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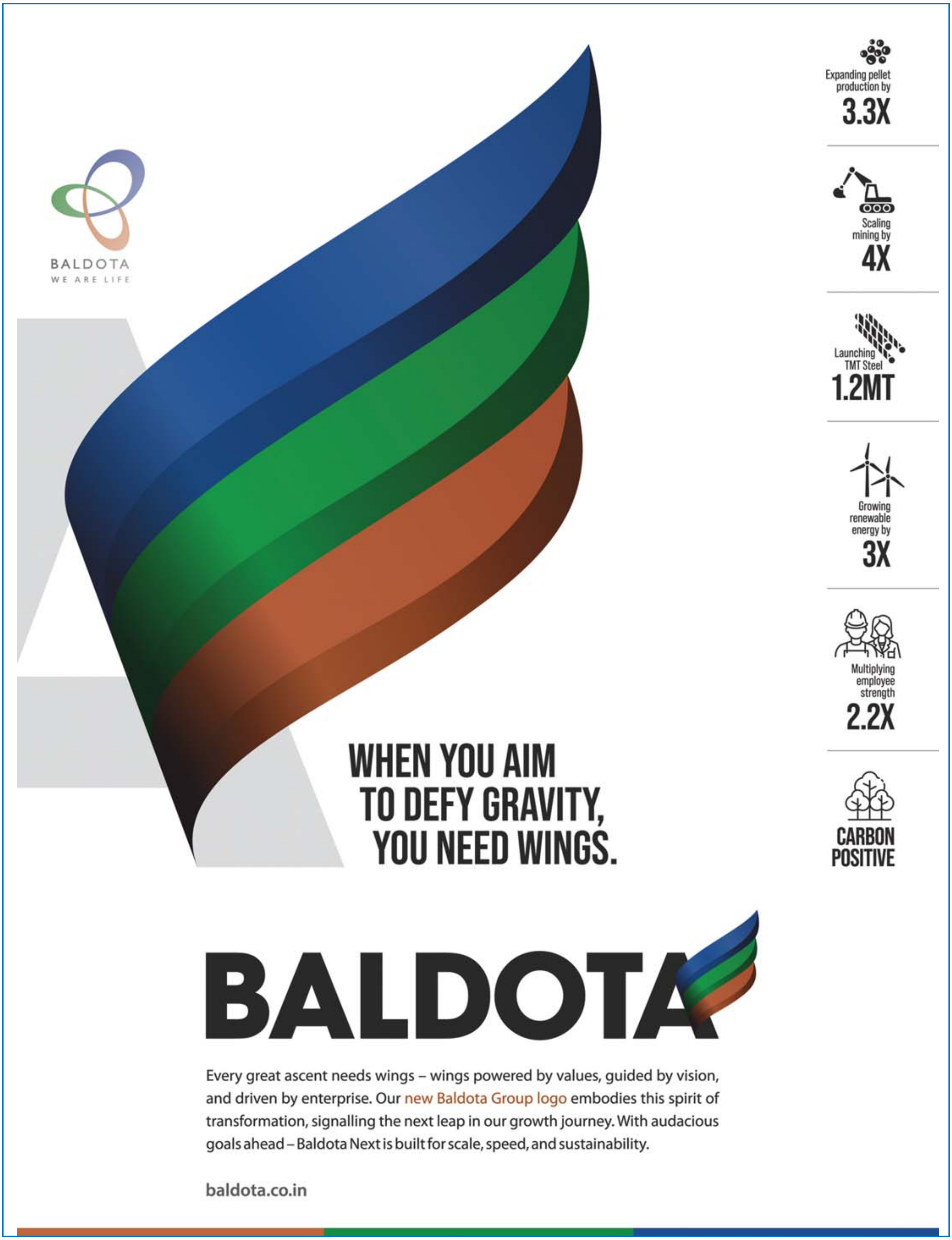
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this issue contains...

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President's Message......

Dear members..

"I extend my warm greetings for the New Year 2026 and all the festivals in January. May the year ahead be filled with prosperity, positivity, good health, and continued success in our professional endeavours."

I am glad that we have successfully completed the 6th series of the MEAI Professional Development Program (MPDP–VI) on 29th November 2025. In the **MPDP-VI** training program, a good number of participants represented organizations such as ***NMDC Ltd., Tata Steel Ltd., Vedanta Ltd., MSPL – Baldota Group, ERM Group, BGR Mining & Infra Ltd., Karnataka State Minerals Corporation Limited (KSMCL), JSW Steel Ltd. and RBSSN Pvt Ltd***. The training sessions were conducted by a distinguished faculty of 15 eminent professionals, comprising industry leaders, academicians, and senior mining experts. I extend my congratulations to all participants and appreciation to the faculty members and organizing team for their exemplary efforts in delivering such an insightful and impactful training program for the mining professionals. I am sure that each participant has enriched their professional knowledge through this program.

Congratulations to the Bangalore Chapter for successfully organizing the workshop on "***Implementation of the Indian Mineral Industry Code (IMIC)***" in association with the Department of Mines and Geology, Government of Karnataka. Appreciation is also extended to Dr. P. V. Rao, Co-Chair, NACRI, for his insightful presentation on CRIRSCO, NACRI, MEAI's role, IMIC development, and its key features. Implementation of the IMIC code in India will improve transparency, which in turn attracts FDI in the mineral sector.

The mining and mineral sector in India is currently performing quite well. Although the mining industry still has scope to enhance its contribution to the GDP, the government's recent initiatives have been highly encouraging. Several industry-friendly policies, schemes, and incentives have been introduced, along with significant amendments to existing laws. Collectively, these measures are fostering a conducive ecosystem for the sustainable growth and prosperity of the mining industry.

The Government of India has launched a ₹210 crore research initiative for critical minerals, rolled out the Critical Mineral Recycling Incentive Scheme, and introduced the first-ever State Mining Readiness Index (SMRI). In November 2025, a three-year program was announced in partnership with the Anusandhan National Research Foundation, bringing together leading Centers of Excellence such as IIT Bombay, IIT Hyderabad, and IISc Bengaluru and industry partners to develop indigenous technologies for exploration, processing, and recycling. The Union Minister for Coal and Mines, Shri G. Kishan Reddy, also highlighted India's commitment to deeper international cooperation, including with Chile, to secure resilient critical mineral supply chains.

The recent labour code reforms under the vision of Atmanirbhar Bharat bring significant pros for mining sector employees, including uniform minimum wages to curb exploitation, expanded social security like PF and ESIC for contract and migrant workers, and robust OSH provisions for safer mines with better health checks, facilities, and women's inclusion—ultimately empowering our workforce for sustainable growth.

The upcoming National Seminar of the association by the Belgaum Chapter on "Rare Earth Mining in India: Opportunities and Challenges," on 10th January 2026, is a good initiative. My best wishes to the Belgaum Chapter.

D.B. Sundara Ramam
President

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Dr. P.V. Rao
Chief Editor, MEJ

Sustainable Mining in Aravalli Hills: Position Paper of PIB-GoI

In November–December 2025, the Supreme Court considered a report from a high-level committee led by the Ministry of Environment, Forest and Climate Change (MoEFCC) with participation from the Aravalli states, the Forest Survey of India, the Central Empowered Committee (CEC), and the Geological Survey of India (GSI). The Court reaffirmed that the Aravallis serve as a barrier to desertification, a key groundwater recharge system, and a biodiversity habitat, including Delhi NCR's "green lungs," and that unregulated mining poses a "great threat to the ecology of the nation."

The CEC's pivotal contribution is to resolve, for regulatory purposes, what exactly constitutes "**Aravalli Hills**" and "**Aravalli Range.**" It noted that only Rajasthan had an operative definition, dating from 2006, which treats all landforms rising 100 m above local relief as hills and prohibits mining both on the hills and on their supporting slopes. All four concerned governments have now agreed to adopt a common "**100 meters above local relief**" criterion, refined so that protection applies to the whole hill unit and connecting ranges, not just individual peaks.

An "Aravalli Hill" is defined as any landform in designated Aravalli districts that stands at least 100 m above local relief, where local relief is measured from the lowest contour line encircling the landform; the entire area within that contour—including peak, slopes, and associated landforms—counts as part of the hill. An "Aravalli Range" exists where two or more such **hills lie within 500 m of each other** with the intervening zone delineated using a buffer and intersection method so that slopes, valleys, and smaller hillocks between them are also included.

The note emphasizes that these ecological safeguards block piecemeal exploitation of foothills and slopes that are critical for soil stability, hydrology, and vegetation. By clustering hills into ranges, the framework aims to protect habitat connectivity, wildlife corridors, and the integrity of the ridge system. All hills and ranges must be mapped on Survey of India toposheets before any mining decision is taken, making the boundaries objective and verifiable, and the definitions are linked directly to conservation tools such as protected areas, tiger reserves, eco-sensitive zones, wetlands, and CAMPA plantations, which are treated as core or inviolate areas.

The Supreme Court, in its 20 November 2025 judgment, accepts these definitions and the broader recommendations on preventing illegal mining and permitting only sustainable mining in Aravalli Hills and Ranges. A key direction is an interim freeze on new mining leases in areas mapped as Aravalli Hills and Ranges until a Management Plan for Sustainable Mining (MPSM) is prepared for the entire Aravalli belt—from Gujarat to Delhi—by the Indian Council of Forestry Research and Education (ICFRE). Once the MPSM is in place, mining will be allowed only where the plan identifies permissible areas and only under conditions consistent with ecological carrying capacity, cumulative impact analysis, and mandated post-mining restoration.

During this transition, existing mines may continue to operate, but only under stricter scrutiny and in full conformity with the committee's safeguards for sustainable mining. For general minerals, no new leases can be granted in mapped Aravalli Hills and Ranges, with a narrow exception carved out for atomic minerals, critical and strategic minerals, and certain Schedule VII minerals of the MMDR Act, which remain subject to all environmental safeguards despite their national security and economic importance. Renewals and existing leases must undergo joint inspection by teams drawn from Forest, Mining and Geology, local administration, SPCBs, and subject experts, who verify compliance, impose additional conditions, and ensure continuous monitoring.

Where mining is permissible, projects must obtain forest clearance and undergo rigorous environmental appraisal under the EIA Notification 2006, including cumulative impact assessment, strengthened terms of reference, and six-monthly reporting.

The elaborate enforcement architecture incluides Joint inspections by MoEFCC regional offices, SPCBs, SEACs, mining, forest, and groundwater authorities, with powers to keep environmental clearances in abeyance in case of noncompliance, plus periodic audits and online monitoring. Additional safeguards address groundwater and cultural heritage. To counter illegal mining, the framework calls for drones, night-vision CCTV, high-tech weighbridges, trenches on access paths, district-level task forces, control rooms with toll-free complaint numbers, clear signage of prohibitions and penalties, and e-challan-based oversight of transport and storage, with immediate closure mandated where illegality is detected.

The document's closing message is explicitly defensive of policy, rejecting "alarmist" claims and asserting that Aravalli ecology is under "robust protection" through MoEFCC and state-level actions. It projects ongoing afforestation, eco-sensitive notifications, strict regulation of existing mines, and a moratorium on new leases pending the MPSM as evidence that the Aravallis will remain a national ecological shield while the state seeks a balance between conservation and "responsible development."

The very definitions of "Aravalli hill" and "Aravalli range" remain contentious in the public domain, signalling that the political and scientific debate is far from settled.

- Chief Editor

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NEWS FROM THE MINERAL WORLD

➤ Chile loads its copper cannon with 13 projects for a bullish 2026

Thirteen Chilean copper projects worth $14.8 billion are expected to hit key milestones in 2026 as prices rise on fears of a global supply squeeze. Chile stands to benefit as seven domestic projects aim to start operations next year, adding almost 500,000 tonnes of annual capacity backed by $7.1 billion in investment, according to official figures.

The list includes Anglo American/Glencore's Collahuasi infrastructure and productivity upgrades, known as project C20+, Codelco's Rajo Inca structural project, Capstone Copper's Mantos Blancos and Andes Iron's debated Dominga. Another six developments plan to begin construction, representing $7.7 billion in spending tied to copper's strategic role in energy and technology. Those include BHP's Spence and Capstone's Santo Domingo.

