batteries, containing mischmetal, a mixture of rare-earth compounds, are used mainly in portable electronic equipment, such as, laptops, camcorders and mobile phones. Though, the market for batteries for portable electronic equipment is growing strongly, the Ni MH batteries are increasingly replaced by lithium-ion batteries.

Ground monazite is digested with caustic soda lye to produce trisodium phosphate (TSP) and mixed hydroxide slurry. This slurry is used for production of diverse rare-earth compounds. Elaborate solvent

extraction and ion exchange facilities were built to produce individual RE oxides, like oxides of Y, Ce, Nd, Pr and La of specific purities. India is the second largest supplier of yttrium in the world and the maximum production is reported from the plant in Kerala. Uranium values present in monazite which are recovered in the form of nuclear grade ammonium diuranate (ADU) are vital supplement to the indigenous supply of uranium. Thorium is separated in its pure oxalate form. A part of it is taken to OSCOM for further processing by solvent extraction to produce thorium nitrate. A small part of the purified thorium nitrate is converte to nuclear grade thorium oxide powder for supply to Bhabha Atomic Research Centre (BARC) and Nuclear Fuel Complex (NFC) for developing thorium-based fuel for nuclear reactors. IREL has built a large stockpile of impure thorium hydroxide upgrade associated with rare earths and unreacted materials.

Monazite contains about 25.28% P_2O_5 which can be recovered as a by-product for manufacture of fertilizers and production of elemental phosphorus or its salts. Beside, rare earths, thorium is also recovered from monazite. It is a source of atomic energy. An important use of thorium is for addition to tungsten in minute quantity (about 0.75%) to increase the ductility of tungsten wire and thus to facilitate its drawing into filaments used in electric lamps. Metallic thorium is also used in photoelectric cells and X-ray tubes and in certain alloys. Thorium is used as catalytic agent for various processes. Amongst thorium salts, thorium nitrate is used largely in the manufacture of incandescent gas mantles. Mesothorium, the chief radioactive element recovered as a by-product in the chemical treatment of monazite, is marketed usually in the form of its bromide and used in self-luminous paints or enamels. Mesothorium is also used in the treatment of certain types of cancer and skin diseases.

World Review

The total world reserves are estimated at 130 million tonnes of rare-earth oxides equivalent content (REO) of which China alone accounts for 44 million tonnes (34%) followed by Vietnm, Brazil & Russia (16% each) and India (5%) (Table- 3).

China holds the leading position among producers of rare-earth oxides with 348 thousand tonnes. The other major producers are Myanmar, Australia, USA, Russia, India, Vietnam and Malaysia (Table-4).

Table – 3 : World Reserves of Rare Earths (By Principal Countries)

(In '000 tonnes of REO equivalent content)

Country	Reserves
World: Total (rounded off)	**130,000,000**
USA	2,300,000
Australia[a)]	[10]4,200,000
Brazil	21,000,000
Burma	NA
Burundi	NA
Canada	830,000
China	44,000,000
Greenland	1,500,000
India	6,900,000
Madagascar	NA
Russia	21,000,000
South Africa	790,000
Tanzania	890,000
Thailand	NA
Vietnam	22,000,000
Other countries	280,000

Source: *USGS, Mineral Commodity Summaries,2023*

[a] For Australia, Joint Ore Reserves Committee-complaint or equivalent reserves were 3.0 million tons.

NA - Not available

Table – 4 : World Production of Rare-Earths Oxides (By Principal Countries)

In tonnes

Country	2019	2020	2021
China[(a)]*	180,000	180,000	348000
Myanmar*	29,000	36,000	35000
USA*	16,800	22,800	25800
Australia[(c)]	19,737	14,562	15970
India[(b)]	4,200	4,200	4200
Madagascar*	2,800	3,200	3500
Russia	2,620	2,663	2276
Vietnam*	1,300	1,000	400
Malaysia	71	14	29

Source: *BGS, World Mineral Production, 2016-21*

**) Estimated*

a :Includes production from iron ore extraction, bastnaesite concentrates and ion absorption clays.

b :Year ending 31st March following that stated.

c :Year ending 30th June following that stated.

To provide a generalised view of the development in various countries, the country-wise description sourced from the latest available publication of rare earths in Minerals Yearbook 'USGS' 2018 is furnished below.

