Rare Earth Metals

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From cellphones to missile guidance systems, rare-earth metals are an essential component of thousands of consumer products and military weapons. China dominates the global trade, acquiring exclusive mining licenses around the world. Rare-earth mining is notorious for the environmental hazards it poses and while the challenges of cleaning up the environment are steep.

In news: Increasing use of rare earth metals in renewable technologies
Placing it in syllabus: Science & Technology
Dimensions:

- What are rare earth metals?
- Uses in clean energy technologies
- Harmful effects of Rare Earth Metals
- Challenges in handling and disposal

Content

What are Rare Earth Metals?

- Rare earth metals or rare earth elements **comprise seventeen chemical elements – 15 lanthanides** (anthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium), **scandium and yttrium.**
- Rare earth metals are actually not as rare as their name might imply. They are found abundantly in the Earth's crust.
- However, they are widely dispersed and found in low concentrations. So they are not economically exploitable.

- These difficulties, combined with the demand for the metals for use in high-tech applications, introduces economic and political complications

Chinese monopoly in Rare Earth Metals

- Until 1948, India and Brazil were the world's primary producers of rare earth metals.
- The countries with the most rare earth metals currently are China (the largest reserves in the world), the United States, Brazil, India, Vietnam, Australia, Russia, Myanmar, Indonesia.
- China is home to some of the world's largest deposits.
- The mining of rare earth metals occurs mainly in southeastern China, in provinces like Jiangxi and Fujian. But there is also mining as north as Inner Mongolia and as west as Sichuan.
- According to the United States Geological Survey, as of 2018, C**hina produced around 80% of world demand for rare earth metals** (down from 95% in 2010). Their ores are rich in yttrium, lanthanum, and neodymium.
- Since August of 2010, **fears over Chinese dominance of crucial rare earth supplies** have lingered as **China restricted export quotas** of the metals with no official explanation, immediately sparking debate over decentralization of world rare earth production.
- There are high **possibilities of caterlization** happening to global rare earth metal reserves and supply chains.
- China's intents of hegemony, non-solidarity with other nations and aims of controlling various sectors and aspects of the world's energy landscape creates new challenges for geo-politics and global renewable energy usage

Uses in clean energy technologies:

- Rare earth elements are used in several technologies to generate cleaner, renewable energy.

- These include wind turbine magnets, solar cells, smartphone components, cells used in electric vehicles, among others.
- These metals are also used in magnets, lasers, GPS satellites, photoluminescence, computer components, lighting, and electronics.

In order of increasing atomic mass, the 17 rare earth metals and some of their common applications are given below:

- Scandium: Used to strengthen aluminum alloys.
- Yttrium: Used in superconductors and exotic light sources.
- Lanthanum: Used in specialty glasses and optics, electrodes and hydrogen storage.
- Cerium: Makes an excellent oxidizer, used in oil cracking during petroleum refining and is used for yellow coloring in ceramics and glass.
- Praseodymium: Used in magnets, lasers and as green color in ceramics and glass.
- Neodymium: Used in magnets, lasers and as purple color in ceramics and glass.
- Promethium: Used in nuclear batteries. Only man-made isotopes have ever been observed on Earth, with a speculated 500-600 grams naturally occurring on the planet.
- Samarium: Used in magnets, lasers and neutron capture.
- Europium: Makes colored phosphors, lasers, and mercury-vapor lamps.
- Gadolinium: Used in magnets, specialty optics, and computer memory.
- Terbium: Used as green in ceramics and paints, and in lasers and fluorescent lamps.
- Dysprosium: Used in magnets and lasers.
- Holmium: Used in lasers.
- Erbium: Used in steel alloyed with vanadium, as well as in lasers.
- Thulium: Used in portable x-ray equipment.

- Ytterbium: Used in infrared lasers. Also, works as a great chemical reducer.
- Lutetium: Used in specialty glass and radiology equipment.

Harmful effects of Rare Earth Metals

- It's challenging to mine and process rare earths without harming the environment.
- They are extracted by removing the topsoil, transporting it to a leaching pond, and adding chemicals (such as **ammonium sulfate and ammonium chloride**) to separate out the metals.
- The **chemicals used in this separation process can create air pollution, cause erosion, and leach into groundwater.**
- The minerals that contain rare earth elements (such as monazite or bastnaesite) invariably contain some thorium and uranium – both radioactive elements. This mildly radioactive waste slurry creates a safety hazard.
- A series of environmental problems including w**ater and soil loss, landslides, cracked ground and settlement, destruction of fertile land, water eutrophication** in the mining area, **heavy metal pollution** and so on will follow one after another.
- The pollution resulting from rare-earth mining has created soil incapable of supporting crops and water supplies have been contaminated in China.
- These metals are mined using extremely energy-intensive processes, spewing carbon emissions into the atmosphere and toxins into the ground.
- Many of these metals, which include mercury, barium, lead, chromium and cadmium, are extremely damaging to the health of several ecosystems, including humans.
- A survey done by **United Nations University (UNU)** and the **World Health Organisation** (WHO) on the impact e-waste has on child health, **raised concerns around chemical**

burns, cancer and stunted growth.

Challenges in handling and disposal

- Hundreds of thousands of tons of rare earth compounds are being produced and manufactured into products each year.
- Recycling rare earth materials is challenging because **once embedded in devices, they're difficult to take out**. (extraction is difficult and costly.)
- **Recycling them is a lengthy process** which involves **demagnetisation** (by heating), crushing and roasting, followed by a **leaching process** and a separation method before a final roasting to produce a mixed rare earth oxide.
- For this reason, **much of the e-waste exported to the developing world** under the pretence of being reused or refurbished ends up being dumped.
- Therefore, instead of discarding phones or IT equipment after a couple of years, consumers should aim to get the most out of the technology they have invested in through repairing or refurbishing

Mould your thought: Why have rare earth metals gained importance in recent times? What are the challenges in using these metals?

Approach to the answer:

- Define Rare Earth Metals
- Write about their increasing use in newer technologies
- Write about monopoly of China
- Mention the environmental and health hazards
- Conclusion