Juan Ignacio Guzmán, CEO of Chilean mining consultancy GEM, said that while several projects are scheduled to begin producing in 2026, they won't achieve full ramp-up immediately. Based on estimates from the Chilean copper commission (Cochilco) Guzmán noted the pipeline could lift Chile's output to about 5.6 million tonnes, or roughly an additional 100,000 tonnes of fine copper within a year.

The analyst said the International Copper Study Group sees a 2026 deficit of 150,000 tonnes, a gap that would widen if Chilean projects stall.

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Projects to be ready in 2026

Project	Company	Capex (US$ M)	Production
Arqueros	Minera Arqueros, Nittets	200	57,000 t/y copper
Collahuasi Infrastructure Development and Productivity	Anglo American	3,200–3,670	116,000 t/y copper
Rajo Inca *(in 2026 according to Cochilco; in December 2025 according to company)*	Codelco	2,400	70,000 t/y copper
Minerals La Farola Exploitation and Operational Continuity Barreal	Minera Altair	260	90,000 t/y copper
Operational Continuity Barreal	Las Cenizas	73.4	76,826 t/y copper
El Espino	Pucobre	700	26,000 t/y copper
Increase in Capacity of Mantos Blancos Concentrator	Capstone Copper	89.5	58,500 t/y copper

Source: Companies' files, MINING.COM.

"The long-term reality is that building a new mine is difficult. Nearly everything the global economy wants to invest in is copper-intensive, including the energy transition and AI," Benchmark Minerals copper analyst Albert Mackenzie said. Guzmán said the main risk for Chile's 2026 slate lies with community relations rather than market dynamics or the new government taking office in March 2026.

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Projects estimated to start construction in 2026

Project	Company	Capex (US$ M)	Production
Playa Verde	Minera Playa Verde	95	8,640 t/y copper
Marimaca Copper Oxides	Marimaca Copper	587	43,000 t/y copper
Puquios	Camino–Nittetsu Mining	142	9,000 t/y copper
Santo Domingo	Capstone Copper	2,300	68,000 t/y copper, 1,500 t/y cobalt
Dominga	Andes Iron	3,000	150,000 t/y copper, 12 Mt/y iron ore
Spence Operational Adaptation	BHP	1,652	71,000 t/y copper

Source: Companies' files, MINING.COM.

"The role of communities will continue to be relevant," he said. While projects starting operations have already cleared key hurdles, he warned that those set to begin construction face ongoing approval processes that could end up in court.

The consultant also highlights that significant investment is essential for these projections to materialize. State-run Cochilco expects the country to attract $105 billion from this year through 2034. The agency notes the estimate includes expansions at consolidated operations such as BHP's (ASX: BHP) Escondida, the world's largest copper mine.

Katz factor

The recent victory of ultra-conservative former congressman José Antonio Kast, who is set to take office as Chile's next president in March, is being viewed by markets as positive. Kast's win represents a shift toward a more pro-investment, pro-development stance in Chile, mining investors said.

His administration is expected to streamline permitting and environmental approvals, reduce regulatory uncertainty and offer greater fiscal stability, lowering the risk of new tax or royalty changes mid-cycle.

Kast's law-and-order approach could also bring greater operational certainty by curbing protests and disruptions that have delayed mining activity in recent years, though it may raise tensions with some local communities, industry insiders noted.

For Chile's 13 copper projects, some of which are nearing production, this could translate into faster decision-making, easier access to private and foreign capital, and a higher likelihood of moving from planning to execution in time to capture a bullish 2026 copper market.

Record highs

Copper has climbed nearly 40% this year, hitting a fresh all-time high above $12,000 a tonne on Dec. 23 as supply concerns deepen. Stockpiling in the US has added strain, with companies accelerating cathode shipments into American warehouses ahead of possible 2027 tariffs on refined copper.

Mackenzie said the US has driven the 2025 price run-up, with an estimated 730,000 to 830,000 tonnes diverted into domestic storage and leveraged against the CME futures curve. The shift has tightened LME inventories, raised premiums in Europe and Asia, and boosted prices for CME-deliverable brands such as Codelco cathodes.

Sentiment also strengthened after Chinese smelters announced a 10% output cut for next year. JP Morgan expects a 2026 refined copper deficit of 330,000 tonnes. Mackenzie said mining capacity will be tight because no major new expansions are coming online and several operations are underperforming. Even when new mines open, he said, metal takes time to reach the market.

“When Freeport’s Grasberg mine had its disruption, prices jumped immediately,” he said. “Traders didn’t say, ‘let’s wait three months for it to matter.’”

The market “finds a way“

Mackenzie dismissed long-term structural deficit forecasts. “The market always finds a way,” he said. Higher prices can curb demand, more scrap can enter the system, and substitution can ease pressure. He acknowledged, though, that demand will rise and extraction is getting harder.

Projects needed to meet that demand should already be under construction, and some buyers are now exploring alternatives after years of bullish shortage narratives.

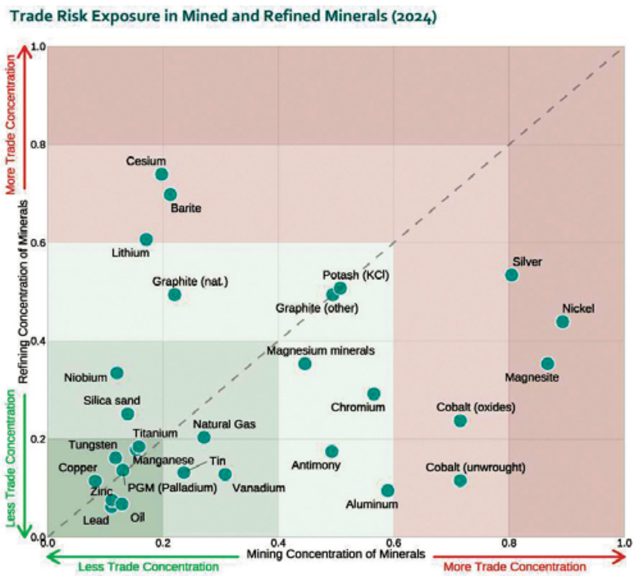
Cecilia Jamasmie | December 23, 2025

➤ Over 60% of critical minerals demand met through global trade: IEF

More than 60% of global critical mineral demands is met through international trade, underscoring the deep structural interdependence between producing and consuming economies as the deployment of clean energy accelerates, according to the International Energy Forum (IEF).

This level of reliance on international trade, the group said, makes the world’s supply chains highly sensitive to geopolitical tensions, export controls, and refining bottlenecks, as minerals become the backbone of electrification, digital infrastructure and advanced manufacturing.

In its latest report, A Critical Minerals Enabled Energy Future, the IEF highlights the mounting supply-side vulnerabilities as demand for the main energy transition minerals rises sharply through 2040. In particular, the copper and nickel markets may face material shortfalls by the mid-2030s, it said, while lithium supply remains concentrated in just a handful of countries.



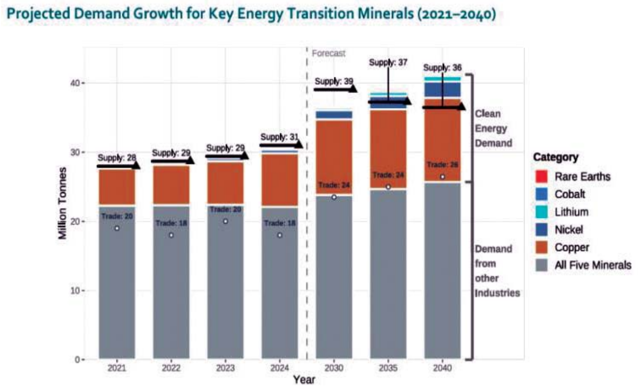
At the same time, government responses are accelerating just as quickly. According to IEF estimates, the number of critical mineral policies issued since 2020 nearly doubled the combined total of the previous two decades, with countries increasingly turning to strategic planning, export controls and domestic processing mandates to shield supply chains.

Market outlook: electrification driving growth

The IEF report shows global demand for key minerals (copper, nickel, cobalt, lithium and rare earth elements) rising from 28 million tonnes in 2021 to nearly 41 million by 2040, highlighting the growing dependence of clean energy technologies on mineral-intensive supply chains.

Within clean energy applications, copper remains the single largest contributor, more than doubling to over 12 million tonnes, while lithium and nickel record the fastest growth rates, expanding more than tenfold due to battery manufacturing and energy-storage systems.

Rare earth elements and cobalt show steadier but still significant increases as electrification efforts advance.



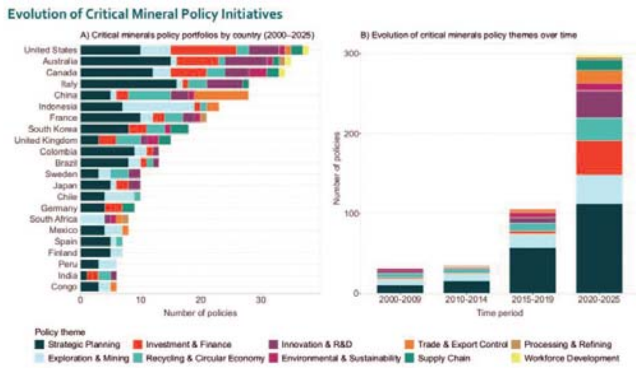
Electric vehicles will continue to be one of the biggest demand catalysts, given they use four times more copper than their internal-combustion counterparts, the IEF predicts. Copper consumption from EVs alone is projected to surge from 200,000 tonnes in 2020 to 3.4 million tonnes by 2035, a 14% average annual growth rate between 2025 and 2035. Meanwhile, the proliferation of AI, data centers, and semiconductor-heavy industries is intensifying competition between sectors for the same minerals.

Geographical concentration compounds the challenge: Indonesia accounts for more than half of global nickel supply, the Democratic Republic of the Congo produces roughly 70% of cobalt, and China controls more than 90% of rare earth refining capacity. Lithium mining remains dominated by Australia, Chile and China, which together accounted for more than three-quarters of global production in 2022.

Policy landscape: export controls, strategic planning

IEF notes that more than 600 policies worldwide now target critical mineral supply chains, revealing both geographic clustering and rapidly shifting priorities. Strategic planning remains the most common theme, but international trade measures and export controls are rising sharply, in some cases surpassing sustainability-focused regulations.

OECD members such as the US, Canada and Australia are rolling out incentives for exploration, refining and recycling, while major producers including Indonesia, Chile and Peru are issuing policies geared toward upstream investment and in-country value addition. The US has also expanded efforts to recover minerals from mine waste and legacy sites as a lower-friction alternative to new permitting.



Despite this acceleration, the report warns that market-distorting interventions may exacerbate volatility unless accompanied by cross-border coordination. The IEF argues that transparent markets, shared data, and structured producer-consumer dialogue — similar to mechanisms used in oil markets — will be critical to sustaining investment and reducing uncertainty in mineral markets where both mining and refining capacity remain concentrated.

➤ Japan to test rare-earth mining from deep seabed mud

Minamitorishima Island.

Japan will conduct a month-long test to extract rare-earth-rich mud from the deep seabed near the remote Minamitorishima Island, marking a first-of-its-kind effort to continuously lift material from about 6,000 metres below the surface.

The operation, led by the Japan Agency for Marine-Earth Science and Technology, will run from Jan. 11 to Feb. 14 about 1,900 kilometres southeast of Tokyo. It aims to connect a full deep-sea mining system and confirm it can raise 350 metric tonnes of mud a day while monitoring environmental impacts onboard and on the seabed.

The test comes as Japan and its Western allies seek more secure access to critical minerals amid tighter export controls by China, the dominant supplier of rare earths. “One of our missions is to build a supply chain for domestically produced rare earths to ensure stable supply of minerals essential to industry," Shoichi Ishii, a program director at the Strategic Innovation Promotion Program, told Nikkei Asia.

Strategic push

No production target has been set, but if the test succeeds, the agency plans a full-scale demonstration by February 2027 to recover the same daily volume. Because the mud cannot be processed at sea, it would be shipped to Minamitorishima, where seawater would be removed using equipment similar to a washing machine's spin dryer, cutting volume by about 80%, before being transported to mainland Japan for separation and refining.