Australia

Arafura Resources Ltd continued piloting studies on its Nolan's Bore project in the Northern Territory with the goal of producing rare-earth, phosphate, and uranium products. Alkane Resources Ltd continued the development of its polymetallic Dubbo Zirconia project in New South Wales with planned production of hafnium, niobium, rare-earths, tantalum, and zirconium products. In 2018, Alkane continued test work and sought financing to advance the development of the project. Australian Mines Ltd completed a bankable feasibility study on the Sconi cobalt-nickel-scandium project in northern Queensland. Clean TeQ Holdings Ltd completed a definitive feasibility study for its Sunrise nickel-cobalt-scandium project in New South Wales. Lynas Corp. Ltd, the leading producer of rare-earth mineral concentrates outside of China in 2018, continued to operate its Mt Weld mining operations in Western Australia to support its processing operations in Malaysia. Northern Minerals Ltd continued work to develop the Browns Range project in Western Australia and the Northern Territory. In 2018, the company was commissioning pilot plant operations that included beneficiation through hydrometallurgical extraction. About 2.6 t of mixed rare-earth carbonate was produced and exported to China in the fourth quarter. Platina Resources Ltd completed a definitive feasibility study for its Owendale polymetallic (scandium-cobalt-nickel) project in New South Wales. The Company planned for an initial capacity of 20 t/yr of scandium-oxide equivalent. Scandium International Mining Corp. (Sparks, NV) continued to pursue financing and offtake agreements for its Nyngan scandium project in New South Wales. In 2018, the company was awarded two patents from the United States Patent Office related to its leaching and solvent extraction technology.

Burundi

Rainbow Rare Earths Ltd continued to commission its mining and beneficiation processing operation at its Gakara project in Bujumbura Rural Province.

Canada

Commerce Resources Corp. continued prefeasibility work on its Ashram project in northern Quebec. In 2018, Commerce Resources was collaborating with Université Laval to conduct process modeling and bench and pilot plant studies. Canada Strategic Metals Inc. merged with Matamec Explorations Inc. and was renamed Quebec Precious Metals Corp. In southwestern Quebec, the new company held joint ownership of the Kipawa project with Investissement Québec and 100% ownership of the Zeus project. In 2018, development activities at both of these adjacent projects were on hold and the company was seeking partners to further develop the projects. Medallion Resources Ltd continued with plans to develop a processing facility to produce mixed rare-earth compounds from monazite. Medallion's proposed facility would purchase monazite by-product from heavy-mineral-sand operations and produce rare-earth compounds. In 2018, the company continued its process development through collaborations with the Saskatchewan Research Council and Rare Earth Salts Separations and Refining, LLC. Search Minerals Inc. was conducting a drilling program and environmental assessments on its Foxtrot project in southeastern Labrador. According to the company, most of the rare-earth mineralisation occurred in allanite (a silicate mineral) and fergusonite (an oxide mineral). The project plan was based on a combined open pit and underground mine followed by processing to produce a mixed rare-earth concentrate.

China

China dominated the global production of rare-earth minerals, separated compounds, and metals. China's Ministry of Land and Resources (CMLR) production quotas for rare-earth mine production were 1,20,000 t of REO equivalent, of which 1,00,850 t was for light rare earths and 19,150 t was for medium and heavy rare earths. CMLR classifications for light, medium, and heavy were not defined. The production quotas for smelting and separation were 1,15,000 t. Nearly all mine, smelting, and separation quotas were allocated to the state-owned enterprises. China's exports of rare-earth compounds (HS code 2846) were 45,800 t (gross weight), nearly unchanged compared with those in 2017. The top four destinations of these exports were, in descending order, the United States

(31%), Japan (28%), the Netherlands (17%), and the Republic of Korea (6%).

Greenland (Denmark)

Greenland Minerals and Energy Ltd (GMEL) continued work on its polymetallic (REE-uranium-zinc) Kvanefjeld project in southern Greenland. In 2018, the company worked to improve its technical designs and submitted environmental and social impact assessments to the Government of Greenland. GMEL was working with several companies based in China [Baotou Meng Rong Fine Materials Co. Ltd, China Communications Construction Co., and Shenghe Resources Holding Co. Ltd (Shenghe)] and North America on the commercial development of the project. Shenghe was a major shareholder in GMEL.