The government-funded project has spent about 40 billion yen ($256 million) since 2018, Ishii said, though estimated reserves have not been disclosed. He also said a Chinese naval fleet entered waters near Minamitorishima in June this year, while a Japanese research vessel was conducting seabed surveys within Japan's exclusive economic zone. "We feel a strong sense of crisis that such intimidating actions were taken," Ishii said.

Cecilia Jamasmie, Mining.Com | December 23, 2025

➤ Disillusionment with mineral exploration AI

Be aware we're hitting the pit of disillusionment with mineral exploration AI.

Ten years ago, AI in mining was frowned upon. We would get push back that AI was a black box and "we can't trust black boxes". People dismissed AI as snake oil.

A few years ago "AI" started appearing everywhere, it was going to revolutionize discovery and dispense with human knowledge. Now having experimented some are quietly walking away, saying AI was oversold.

The problem is that people expected AI to be an all answer machine. Pour your data into the top, shake it around, and the solution to everything comes out the bottom. Where should I drill?, What are my geological domains?, what spacing do I need?. When the tool didn't solve all of that at once, the conclusion was that AI doesn't work.

That's the equivalent of saying I tried math and it didn't work.

There are many types of AI serving many different purposes, and the value was never about producing answers magically. The value is that AI helps you do hundreds of small things better so your overall efficiency improves in ways that compound over time.

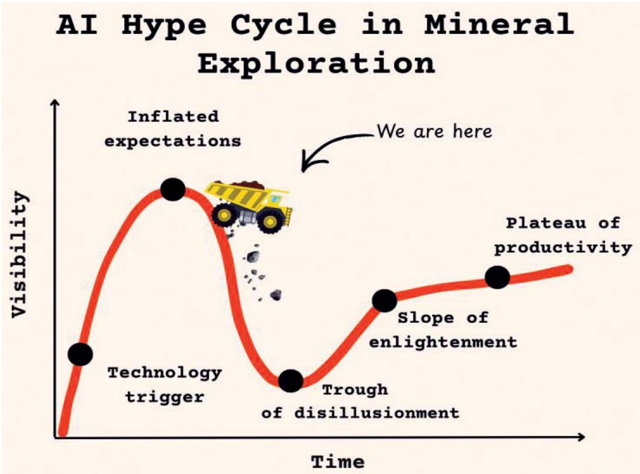
Think of AI as a spreadsheet, it's versatility can be applied to many things. When Dan Bricklin launched VisiCalc in 1979, it made people dramatically more productive. (Visicalc is also credited for turbo charging Apple's early growth).

Ten years ago, out of a hundred holes you got a certain hit rate, and today with AI-optimized programs, that rate goes up. Not all exploration holes are hits, but many more are. Nobody writes press releases about that kind of incremental gain, but across an industry running thousands of programs every year, a consistent 10% improvement in exploration success represents an enormous shift in how value gets created.

AI can process datasets too large for any geologist to hold in their head and bring to surface (pun intended) outliers worth investigating. It can optimize drilling sequences in ways that translate directly into millions saved. None of that is magic, and it need not replace geologists thinking. It's math and algorithms applied at scale to problems that have always existed but were too computationally intensive to solve properly.

Greenfield exploration is fundamentally sparse. You're working with limited information and hoping to find patterns that may or may not exist, which is a brutal environment for any algorithm and explains why AI exploration tools have seemed to disappoint.

Companies abandoning AI after one failed experiment in the wrong application are making the same mistake as someone who threw away their calculator because it couldn't write poetry.



Andrew Dasys, LinedIN | 4 Dec 2025

(Continued on Page 24)

MINING OF MINERAL RESOURCES IN SPACE: CHALLENGES AND FUTURE PROSPECTS

Arun Kumar Sahoo[1] and Dr. Debi Prasad Tripathy[2]

Abstract

Extraterrestrial mining represents a frontier in space exploration, offering the potential to access vast resources from celestial bodies such as the Moon, Mars, and asteroids. This emerging field aims to utilize in-situ resources to support sustainable space missions and reduce reliance on Earth-based supplies. As a result of the joint efforts of space agencies, private companies, and international collaborations, countries are moving closer to the exciting frontier of mining asteroids, which could revolutionize resource availability and economic growth. Mining Mars could support human colonization and supply valuable resources for use both on Mars and on Earth, providing critical resources for sustaining human presence on the Moon and beyond. Key technologies include robotic mining, bioleaching microorganisms, and synthetic biology, which enable the extraction of essential minerals, metals, and volatiles. However, significant challenges remain, including the development of a comprehensive legal framework, environmental concerns, and the adaptation of terrestrial mining techniques to extraterrestrial conditions. Continued research and international collaboration are essential to address these challenges and unlock the full potential of space resource utilization. As Earth's resources become increasingly strained, the potential of mining in space offers a promising solution to meet future demands. This paper explores the technologies, challenges, and opportunities associated with extraterrestrial mining in India and across the globe.

Keywords: *Space mining, mineral resources, moon, asteroid, mars, India*

1. INTRODUCTION

The mining industry plays a crucial role in the global economy, in which the US, China, and India play a major role [1]. Minerals such as bauxite, coal, copper, gold, and iron ore are essential. Iron ore and bauxite are two commodities in which Australia ranks high, but rare earth elements are a specialty of China [2]. Many countries' GDPs are boosted by the mining sector. As an illustration, around 10% of Australia's GDP is derived from the mining industry [3]. Raw materials for many other types of businesses rely on this sector, which employs millions of people throughout the world [4, 5].

There are large quantities of coal, limestone, iron ore, chromite, and bauxite in India's mineral resources [6]. Industries and economic growth have been propelled by the country's 95 discovered minerals. In India, the mining sector adds 2.1% to 2.5% to the GDP [6]. With a share of more than 40% in India's mineral output, Odisha plays a pivotal role. Regulatory obstacles, environmental concerns, and the need for technological advancements are some of the issues that India's mining industry faces, despite the country's mineral abundance. Opportunities to expand exploratory efforts, implement more environmentally friendly procedures, and make better use of technology to boost productivity are all there. The mining sector is crucial for India's and the world's continued attempts to strike a balance between economic growth, sustainability, and technical innovation [5].

Mining in space could be a great way to satisfy future demands when Earth's resources are already at a premium. In light of Earth's diminishing resources, exploration of space offers new sources of energy and raw materials. The moon is a treasure trove of fusion fuel-related minerals, including uranium, titanium, and helium-3 [7, 8]. Space mining operations involving asteroids and the lunar surface are currently underway between NASA and China [9, 10]. Planetary Resources intends to mine asteroid rocks for precious metals and other unusual materials. When it comes to efficiently regulating space mining activities, the current legislative framework is vague. The sustainable utilization of energy and resources in space depends on appropriate governance [11].

With the advancements in space technology, private corporations are now plotting to mine minerals from the moon and asteroids. Google Lunar XPrize and similar competitions provide $30 million, and both Europe and China have come

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a long way in space exploration [12]. A growing number of public and private organizations are investing resources into researching and creating methods to mine asteroids and the moon ("space mining"). Space mining proponents point out that it reduces pollution, environmental deterioration, and human habitat invasion, which are common issues with mining on Earth. Mining from space, specifically from asteroids, the Moon and Mars, for minerals and other valuable commodities, is a huge step forward in space research and resource exploitation. The public is more accepting of space mining than land mining [13].

Space mining is a promising field with the potential to unlock vast resources from celestial bodies like asteroids, the Moon, and Mars. However, the technological advancements required to make space mining feasible are still in their infancy, and significant research gaps remain [14]. Current technologies for detecting and mapping resources on celestial bodies are limited in accuracy and efficiency [15]. Advanced sensors and remote sensing techniques are needed to identify valuable minerals and their distribution [15, 16]. Existing mining methods are designed for Earth-like conditions and are not suitable for the microgravity and extreme environments of space [17]. Research is needed to develop specialized tools and techniques for excavation, processing, and transportation [18]. Space mining operations will rely heavily on autonomous robots and AI systems [18, 19, 20, and 21]. However, the development of reliable, self-sufficient systems capable of handling unforeseen challenges in space is still a work in progress [22].

This paper is organized as follows. The methodology is shown in section 2. The key targets for extraterrestrial mining are presented in section 3, while the methods and techniques for extraterrestrial mining in India and the world are discussed in sections 4 and 5, respectively. Finally, discussion and conclusions are presented in sections 6 and 7.

2. METHODOLOGY

Space mining technology, difficulties encountered, and potential solutions were all examined in this literature review. Following the identification of research gaps in the literature evaluation, the authors commenced the study. The authors used search engines like Google to find articles about space mining, moon mining, asteroid mining, technology used in space mining, advancements in space mining, and other related topics for the review of literature. Further efforts were made to take note of any missions that were successful in space mining. Next, make sure that the methods for extracting minerals from space are feasible, scalable, and long-term sustainable. The detailed methodology followed is shown in figure 1.

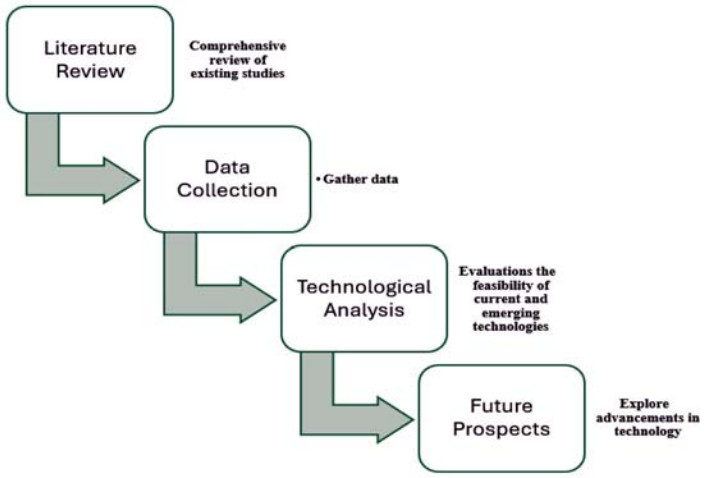

Figure 1. Methodology

3. KEY TARGETS FOR EXTRA-TERRESTRIAL MINING

3.1 Asteroid Mining

In theory, it would be possible to mine asteroids and other minor planets, even ones close to Earth, for their constituent minerals. Iron, nickel, iridium, palladium, platinum, gold, cobalt, and magnesium are just a handful of the minerals that can be found in asteroids [23, 24]. The mining of asteroids would not, however, be limited to metals alone. The extraction of water has a specific allure [25, 26]. Most asteroids fit into three basic categories, as given in figure 2.

Platinum group metals in many asteroids that are scarce and expensive on Earth are abundant [26]. About ten million times as much iron as is now known to exist on Earth is located in the Main Belt, as shown in Fig. 1. Because of their relative ease of access, near-earth asteroids (NEAs) are ideal starting points for mining operations in comparison with other celestial bodies. However, the possibility of really utilizing these resources has appeared implausible for an extended period. The once fanciful "mining the sky" is now considered a real endeavor that is both feasible and difficult. There have been several high-profile start-ups whose stated mission is asteroid mining since the turn of the century: space-based materials, among them are Deep Space Industries and Trans Astra, Astro Forge, Karman+, Origin Space, and Helios [12, 27].

Asteroid mining missions have not been launched by the Indian Space Research Organisation (ISRO), India. Although asteroid missions were considered throughout the Indian subcontinental period, the necessary technological and infrastructural improvements are formidable obstacles to the practical implementation of asteroid mining. Among these goals is the improvement of transportation, resource extraction, and deep-space mission capabilities. The US and Luxembourg, for example, have passed laws to make commercial space mining easier [28]. As a possible model for India to follow, these rules give private corporations ownership of space-mined minerals [30]. India might gain from forming alliances and collaborating with other nations and commercial enterprises that are currently investing in space mining technology. There is a lot of room for growth in asteroid mining, even though India isn't currently doing much of it. India has the potential to access the immense resources in space if space technology and strategic planning continue to progress [11].

According to one NASA study, there may be more than six billion people living on Earth, and the material riches of the asteroids in the asteroid belt might be more than $100 billion for each of them [29]. The solar system is home to at least a million asteroids of this magnitude. It is possible that one of these asteroids contains 7,500 tons of platinum, 1.5 million tons of cobalt, and 30 million tons of nickel. Just the platinum would be worth over $150 billion [25].

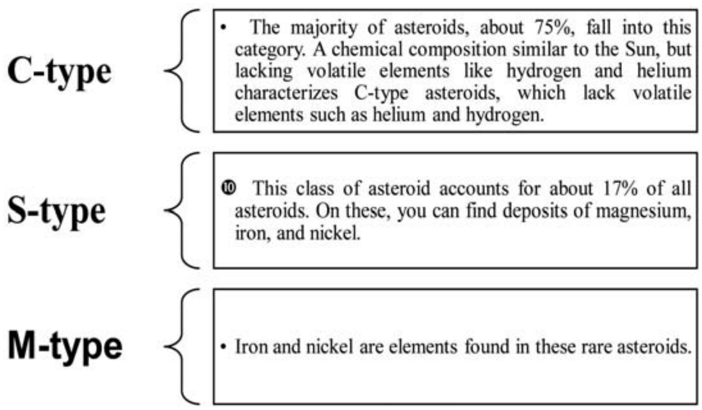

Figure 2. Basic categories of asteroids [25, 26]

3.1.1 Key developments in asteroid mining in India

A space mining initiative is being considered by the Indian Space Research Organisation (ISRO), which is looking into space research as a whole [30]. The Indian Space Research Organization (ISRO) has laid the framework for future endeavors with its advances in space technology and exploration, even though no particular asteroid mining missions have been declared. In order to facilitate space mining, India is investigating potential legal and policy frameworks. Like laws in the United States and Luxembourg, these talks cover space property rights and the commercialization of space resources. Technologies that would be essential for mining asteroids are now being developed by Indian academics and business enterprises, as given in Table 1 [14]. Included in this category are developments in robotics, automated mining software, and optical mining that make use of concentrated sunlight. In order to improve its space mining capabilities, India is also considering international partnerships. India could make more headway in this area if it forms partnerships with private space businesses and other spacefaring nations [31].

Table 1. Indian universities and companies involved in asteroid mining technologies [14]

Organization	Focus Area
IIT, Bombay	Space technology and robotics
IISc, Bangalore	Advanced materials and autonomous systems
MIT-ADT University, Pune	Asteroid prospecting and in-situ resource utilization
Big Dipper Exploration Technologies, Delhi	Modular and autonomous robots for resource extraction
Asteria Aerospace, Mumbai	Drone technology with potential asteroid mining applications
JS Mining Consulting, Andhra Pradesh	Innovative mining practices and extractive metallurgy

Possible disruption of celestial bodies, pollution from spacecraft and introduction of extraterrestrial elements are all potential environmental implications on Earth and space ecosystems. Mining in space could change the paths of asteroids, and on Earth, a flood of rare metals could drive up prices and force governments to enact policies for the responsible use of resources found in space [32].

Space resource exploitation, property rights, and benefit distribution must all be defined with precision [33]. To ensure the peaceful, equitable, and sustainable use of extraterrestrial resources, new agreements may be added to or modified to the Outer Space Treaty of 1967, which governs space activities. These agreements might address the specific difficulties and prospects of asteroid mining [32].

3.1.2 Asteroid extraction and processing

It will be significantly more cost-effective to establish a mining operation on an asteroid, which will require billions of dollars, than to transport materials from Earth to the Moon or Mars. The mining team, along with their equipment, would need supplies and food, which could only be transported by spacecraft. Landing on an asteroid should be feasible with newly built spacecraft that use less rocket power and fuel compared to a lunar mission [25].

While the exact shape of the first asteroid mine remains a mystery, the following are some reasonable guesses: In order to be transported to the asteroid, the machinery must be lightweight and fueled by solar energy. To reduce the number of workers required to complete the mining project, some advocated for the use of robotic equipment. A manned trip may use less food and other supplies if this were to happen [25].

For asteroid miners, the most probable approach would involve removing the material of interest from the asteroid and then penetrating its veins to retrieve it. To minimize fly-off, a big canopy might be utilized to catch the rich minerals that will float off the asteroid during scraping, also known as strip mining [25, 34].

By separating the water from the asteroid into hydrogen and oxygen, rocket fuel for a ferrying spaceship might be manufactured once a cargo is prepared to be transferred to Earth or a space colony [35]. Once the mining project has depleted an asteroid's resources and minerals, the machinery can be moved to the next target [25].

3.2 Moon Mining

Helium-3, titanium, rare-earth minerals, platinum-group minerals, and other important minerals can be found on the moon [36]. Because of its usefulness in nuclear fusion power plants, the abundant helium-3 on the moon is in high demand. Moon Express (https://moonexpress.com/) and Planetary Commodities (Planetary Commodities - EVE University Wiki) are two private enterprises that are dedicated to mining commodities like helium-3 and platinum. The lunar cold traps contain volatile materials that can be used for rocket fuel and life support. A robotic mining operation at Shackleton Crater has been conceptualized by the Massachusetts Institute of Technology (MIT), USA. Power plants, autonomous mining rovers, electrolysis cells, and fuel cells that regenerate themselves are all part of the blueprint. The regolith will be processed as part of the mining operation in order to recover oxygen and hydrogen, two significant minerals. Hyper-velocity accelerators and cable-bucket systems are among the potential ways that volatiles can be removed from the crater [12].

Mining on the moon entails harnessing the power of solar panels or lasers to retrieve volatile minerals. The regolith is collected and transported to processing sites by means of robotic mining rovers. While both batteries and fuel cells may store energy, the latter has a greater energy density. One alternative to traditional lunar mining methods is to use on-site resources and extracted water [37]. Commercial operations and a lunar settlement are detailed in the National Space Society's route map. The Chinese space program (Chinese Lunar Exploration Program - Wikipedia) has landed a rover on the moon and completed several lunar missions with success. Improving exploration and mining capabilities is part of China's mission to establish a permanent lunar settlement.

The plan is for robotic mining rovers to collect regolith material and bring it to centralized mining operations for processing and electrolysis of the water. The rovers will then get power from these operations. Powering the mining rovers will be a central processing facility on the floor of the Shackleton Crater, which will generate hydrogen and oxygen. Using lasers from one or more towers situated on the rim of the crater, energy will be created by the processing plant's electrolysis module, which contains a photovoltaic cell. Installed on the towers will be solar panels that can gather electricity, run a powerful laser, and use radio receivers to triangulate the positions of rovers inside the crater. Placing the towers such that they receive the most amount of sunlight is ideal [12].

3.2.1 Key Developments in moon mining in India

Chandrayaan-3 Mission

Landing a spacecraft near the Moon's south pole was a first for India on August 23, 2023. Lunar surface exploration and scientific experimentation, including the quest for water ice, are the goals of this mission. A better understanding of the lunar environment and the planning of future mining operations are made possible by the mission's equipment that measures the surface thermal characteristics and seismic activity [38].

Helium-3 Extraction

In 2030, ISRO intends to extract helium-3 from the moon's surface. Nuclear fusion, which might make use of the rare isotope helium-3, could provide an abundant and clean energy source. Helium-3 mining, according to ISRO-affiliated scientists, could one day supply all of India's energy needs [39].

Technological and Infrastructure Development

For the purpose of assisting lunar operations, India is concentrating on developing In-Situ Resource Utilization (ISRU) technologies that make use of native lunar minerals. The lunar regolith can be mined for its water, oxygen, and metal content. The lunar surface is known for its extreme conditions; therefore, engineers are developing rovers and autonomous robots, as shown in Figure 3, to handle activities including transportation, excavation, and drilling [40].

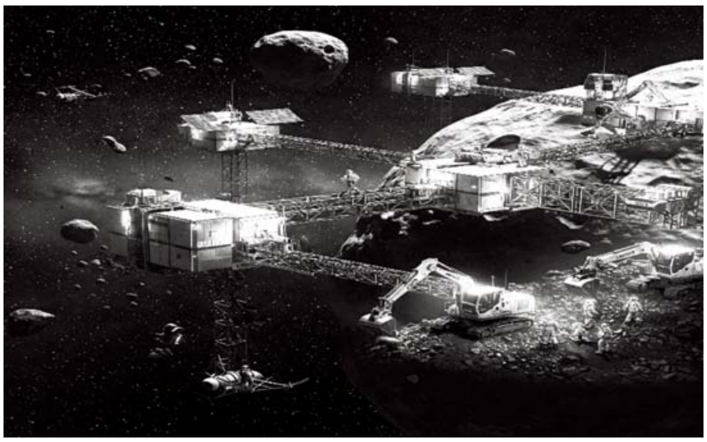

Figure 3. Future technological advancement in space mining (AI-created image)

3.3 Mars Mining

Magma and minerals formed by the erosion of lava make up the bulk of Mars' composition, making it an igneous planet at its core. These minerals are derived from basalt and include plagioclase feldspar, pyroxenes, and olivine. Gases like silicon, oxygen, iron, magnesium, aluminum, calcium, and potassium are abundant in the Martian crust. This planet has the elements that are essential for life: sulfur, phosphorus, sodium, boron, chlorine, and bromine. The chromite, magnetite, and ilmenite minerals are thought to be present in Mars' basalt dunes. They contain a fair amount of magnesium, aluminum, titanium, iron, and chromium. There have also been trace amounts of gold, tungsten, europium, copper, zinc, niobium, molybdenum, lanthanum, and cobalt [41, 42, and 43]. The extraction of basic materials from Mars's natural resources for use in manufacturing is known as mining. Martian minerals, ore, and frozen water make up the bulk of the raw materials brought back from the red planet. Atmospheric mining is a way to extract materials from the thin atmosphere [41, 44, and 45].

Strip Mining

A strip mine is the most effective way to recover resources when they are near to the surface of Mars. Mining involves removing the regolith layers that cover a resource in order to disclose its ore [41].

Dust Mining

Metallurgically rich Martian dust is dispersed across the entire planet by the wind. It is possible to extract silicon, sulphur, magnesium, calcium, oxygen, and other elements from it. It can be utilized to create bricks of varying grade through sintering or little additions, or even unmodified low-quality bricks. Eventually, every area where the wind blows dust could be a good site to mine. Larger communities may have a lower refill rate compared to the extraction rate [41].

Mangalyaan (Mars Orbiter Mission)

India became the first country to reach Mars on its first attempt with this mission, which launched in 2013. The study of Mars's surface and atmosphere was its primary goal. In the future, ISRO intends to send missions to Mars, such as Mangalyaan-2, which might include a lander and more sophisticated research equipment. ISRO, India's space agency, has proven it can send probes to other planets. Mines on Mars will not be possible until certain technologies, such as resource extraction systems and autonomous mining robots, are perfected.

Much like the Moon, Mars, especially near its poles, possesses vast stores of water ice. Human space missions may rely on this water, which may be used to produce fuel by splitting it into hydrogen and oxygen. Mars may contain a wealth of minerals that could be useful for space businesses in the future, such as iron, nickel, and maybe even rare earth elements. There would be less need to ship supplies from Earth if Mars could maintain self-sustaining communities through its mining resources. Sharing knowledge and resources in Mars mining is an area where India and other spacefaring nations and commercial enterprises could work together [31].

3.3.1 Key global developments in Mars mining

The Perseverance rover, which is presently gathering samples to be sent back to Earth, is one example of how NASA has been leading the charge in Mars exploration. Large-scale water mining operations are part of NASA's future plans to support human missions. The Mars sample return mission is a joint effort between NASA and the European Space Agency (ESA) with the goal of returning soil and rock samples from Mars to Earth for in-depth analysis.

A human colony on Mars is one of the lofty goals of Elon Musk's SpaceX. Starship, the company's spacecraft in development, will carry people and goods to Mars. This encompasses strategies for using resources on Mars to create fuel and other goods, often known as in-situ resource utilization (ISRU). The Tianwen-1 rover, operated by the China National Space Administration (CNSA), touched down on Mars in 2021. Extraction and use of resources are possible objectives for future Chinese expeditions.