Kazakhstan

Kazakhstan's National Mining Co. Tau-Ken Samruk JSC acquired the Summit Atom Rare Earth Co. LLP (SARECO) from Kazakhstan's National Atomic Co. Kazatomprom JSC. The SARECO operations in Stepnogorsk were reported to have a capacity of 1,500 t/yr of REO equivalent, although the company described the production as insignificant in 2018. SARECO's REO was a by-product of uranium mining and processing.

Madagascar

In 2018, QIT Madagascar Minerals (QMM) produced 16,000 t of monazite concentrates as a by-product of processing heavy-mineral sands to produce ilmenite and zircon sillimanite concentrates.

Malaysia

Lynas continued to increase production of rare earth compounds at its Lynas Advanced Material Plant (LAMP) near the Port of Kuantan in the State of Pahang. Lynas continued efforts to increase its capacity to produce separated neodymium and praseodymium compounds. In December, Malaysia's Ministry for Energy, Science, Technology, Environment and Climate Change (MESTECC) added preconditions for the LAMP operations licence renewal. The MESTECC preconditions included the removal of residues containing radioactive materials from Malaysia and an action plan for the disposal of "neutralisation underflow" residues.

Philippines

Japan's Sumitomo Metal Mining Co., Ltd (SMM) was preparing to begin commercial-scale production of a scandium intermediate product at its subsidiary Taganito HPAL Nickel Corp. on Palawan Island. The plant was expected to recover up to 7.5 t/yr of scandium-oxide equivalent from a process stream following the leaching of nickel laterite for nickel-cobalt sulphide. Processing of the intermediate product into scandium oxide was performed at SMM's Harima operation in Japan. Russia— PJSC Acron continued to operate a 200-t/yr pilot plant to produce REEs in the form of mixed and separated rare-earth compounds at its Veliky Novgorod facility. The feed for the operation was a by-product apatite mineral concentrate sourced from the company's Oleniy Ruchey phosphate mine in the Murmansk Region. JSC Dalur continued to recover an unknown quantity of scandium-oxide equivalent at the Dalmatovskoye uranium mining and processing operation in the Kurgan Region. In 2018, the company commissioned a pilot plant to produce aluminum-scandium master alloys. United Company RUSAL Plc, one of the world's leading aluminum producers, was conducting pilot-plant studies in the Ural Mountains to recover scandium concentrate from red mud, a residue from the processing of bauxite. RUSAL was reported to have produced scandium oxide with greater than 99% purity.

South Africa

Steenkampskraal Holdings Ltd continued plans to reopen the Steenkampskraal (SKK) monazite mine that was active from 1952 to 1963. The Company expected to produce up to 2,700 t/yr of REO equivalent in mixed carbonates.

Sweden

The Swedish Mines Inspectorate notified Leading Edge Materials Corp. that it had extended the exploration licence for the Norra Karr project in southern Sweden through 2019. In 2018, the Geological Survey of Finland performed a beneficiation study focused on removing iron impurities on bulk samples from Norra Karr. The predominate REE mineralisation was eudialyte. A prefeasibility study was based on production of 5,000 t/yr of mixed REO and a 20 year mine life, using the 0.4%-REO cut-off grade.

Tanzania

Peak Resources Ltd continued the development of its Ngualla project with plans for mining operations in southwest Tanzania.

United Kingdom

In September, Peak Resources was granted an environmental permit for its Teesside extraction and separation operations located in the Wilton industrial area near Middleborough.

FOREIGN TRADE

Exports

Exports of Rare-earth Metals (Scandium & Yttrium) in 2020-21 decreased substantially by 56% to 3.67 tonnes from 8.41 tonnes in the previous year. UAE (87%) and Bhutan (12%) were the main buyers from India (Table-5).

Imports

The imports of Rare-earth Metals (Scandium & Yttrium) in 2020-21 marginally decreased by 0.64% to 470.61 tonnes as comapred to 473.64 tonnes in 2019-20. China (94%) and USA (1%) were the main suppliers to India (Table-6).