Mars mining cannot proceed without significant advancements in automation, AI, and robotics. In order to drill, excavate, and process resources on Mars, these technologies are being developed to withstand the hostile environment. Moving forward with Mars mining requires international collaboration. In order to make Mars mining a reality, commercial enterprises and nations are collaborating to share resources, expertise, and data [46].

4. METHODS AND TECHNIQUES FOR EXTRATERRESTRIAL MINING

Using spacecraft to mine asteroids, the Moon or Mars for precious metals and other minerals is known as extraterrestrial mining. Some of the most important methods and equipment deployed in this emerging field are as given in Table 2.

5. INNOVATIVE TECHNOLOGIES FOR EXTRATERRESTRIAL MINING

In order to make resource extraction from asteroids more practical and efficient, a number of new technologies are being developed in the field of asteroid mining, as shown in Figure 3. A few of the most exciting new developments in technology are as given in Table 3.

6. DISCUSSION

The developments of autonomous robots and AI systems that can handle the rigors of space mining are pressing matters that need immediate attention. Radiation, microgravity, and temperature swings are just a few of the harsh space conditions that mining operations must contend with. It takes sophisticated sensors and investigation methods to correctly

Table 2. Methods and techniques for extraterrestrial mining [47, 48 & 49]

Methods	Techniques	Descriptions
Mechanical Excavation	Robotic Mining	The rovers and autonomous robots are engineered to work in challenging terrains, carrying out activities including hauling, digging and excavation. A wide variety of tools for breaking and collecting objects are available to these robots.
	Drilling and Blasting	Surface material can be broken up for easier collection using drilling and blasting procedures, similar to terrestrial mining.
Thermal Extraction	Solar Heating	It is possible to facilitate the extraction of precious components by heating and vaporizing materials using concentrated sun radiation. Water ice extracted from the surface of the moon or Mars is an ideal candidate for this technique.
	Microwave Heating	Materials below the surface can be heated to the point where they sublimate or melt when exposed to microwaves. Volatile substances, like water, can be successfully extracted using this method.
Chemical Extraction	Leaching	In order to extract certain minerals from the ore, chemical solvents might be employed. As an example, research on the solubility of metals in meteorite samples has focused on deep eutectic solvents.
	Catalytic Dissolution	The process entails dissolving materials and extracting metals through chemical reactions. As an example, one study showed that metals from meteorite proxies[2] could be extracted using a deep eutectic solvent including iodine and iron (III) chloride.
Biomining	Microbial Leaching	Bioleaching is a method that uses microorganisms to remove metals from ores. This technique has possible uses in space and is being utilized on Earth to extract gold and copper.
	Biomining	The utilization of microorganisms allows for the extraction of valuable components from materials found on other planets. This method makes use of microorganisms' inherent mechanisms to decompose minerals and liberate metals.
Physical Separation	Magnetic Separation	By applying a magnetic field, it is possible to distinguish between metallic and non-metallic particles. Iron and nickel may be extracted from asteroid material using this process.
	Density Separation	By creating density gradients in liquids, methods such as sonic streaming can aid in the separation of components of varying densities.

Table 3. Innovative technologies for extraterrestrial mining [14, 23, 30, 47, 48]

Technologies	Area	Descriptions
Autonomous Drones	Mapping and Exploration	Asteroid mapping, lucrative area identification, and first extraction operations can all be accomplished by autonomous drones. These flying robots can navigate the hazardous space environment and increase the scope of exploration.
Optical Mining	Solar Energy Utilization	In optical mining, minerals from asteroids are heated and fractured using concentrated solar energy. Water, oxygen, propellant, and shielding materials can be extracted from regolith, asteroids, and boulders in microgravity using this procedure.
	In-Situ Resource Utilization (ISRU)	The use of optical mining reduces the expense and increases the efficiency of returning resources to Earth by processing them immediately on the asteroid.
Catalytic Dissolution	Deep Eutectic Solvents	This method entails dissolving metals from meteorite proxies of metal-rich asteroids using deep eutectic solvents. A lot of precious metals, such as platinum and gold, can be extracted using this process.
	Chemical Processing	Asteroid materials can be efficiently processed by catalytic dissolution, making it a potential option for space metal extraction and refinement.
Advanced Robotics	Robotic Miners	Duties like digging, excavating, and material handling are within the capabilities of robots outfitted with sophisticated sensors and tools. Space is a hostile environment, yet these robots are built to handle it on their own.
	AI and Machine Learning	Using algorithms for artificial intelligence and machine learning, these robots can adjust to new environments and improve their performance to the fullest extent possible.

detect and evaluate the make-up of heavenly bodies. It will take major technology developments to process and use extracted materials in space efficiently [50].

International treaties and national regulations must be harmonized to provide a framework that governs the extraction and ownership of resources from space. This framework is continuously emerging. Avoiding disputes and ensuring fair access to space resources requires the establishment of unambiguous legal frameworks for their ownership and utilization. For space exploration to be sustainable, it is crucial that mining operations do not interfere with scientific study or cause harm to celestial bodies [47, 50, and 51].

Everything from research and development to transportation and infrastructure adds up to astronomical starting expenses for space mining companies. A stable market for space resources and the capacity to compete with terrestrial sources are crucial to the economic feasibility of space mining. Because space is so dangerous and unpredictable, it is of the utmost importance that astronauts and anybody working in space mining activities stay healthy and safe. Equal distribution of resources and the possible impact on indigenous celestial habitats are two of the most pressing social and ethical concerns surrounding space colonization. A major obstacle to economic viability is the present high cost of launching and running space missions. It takes a lot of time and money to develop and test new technology for space mining [52 & 53].

A new source of wealth and an accelerator for economic expansion might be the enormous quantities of precious minerals in space. The expansion of space mining has the potential to give rise to brand-new economic sectors, such as the space tourist, building, and manufacturing industries. Space mining is a formidable industry that pushes technology to new limits, which in turn benefits other sectors on Earth. One way to encourage sustainable growth and lessen the burden on Earth's resources is to use resources from other planets. By producing necessary materials and laying the groundwork, mining activities can bolster space exploration efforts.

By bypassing Earth-based transportation altogether, space mining enables the direct extraction of vital resources from space. The ability to build homes and support human existence depends on these resources, which include water, metals, and construction materials. Hydrogen and oxygen, two ingredients necessary for rocket fuel, can be extracted from lunar or Martian water ice. This has the potential to lower the cost of missions while allowing for more space exploration. The space and terrestrial industries can both benefit from the investment and technological innovation that space mining has the potential to bring about, due to its high profitability. Reduced environmental deterioration and increased sustainability can result from using materials sourced from space rather than Earth's limited resources. To reduce waste and increase sustainability, space colonies can create closed-loop systems that recycle and reuse resources continuously.

6.1 Implications

Rare earth elements, gold, platinum, and other precious metals and minerals could be mined in space, opening the door to new technological advancements. India's space mining ambitions have far-reaching technical, geopolitical, and economic consequences. It might provide India with a steady supply of essential resources and lessen its reliance on imports by opening the door to precious metals and rare earth elements. Robotics, autonomous systems, and resource extraction technologies have the potential to elevate India's space capabilities and establish the nation as a frontrunner in space innovation. In terms of geopolitics, space mining is an opportunity for India to increase its clout in global space governance while also promoting collaboration in STEM (Science, Technology, Engineering and Mathematics) fields and the military. The world's economy might undergo a radical shift if space mining were to become a commercial enterprise, giving rise to a plethora of new enterprises, occupations, and possibilities. One possible solution to resource depletion and environmental deterioration is space mining, which would reduce the need to use Earth's limited resources. Space exploration and colonization of other planets may be possible with the help of commodities retrieved from space, such as water and oxygen.

7. CONCLUSIONS

Resources like helium-3 and minerals like potassium, rare earth elements, iron, platinum group minerals, and more can be mined from the Moon, Mars, and the asteroid belt, among other solar system bodies. Policymakers might benefit from a thorough examination of space mining's technical, economic, and legal hurdles, which would allow them to zero in on critical areas for intervention. It might help universities and other research organizations adapt their curricula to meet the growing demands of the space mining industry. The findings may help the Indian government decide how to best fund space mining projects. In order to boost India's strengths in this area, it could be useful in locating possible overseas collaborations and partnerships.

Extraterrestrial mining has the power to greatly facilitate and quicken the process of space colonization by supplying vital minerals, boosting the economy, and fostering sustainability. On the other hand, there are major ethical, legal, economic, and technological issues that need fixing. To ensure the viability and longevity of future space colonies, it is crucial that appropriate and sustainable space mining procedures are developed as mankind continues to explore and expand into outer space. It has the potential to help shape India's space exploration and resource utilization strategy for the future in a way that is in line with both international and domestic aspirations. This article has the potential to provide the groundwork for India's position on space resource usage in global forums, where it may promote policies that are fair and inclusive.

People may see the extraction of resources from space as an extreme display of greed on the part of various economic actors, which could lead to hyper-capitalism if only a select few nations and corporations were able to reap the benefits of these resources. Space resources may be considered as a way to maintain the current economic model—constant economic expansion and human exploitation of the geo- and biosphere—in spite of rising worries about the model's viability in the face of Earth's finite resources.

8. FUNDING

No funding.

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OBITUARY

Shri. V. Krishnamurthy
(LM-1372/BAN)
08 August 1937 – 18 November 2025

Born in Bangalore on 8th August 1937, V. Krishnamurthy dedicated 45 years of his life to the mining profession, serving it with quiet strength, integrity, and unwavering commitment. He passed away on 18th November 2025, leaving behind a legacy that extends far beyond his professional achievements.

During his long association with Trafalgar House Construction (India) Ltd., he worked at Kolar Gold Fields (Karnataka), coal mining operations in Dhanbad (Jharkhand), and Zawar Mines (Udaipur, Rajasthan). He was deeply respected for his technical skills, meticulous approach, and strong emphasis on safety. More importantly, he was valued for the guidance he offered, the patience he showed, and the trust he earned from those who worked with him.

A man of humility and discipline, he led by example and believed in doing his work thoroughly and responsibly. His presence brought reassurance to worksites and confidence to teams. He is an active MEAI member of the Bangalore chapter. His passing is a profound loss to the mining community.

MEAI prays for the Sadgati of the departed soul and offers condolences to his family members.

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WORKSHOP ON CRITICAL MINERAL PROCESSING HELD AT NEW DELHI

Date & Venue: 19 October 2025 I The Energy and Resources Institute (TERI), India Habitat Centre, New Delhi

Topic: Workshop on Critical Mineral Processing

Virtual Participation: Microsoft Teams

The Indo-German Energy Forum Support Office (IGEF-SO), The Energy and Resources Institute (TERI), the German Federation of International Mining and Mineral Activities (FAB), and ICF International jointly organized an in-person workshop on Critical Mineral Processing to explore areas of mutual interest and potential Indo-German collaboration in strengthening critical mineral value chains in India.

With the launch of the Indian Critical Minerals Mission, India has a unique opportunity to strengthen its refining and processing capabilities and reduce import dependence. The workshop served as a strategic platform to deliberate on avenues for Indo-German cooperation in critical mineral processing and value-chain development.

The workshop featured insightful presentations on:

- Opportunities and Technological Bottlenecks in India's Critical Mineral Processing Landscape, by Mr. Archit Garg, ICF International
- International Mineral Partnerships for Industrial Transformation, by Dr. Martin Wedig

The meeting was chaired by Shri Anshoo Pandey, Director, National Critical Mineral Mission, Ministry of Mines. He deliberated on key policy interventions undertaken by the Government of India, highlighted initiatives under the National Critical Mineral Mission to support India's critical mineral roadmap, and emphasized the importance of active collaboration among industry stakeholders to achieve self-reliance in the sector.

The workshop concluded with a panel discussion that focused on the need for transparent and internationally benchmarked mineral resource and reserve reporting for critical minerals. Participants emphasized that such reporting is essential to meet global standards relied upon by international investors for informed decision-making. Dr. P. V. Rao, Co-Chair, NACRI, who participated virtually, outlined the current status of resource reporting in India under the MEMC Rules. The Panel Members, including Mr. Pankaj Sinha,

Managing Director, DMT Consulting Ltd, UK, strongly advocated the adoption of CRIRSCO-compliant reporting frameworks, such as the Indian Mineral Industry Code (IMIC), as a crucial first step toward building investor confidence and encouraging greater participation in India's critical minerals development journey.

By Dr P.V. Rao

(Continued from Page 14)

The disillusionment we're seeing now isn't the end of AI in mining and mineral exploration. It's the painful but necessary process of learning which tools solve which problems. An unmet expectation or failed hole, should not mean you should stop exploring the application of AI toolsets.

- **Mines ministry notifies new royalty rates for 4 critical minerals**

  The Union Cabinet earlier this month approved rate rationalisation for the four minerals to boost domestic production and facilitate their auctions

The mines ministry on Friday notified new rationalised royalty rates for four critical minerals: Caesium, graphite, rubidium and zirconium. Graphite will attract ad-valorem royalty rates, moving from the per tonne royalty in effect since September 2014.

Graphite was the only critical and strategic mineral whose royalty rate was specified on a per tonne basis. The shift to ad valorem royalty is in line with the huge variations seen in graphite prices across grades.

(Continued on Page 29)

I-RARE EARTHS: A NEW FACET IN THE EXPLORATION/EXPLOITATION OF REE MINERALS-A WAY FORWARD IN INDIA

G. Lakshminarayana and K. Raghava Reddy

Abstract

'i-rare earths' (ionic rare earths) were first discovered in the Jianxi province of China in 1969 and are different from the conventional hard rock ores. The i-rare earths are exogenous geomorphology-controlled deposits formed in soil regoliths of tropical/subtropical climates, easy to mine out and extract. These deposits are under active exploitation in eastern Myanmar and South China but have attracted worldwide attention in recent years. The Chinese domination in rare earths owes a great deal to the ionic rare earths, which are rich in critical heavy rare earths and also neodymium (Nd) and praseodymium (Pr), used in the preparation of heavy rare earth magnets used in modern green technologies. Mineralization controls are illustrated. Although some information is available on the current awakening of ionic rare earths and also on ongoing research in Australia, the USA, Vietnam, Brazil, and Madagascar, very little is known about this type of deposit in India. Therefore, this communication provides a brief account of ionic rare earths in the context of tropical India.

1. INTRODUCTION

With the rapid advancement in clean energy technologies such as electric vehicles, wind turbines, defense applications, smartphones, and computer hard devices, the demand for rare earths has gone up by leaps and bounds in recent times. Rare earth elements are used as vitamins in the making of electric and mechanic gadgets along with other metals for enhancing the efficiency and functionality of modern machines.

A series of 17 metallic elements with atomic numbers 57 to 71 (lanthanoids), besides scandium (21) and yttrium (39), is included in rare earths (REEs), which are also considered as critical minerals on the grounds that these are critical in modern technologies. Contrary to the general belief, these elements are not rare but ubiquitous in different layers of the earth and localized. Based on sulfate solubility, the REEs are categorized into three types, viz., LREE, MREE, and HREE. They are LREE (lanthanum-La, cerium-Ce, praseodymium-Pr, and neodymium-Nd); MREE (samarium-Sm, europium-Eu, gadolinium-Gd, terbium-Tb, and dysprosium-Dy); and HREE (holmium-Ho, erbium-Er, thulium-Tm, ytterbium-Yb, lutetium-Lu, scandium-Sc, and yttrium-Y). China is the leading producer of REE, which accounts for almost 50% of global resources, while the remaining resources are shared by Brazil, India, Australia, Russia, Vietnam, the USA, Greenland, South Africa, Tanzania, and Canada. Of these, India contains only 7.7% of global REE resources. However, China, with its robust resource position and technological superiority in mining and refining capacity, accounts for ~60% of global REE production, supply, and trade (Liu et al., 2023).

2. REE ORE DEPOSIT TYPES

REE ore deposits may broadly be categorized as a) hard rock-based conventional ores and b) soft rock ores of ion adsorption type.

3. PRODUCTION CENTRES

3.1 Conventional ores

There are about 146 REE projects (including advanced projects and active mines) in the world. These projects contain a total of 303.4 million tons of REOs (Liu et al., 2023). These REE resources are mainly contained in five types of rocks: carbonatite, alkaline rock/alkaline granite, IOCG/hydrothermal, and placers. The tonnage and grade of the deposits vary significantly, and the distribution is highly heterogeneous. Several giant deposits account for over half of the total resources. The Bayan Obo deposit in north China alone contains 33% of the world's total resources, followed by the Olympic Dam, Australia (20%), Lovozersky, Russia (2.4%), Mountain Pass, U.S. (1.4%), and Mt Weld, Australia (1.0%) (Liu et al., 2023). These hard ore deposits usually have large tonnages yet low grades of REE resources.

3.2 Soft rock ores (i-ree type)

The soft rock ores are exogenous and hosted in regoliths/soil. These deposits were first discovered in Jiangxi province of south China in 1969. The follow-up intensive research for four decades by the dedicated exploration teams has culminated in the identification of more than 200 i-ree (ionic rare earth element) deposits spread across the provinces of Guangxi, Guangdong, Fujian, Hujian and Hinan of southern China, whose area-wise resource account is furnished by Chi and Rian (2008). Distribution of i-ree production centres located

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along the fringes of the eastern Myanmar and adjacent south China are shown in Fig.1. The known reserves of ion-adsorption rare earth element (i-REE) deposits (weathered crust elution–deposited rare earth ore in China alone is over $1x10^6$t (REO) and among which the HREE reserve constitutes over 80% of the world total heavy REE reserve. The current annual production of i-ree ore in China is of the order of about 1×10^4 t concentrate (REO >60%) from this ore annually and thus now stands in a commanding position in the supply and trade across the globe (Luo et al 2022).

Fig. 1. i-ree mining areas in Myanmar and South China relative to the position of India (data extracted from Wang et al., 2018; Zhu et al., 2022; and ISP Myanmar 2025). Please note latitudinal position of India in relation to Myanmar and South China

It is disheartening to note from Fig. 1 that India, being located in the same tropical latitudes as South China and Myanmar and having a plethora of granitic, alkaline, and volcanic rocks, does not find a place in the i-ree deposits map of the world due to paucity of published information. However, a recent update by Krishnamurthy (2024) mentions some possible i-ree localities at Nongpoh granite (Sadiq et al., 2014) and also in parts of the eastern Dharwar complex (Reshma et al., 2022). The aim of the present communication is to draw the attention of the Indian exploration scientists to this important type of REE deposit and its operating processes for the benefit of Indian exploration geologists and mining engineers to move forward on the subject.

4. MINERALISATION CONTROLS (CHI AND TIAN, 2008; PENG, 1991; CHEN ET AL., 2020; AND SANEMATSU AND WATANABLE, 2016)

The original Chinese name of the i-ree deposits is the exogenous weathered crust elution-deposited rare earth ores developed over weathered granite or volcanic tracts in hilly tracts over long periods of geological time. Peculiarities of these deposits are that they span over large areas, are easy to explore, are easily mineable at shallow depths, and have a low radioactive nature. Other controls are:

4.1 Geographical factors

Development of weathering-related i-ree deposits is controlled by warm climate in tropical and subtropical climates, where soil profiles at places attain up to ~30 m thickness. In such a profile, the mineralized ore zones are found at the contact between partly weathered rocks and soils (Fig. 2) along the hill slopes. Thus, an understanding of tropical soil/regolith development is the prime geological control in the location of i-ree deposits.

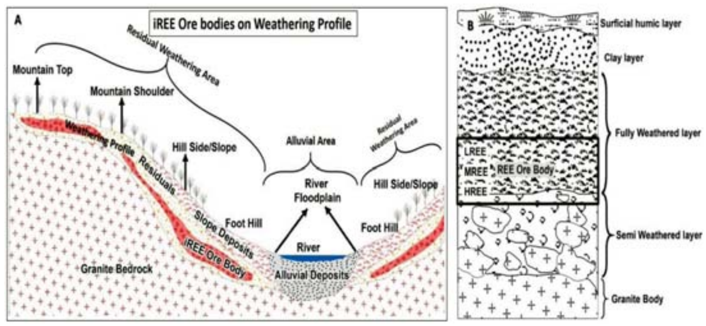


Fig. 2 A Generalised sketch showing i-ree ore body in hilly region (Modified after Zhu et al, 2022) B) Partitioning of i-ree ore body in soil regolith (simplified after Zhu et al, 2022)

4.2 Age of the host rocks

It is an empirical observation that the geological age of the host rocks ranges from Palaeozoic to Tertiary leucogranite, alkaline rocks, or volcanic terrains.

4.3 Colour of Ores

The weathered crust elution-deposited rare earth ores are yellow, pale red, or white sand/clay, which can be dug manually and easily explored by auger drilling or shallow, easily penetrable drill pipes (Wang et al., 2018).

4.4 REE grade

The grade of raw i-ree ore is generally low, in the range of 0.05%-0.3% of REO (RE oxides), and the ionic phase ratio fluctuates between 60% and 90% in different mining areas. Rare earth molecules are segregated in ore granules of the size of -0.78 mm along with kaolinite and halloysite.

4.5 RE partitioning

From the angle of RE partitioning on the weathered crust elution-deposited rare earth ore, the content of heavy rare earth increases gradually from the earth's surface to underground. Rare earth partitioning of each mining area has notable characteristics and differences, e.g., LREE—La and Ce rich in the upper part of the ore profile; MREE rich in the middle part; and HREE accumulations in the lower part of the ore profile (Fig. 2B).

4.6 Low radioactivity of raw ores

The content of radioactive elements in the weathered crust elution-deposited rare earth ore is extremely low. And the radioactivity value of mixed rare earth oxides is lower than that of the Chinese hard rock ores by any Chinese standards (2 ~7 x 104 Bq/kg).

4.7 Ore beneficiation

The ion adsorption ores do not require crushing, grinding, or mineral processing, and REEs are easily extracted by ion- exchange using a dilute electrolyte solution, such as ammonium sulphate solution at room temperature this metallurgical process enables mining of low-grade ores.

4.8 Ion adsorbed type

Rare Earth Element deposits produced by sedentary weathering processes include ion adsorption type and residual (placer) REE deposits. The difference in these deposit types is whether the REEs are adsorbed on weathering products (clays) .

4.9 Adsorption-desorption process

The characteristic feature of ionic REE deposits is that the ore elements (REE) are adsorbed onto the surface of alumina silicate minerals (e.g., kaolinite, illite, halloysite, and smectite) (Chen et al., 2020). The deposits containing adsorbed lanthanides (REE) are the result of in situ lateritic weathering of REE-rich host rocks during geological periods by supergene processes. This process leads to the formation of fine particles of alumina silicate clays, which have the capability of adsorbing lanthanide ions released/solubilized onto the clays (Fig. 3). Although the clay deposits containing adsorbed lanthanides are substantially lower grade than other types of conventional REE ore sources, the lower grade is largely offset by the easier mining and processing costs and the very low content of radioactive elements such as U and Th. It has the characteristics of shallow ore body coverage, soft ore, and very fine grain size. The 80%–90% REE is in the state of positive hydrated ions adsorbed on the surface of clay minerals such as kaolinite, halloysite, and illite (Fig. 3).

Because the REE in the ore mainly occur in the state of hydrated ions adsorbing on the surface of clay minerals, which can be effectively extracted by the ion-exchange method during the leaching process. (Luo et al., 2022) The adsorbed REE ions are not dissolved in water or ethyl alcohol, but they are dissolved in the electrolyte solutions of NaCl (sodium chloride), (NH) SO (ammonium sulfate), and NH Cl (ammonium chloride) by ion exchange. The percentages of REE in different phases of i-ree ore are aqueous phase 6 to 8%, ion exchangeable phase 80-84%, colloidal phase 4 to 5%, and mineral phase 9-13% (Chi and Tian, 2008).