Table-5 : Exports of Rare-Earth Metals (Scandium & Yttrium) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**8.41**	**3990**	**3.67**	**4178**
Bhutan	7.55	3405	0.44	247
Canada	-	-	++	19
China	-	-	0.03	11
Czech Republic	-	-	++	35
Denmark	0.04	41	++	104
Ghana	0.01	3	-	-
Israel	-	-	++	23
Korea, Rep of	0.06	6	-	-
Netherlands	-	-	++	79
U A E	0.75	490	3.2	3659
U S A	++	44	-	-

Figures rounded off

Table-6 : Imports of Rare-Earth Metals (Scandium & Yttrium) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**473.64**	**1,62,305**	**470.61**	**1,75,172**
Belgium	++	5	++	7
China	437	1,45,447	444.8	1,50,440.00
Germany	++	131	++	273
Hong Kong	34	10827	0.05	774
Japan	2	1304	11	8409
Sweden	-	-	10	519
U A E	-	-	0.04	257
UK	0.08	638	0.03	1560
USA	0.56	3954	4.69	12933

Figures rounded off.

FUTURE OUTLOOK

Worldwide explorations for economic deposits of REEs and efforts to bring them into production have increased substantially since 2000. Recovery of REEs can be complex because they occur in minerals as a group of similar elements, and at many deposits the REEs are hosted within more than one mineral. The success and timeliness of rare-earth mining projects, and the rare-earth elements industry in general, is difficult to predict and will be continuously monitored and studied by various countries in the world.

As per Roskill report 2021, the global demand of RE is to the tune of 1,31,500 tonnes and the processing capacity is of the order of 1,47,570 tonnes, while as per Argus Report 2021, the global demand of RE is to the tune of 1,59,000 tonnes and the processing capacity is of the order of 1,97,000 tonnes. Hence, as such, there is no supply chain constraint. However, Rare earth comprises of seventeen elements and are classified as light RE elements (LREE) and heavy RE elements (HREE). Some REE which are available in India, such as, Lanthanum, Cerium, Neodymium, Praseodymium, Samarium, etc. are in supply surplus while Dysprosium, Terbium, Europium which are classified as HREE are having supply constraint. These HREE are not available in Indian deposits in extractable quantity. The Government is actively engaged in capacity building for consumption of LREE.

The RE resources in India are fifth largest in the world. Indian resource is significantly lean with reference to grade and it is tied with radioactivity making the extraction long drawn, complex and expensive. In comparison to China, Indian resources are significantly lean.

Production of RE depends on deposits and end Industry consuming the products. India is one of the pioneers in processing of RE and these capabilities are available in terms of capacity, technology and skill. The Government has targeted increasing REO producing capacity by 3 times by the year 2032. Also, in order to enhance consumption of RE in Indian industries, specially Electric Vehicles, recently Government has announced a PLI scheme vide item No. 6 page 44 of Notification No. S.O. 4632(E) dated 9th November of Ministry of Heavy Industries.

AMD is presently carrying out survey and prospecting operations to augment REE in Barmer district, Rajasthan; Chhota Udaipur district, Gujarat; Cuddalore, Ariyalur, Sivaganga & Madurai districts, Tamil Nadu; and East Singhbhum district, Jharkhand. AMD is carrying out collection of xenotime-bearing polymineral concentrate in the unit established in Jashpur district, Chhattisgarh.

Further, AMD has also been undertaking exploration works to identify additional resources of monazite in the beach sand deposits along coastal tracts in parts of Ganjam and Puri districts, Odisha; Srikakulam district, Andhra Pradesh, Thoothukudi – Kanyakumari – Tirunelveli districts, Tamil Nadu and Kottayam, Ernakulam, Thiruvananthapuram, Kollam and Alapuzha districts, Kerala.

IREL has provision for expanding the capacity of processing rare-earth-mineral to 20,000 tonnes per annum in near future.

The EV car projects which were expected to boost demand for Rare-earth Magnets are likely to be put on a back burner as the industry will take some time to come back on trach.

IREL is actively pursuing setting up of greenfield operations in Kanyakumari district of Tamil Nadu and Bramhagiri district of Odisha. The proposal for harnessing the beach sand mineral deposits in Tamil Nadu by constituting a Joint Venture Company with the nominated State Government Agency, TAMIN, is under active consideration by the State Government.

As the country is gearing up towards e-mobility, green energy, e-office and other niche sectors there is need to secure rare-earth mineral resources in areas beyond the boundaries of the country. Towards the above, IREL has been given the mandate to explore and acquire rare-earth resources abroad towards which activities for constitution of a separate entity under the aegis of the Department have been taken up.