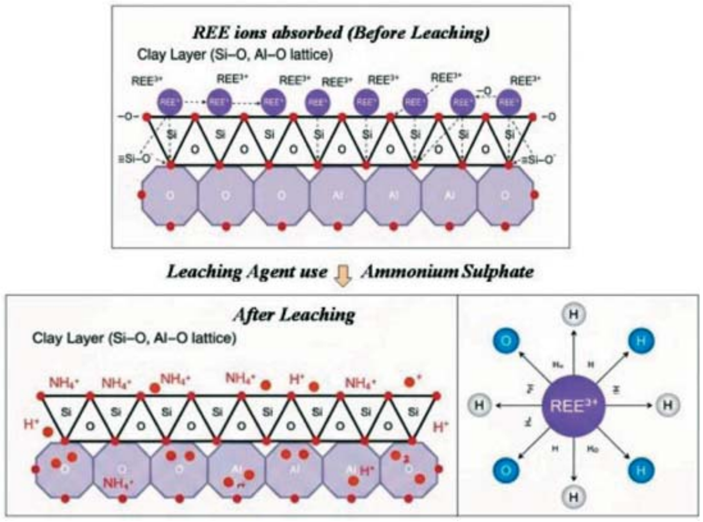


Fig. 3 A sketch showing the adsorption of REE ions on the surfaces of alumina-silicate minerals (weathered clay) and their B) interaction with hydrogen/hydroxyl ions (desorption) (simplified after Luo et al., 2022).

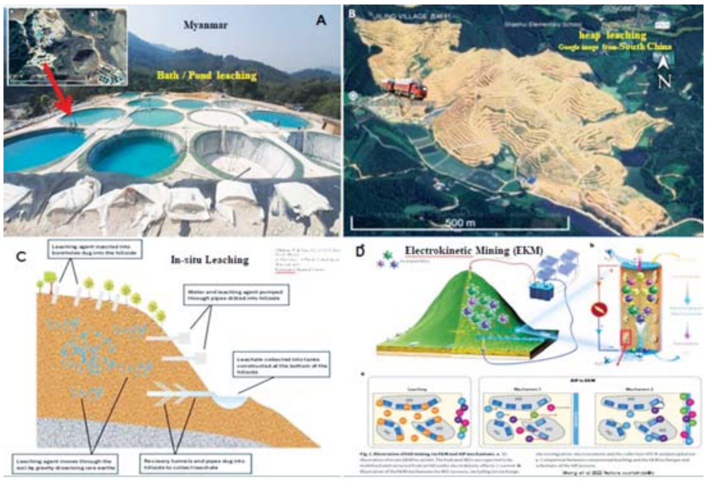
Until the 1970s NaCl was used as the leaching solvent to dissolve REE by ion exchange. This process required high solvent concentration and long leaching time. Moreover, the solvent consumption and processing cost were high, and the grade of RE concentrate can only reach 70% REO. Since the 1980s, (NH) SO has been used in place of NaCl as the solvent, due to which the high grade (REO 92%) of RE concentrate has been achieved.

5. EXTRACTION (MINING) METHODS

The REE extraction is done by spot leaching or heap leaching. The spot leaching process is usually run in a cement bath (see Fig. 4A) with a volume of about 10–20 m^3. When the bath/tub is filled with the ore to the depth of about 1.5 m, the solvent of (NH) SO solution with the concentration of 1–4% is poured through the ore for leaching at pH 4 to 5 (Fig. 4A) (Chen et al. 2020).

Fig. 4 A) i-ree mining & extraction by spot leaching using circular baths in Myanmar; B) i-ree mining of the weathered crust on contour pattern in hilly tracts of South China (Images extracted from Google satellite imageries available in public domain as the access is denied to general public); C) on-site leaching on ore dumps using solvent pipes D) Electrokinetic Mining. (After Zhu et al., 2022)

The pregnant solvent is obtained at the bottom of the bath (Fig. 4A). Oxalic acid is used as the precipitant to get the mid-product of oxalic acid–rare earths and further processed by calcination to get the final rare earths product (>REO 92%). Another method is heap leaching, where the weathered regolith is mined out by making contour bunds or contour mining in hilly areas. The scooped-out heaps are transported to nearby areas for heap leaching (Fig. 4B). This method is widely practiced in South China (for details, see Wang et al., 2018). Heap leaching in situ and electrokinetic mining methods are shown in Figs. 4C & 4D. The in-situ leaching process, also called solution mining, was studied from the 1980s to resolve the ecological environmental problems in the exploration by the bath leaching technology. The wells are drilled in the natural ore body, and the leaching reagent is injected. REE ions were selectively leached. Collected leachate is precipitated by the solution of oxalic acid or ammonium bicarbonate to obtain rare earth oxide products.



6. EXPERIMENTAL DEVICE AND FLOWSHEET

In this experiment, the rare earth ore samples were fully mixed evenly, and the quartering method was adopted for sampling. Each group of 250 g ore samples was weighed into the leaching column, and the surface was lined with filter paper to make the leaching agent seepage even. The formate salt solutions with different concentrations were added into the column slowly according to the liquid-solid ratio of 2:1 through the controlled leaching device (after Chen et al., 2020). The flow sheet of the extraction technique is shown in fig. 5B (after Li & Yang, 2014).

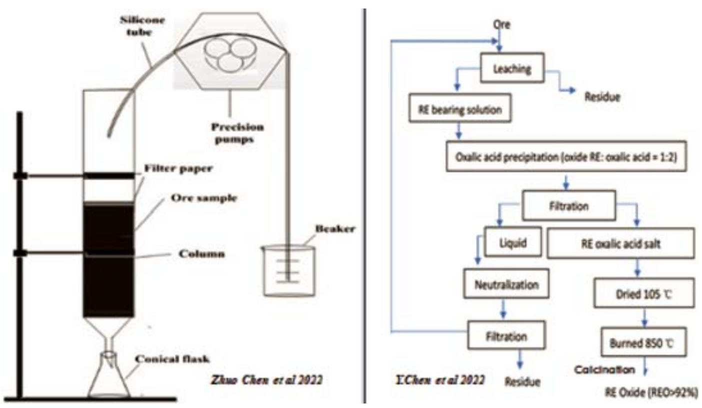


Fig. 5 A) Basic leaching apparatus on laboratory scale, B) Flow sheet for ore recovery

7. ENVIRONMENTAL IMPACT

With the increased exploitation of the ionic REE deposits in the soil profile, the ore grades and tonnages become depleted; thus, there is an upsurge in exploitation or extraction costs. Contamination of local water resources near the mining sites with NH -N (ammonium nitrogen) is an issue and has serious health concerns for the local people in surrounding mining areas.

8. ENVIRONMENTAL MANAGEMENT

The in situ leaching process, also called solution mining by bath leaching, was studied from the 1980s to resolve the ecological/environmental problems during the bath leaching technology. The wells are drilled in the natural orebody, and the leaching reagent is injected. REE ions were selectively leached. The leachate thus collected is precipitated by the solution of oxalic acid or ammonium bicarbonate to obtain rare earth oxide products. The water is recycled. It was reported that two key technical problems must be solved during the in situ leaching process. One is how to avoid the leaching reagent solution spreading around the wells to restrict the environmental pollution, and the other is how to recover the leachate so as to optimize the leaching rate through boreholes along the hill slopes (Meehan and Dan 2024). The technology has been utilized in Wenfeng, Jiangxi province. This basic research method should be perfected by the Indian scientists to speed up the exploration for this invaluable i-ree resource.

Further research should be focused on the following aspects, like on-site leaching technology, leaching solutions, mechanical leaching, and mathematical modeling (Sobri et al., 2024).

9. PROBABLE TARGET AREAS FOR I-REE IN INDIA

India is endowed with vast stretches of granitic and volcanic terrains whose geochemical and REE information is published by many a worker and is available in annals of the Indian geoscientific literature, which should be relooked for the identification of probable i-ree target areas in the light of i-ree attributes presented in this note.

10. CONCLUSIONS

The topic of i-ree (Ionic REE) has attracted worldwide attention due to increased demand of rare earths in the emerging green technology and also due to restrictions imposed by China on REE supply and trade, particularly HREE, on geopolitical considerations.

The ionic rare earths were first discovered in China in 1969 in soil regoliths as exogenous, geomorphology-controlled ore deposits that are easy for exploration and extraction and have a low content of radioactive elements with little impact on the environment. Mineral exploration controls were presented. Mining methods are outlined. Basic aspects of ore extraction, ore treatment, and flowsheets are presented.

India, being a tropical country occupying the same latitudinal positions as Myanmar and South China and also of similar geological diversities as in East Asian production areas, offers immense scope for locating and developing i-ree deposits for the benefit of India.

11. ACKNOWLEDGEMENTS

The present note has been conceived on the basis of the English versions of Chinese publications available in the public domain and also on the reconnaissance visits of Sri K. Raghava Reddy to I-REE mining areas in Myanmar. The senior author is engaged in the study of possible i-ree localities in India. Adsorption/desorption processes of lanthanide elements on weathered regolith clays are in the experimental stage in the laboratories of Midwest Energy Limited. There is no conflict of interest in between the authors Sincere thanks are due to Sri. Y.V. Rathaiah, Scientist (G) (Retd) Atomic Minerals Directorate for Exploration and Research, and Sri. K.V. Krishnamurthy, who read the manuscript and offered valuable suggestions for improvement in the presentation. S/Sri. M. Subhakar, geologist, and M. Manikanta, chemist, rendered valuable help in the preparation of this geological note. Encouragement received from Dr. P.V. Rao, Chief Editor of the Mining Engineers' Journal is acknowledged.

Note: This topic has been presented in the Industry Conclave organized by CSIR-NML at Chennai on 09-10-2025.

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(Continued from Page 24)

The Union Cabinet earlier this month approved rate rationalisation for the four minerals to boost domestic production and facilitate their auctions. The Cabinet's decision followed the government's sixth tranche of critical mineral auctions, announced on September 16, which includes five graphite blocks, two rubidium blocks, and one each of caesium and zirconium.

The rate rationalisation will ensure that royalty accruals in different grades would proportionately reflect the changes in the prices of the mineral. It will unlock better value for the four resources and associated critical minerals, such as lithium, tungsten and niobium.

Saket Kumar, BS, New Delhi | Nov 28 2025

➤ India's New Earthquake Zonation Map by Bureau of Indian Standards

India has released a revised Seismic Zonation Map under the updated Earthquake Design Code (BIS, 2025) based on faults, maximum likely events, attenuation, tectonics, lithology, etc.

Details of New Zonation

- Number of Zones: Earlier, the Indian landmass was demarcated into four earthquake zones, namely Zones II, III, IV, and V.
  - Introduces new highest-risk Zone VI, placing the entire Himalayan arc under it for the first time (previously split between Zones IV and V).

(Continued on Page 43)

MEAI SENIOR CITIZENS' WELFARE SCHEME - BENEFITS

The Mining Engineers' Association of India (MEAI) is a society established under the Societies Registration Act, 1860, and has been functioning since 1957, inter alia achieving the following objects:

- To protect the interests of mining engineers, geologists, and allied professionals connected with mining and mineral industries in India and to improve their social and intellectual position/status in their profession.
- To raise and collect funds for general purposes or any specified objectives and to invest and disburse the same in a manner conducive to the attainment of objectives referred to in the objects of the Association or for which the fund was specially created.
- To accept any request, gift, donation, endowment, or subscription or to accumulate and provide any fund or endowment to invest the same and apply the income arising therefrom or to resort to the capital thereof for any of the objectives of the Association.

ELIGIBILITY

MEAI Life members/Fellow members/Honorary members who are above the age of 65 years and not in active employment/service and are living in total neglect and in penury are eligible to opt for the Scheme. The beneficiaries of the 'Scheme' should have been life members/fellow members/honorary members for a minimum period of 10 (ten years) to become eligible for the 'Scheme.' The President & the Committee shall from time to time modify the eligibility criteria depending on the situation prevailing at a given time.

For other details, please visit our website, meai.org, in which the complete bylaws governing the scheme is posted.

Persons to be contacted:

1. Respective Chapter Chairmen & Secretaries
2. Secretary General

MEAI SENIOR CITIZENS' WELFARE SCHEME

NEW COMMITTEE MEMBERS

S. No	Name	Position
1	Shri. D.B. Sundara Raman	Chairman
2	Shri. Sanjay Kumar Pattnaik	Advisor
3	Shri. Dhananjaya G Reddy	Vice Chairman
4	Shri. M. Narsaiah	Secretary
5	Shri. B. Sahoo	Treasurer

MEMBERS

S. No	Name
1	Shri. V.S. Rao
2	Shri. T. Victor
3	Shri. Arun Kumar Kothari
4	Shri. K. Madhusudhana
5	Shri. S. N. Mathur
6	Dr. P. V. Rao
7	Dr. Pukhraj Nenival
8	Dr. T. N. Venugopal
9	Shri. Pankaj Kumar Satija
10	Shri. Vinay Kumar
11	Shri. Sanjeev Kumar Sinha
12	Shri. Sabyasachi Mohanty
13	Shri. Swagat Ray
14	Shri. A R Vijay Singh

MEAI NEWS

MEAI HEADQUARTERS

MEAI Professional Development Program (MPDP – VI) Highlights 6-11-2025 to 29-11-2025

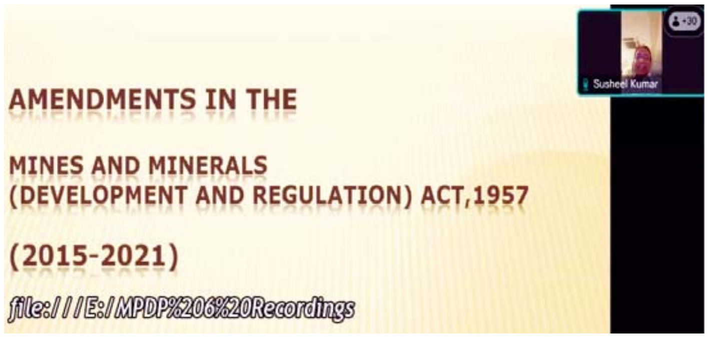
The MPDP-VI Program featured an impressive lineup of 23 expert-led sessions delivered by 15 distinguished faculty members from leading institutions and industry bodies. The sessions covered a wide spectrum of crucial mining topics, impacting the mining sector. The diverse knowledge contributions enriched participants with both technical depth and practical industry perspectives. Overall, MPDP-VI successfully bridged learning, leadership, and innovation through its comprehensive topic coverage and renowned faculty panel.

In the 6th series of MPDP training, there are 33 participants from the mining and mineral industries, including NMDC Ltd, Tata Steel Ltd, Vedanta Ltd, MSPL-Baldota Group, ERM Group, BGR Mining & Infra Ltd, Karnataka State Minerals Corporation Limited (KSMCL), JSW Steel Ltd, Rai Bahadur Seth Shreeram Narasingdas Private Limited (RBSSNPL), and other individuals.

Glimpses of the program:

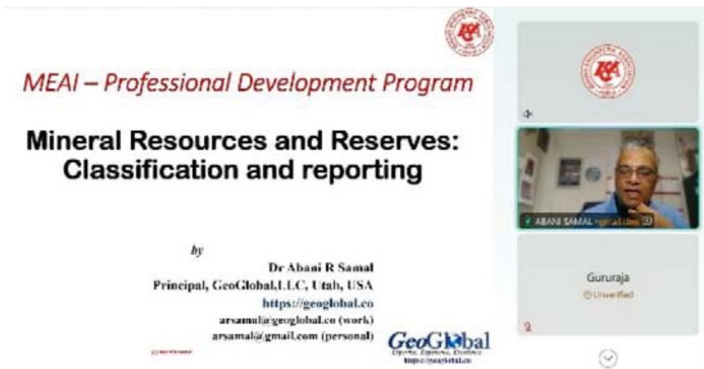
The Inaugural Program of the MEAI Professional Development Program (MPDP-VI) was held virtually on 6th November 2025, with participation from leading mining organizations across India.

Shri. M. Narsaiah and Shri. K. Madhusudhana highlighted the journey, legacy, and industry relevance of MPDP. Chief Guest Shri. Vinay Kumar appreciated MEAI's efforts and emphasized leadership development, practical learning, and sustainable mining practices. Shri. D. B. Sundara Ramam underscored mining's role in nation-building, innovation, and sustainability, urging young professionals to lead with curiosity, collaboration, and integrity. The Vice Presidents, Shri. Dhananjaya G. Reddy, VP-I, and Dr. Pukhraj Nenival, VP-II, emphasized interactive learning, knowledge sharing, and continuous skill development within the mining fraternity.



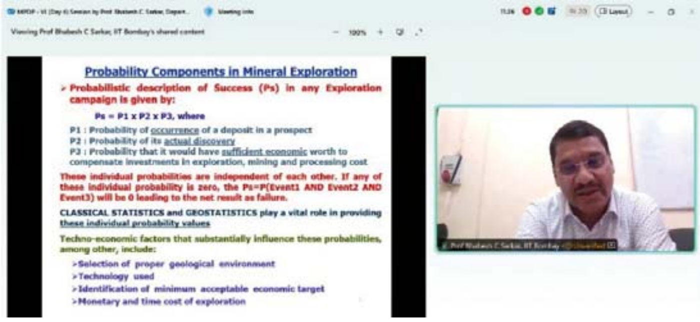
Mineral Policy 2019 by Mr. BRV Susheel Kumar, Former Director, DMG, Hyderabad on 06-11-2025

MMDR Act, 1957 & Its Amendments by Mr. AR Vijay Singh, BE (Mining), FCC (R), FCA, Chartered Accountant on 07-11-2025



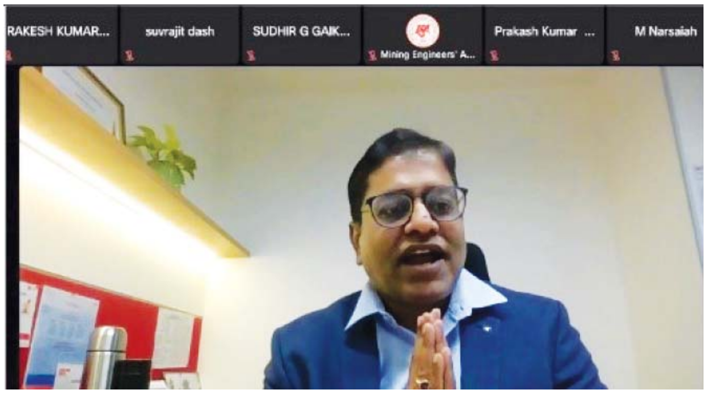
Mineral Resources & Reserves – Classification & Reporting by Dr. Abani R. Samal, Principal, Geo Global LLC, USA on 08-11-2025

Hyperspectral Remote Sensing & Its Application by Prof. Anup Prasad, IIT(ISM), Dhanbad on 08-11-2025



Hyperspectral Remote Sensing & Its Applications by Prof. Anup Prasad, IIT(ISM), Dhanbad on 13-11-2025

Mineral Auction by Mr. Sabyasachi Nayak, Director, Mine Magma on 14-11-2025

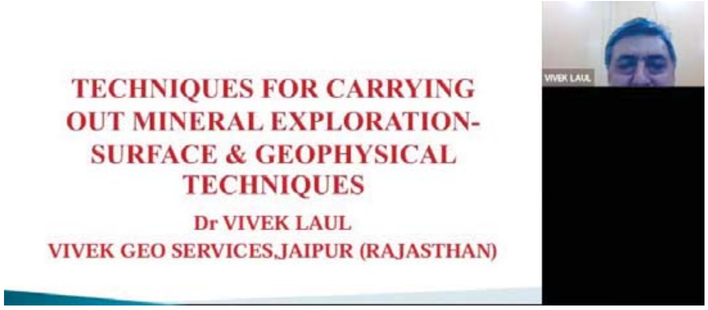


Building High-Performing Teams to Navigate Business Challenges by Dr. Debabrata Dash

Head Human Resources Eastern India
ArcelorMittal Nippon Steel India on 14-11-2025

Environmental Clearance by Mr. AR Vijay Singh, BE (Mining), FCC (R), FCA, Chartered Accountant, Bangalore on 15-11-2025

Technological Trends in Large Mining Trucks by Mr. Suresh Nair, VP, Tata Hitachi Sales & Marketing on 20-11-2025

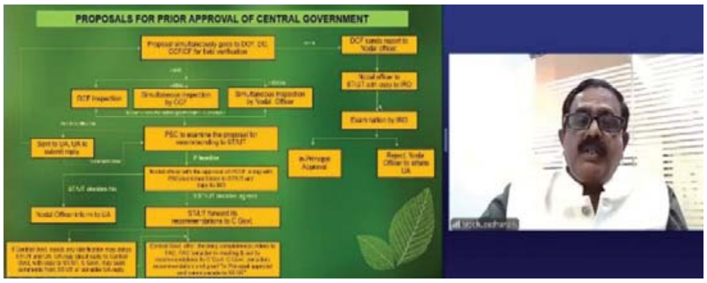


Preparation of Mining Plan, Mine Closure Plans & IBM Approvals by Dr. Vivek Lal, Consultant, Jaipur on 20-11-2025

Industry 4.0 Maturity Index and Roadmap for Digital Transformation in Mining by Mr. Lalit Mohan Soni, Chairman, MEAI Jaipur Chapter on 21-11-2025

Strategic and Tactical Mine Planning for Opencast Mines by Mr. Suryanshu Choudhury, Asst. Vice President, Hindalco Industries Limited, on 22-11-2025.

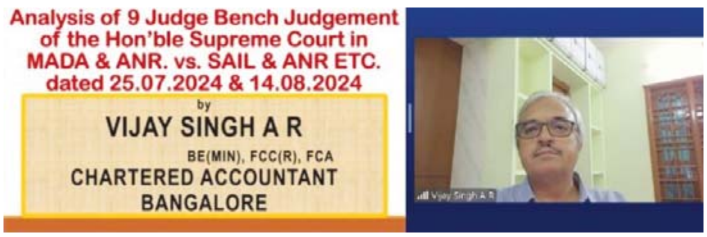
Role of Leadership in the Artificial Intelligence Era by Mr. Rajesh Pershad, Educator & Human Potential Trainer on 27-11-2025



Forest Clearance of Mining Projects by Mr. K. Madhusudhana, Past President MEAI and CEO of MSPL Ltd., on 28-11-2025

Safety Management Plan by Mr. V. Lakshmi Narayana, Dy. DGMS (Retd.) on 28-11-2025

Digitalization for Productivity Enhancement in Mines by Mr. Mahesh Kumar, Consultant IT, Minematics on 29-11-2025



9-Judge Bench Judgement of Hon'ble Supreme Court in MADA vs. SAIL by Mr. AR Vijay Singh, BE (Mining), FCC (R), FCA, Chartered Accountant, Bangalore on 29-11-2025

MPDP-VI Valedictory Program

The MPDP-VI Training Program concluded on a high note, featuring powerful insights from global mining leaders and distinguished professionals. The initiative received exceptional appreciation for effectively bridging classroom learning with practical case studies, group tasks, and discussions.

Highlights from the Valedictory

Shri. Vinod Kumar, COO - Mining, Vedanta Limited, Sesa Goa Iron Ore & Chief Guest of the Program. Shri. Vinod Kumar congratulated MEAI for shaping a knowledgeable and industry-ready talent pool.

He emphasized the urgent need to embrace digitization and artificial intelligence across the mining value chain—including safety, exploration, operations, and beneficiation—to drive the vision of "Viksit Bharat." He applauded the program's role in preparing professionals to meet the rapidly evolving technological demands of the mining sector.

Dr. Pukhraj Nenival, Vice President - II, MEAI, addressed a compelling message on continuous learning, upskilling, and staying aligned with the dynamic needs of modern mining. He highlighted the program's comprehensive curriculum delivered by 15 eminent faculty members, covering AI & Remote Sensing, Statutory and Policy Updates, Environmental & Forest Clearances, Mineral Auctions, Safety Management & Legal and Compliance Aspects

Shri B. Surender Mohan, former CMD, NLC India Ltd., praised MEAI for equipping field engineers with practical exposure to laws, procedures, and environmental clearances.

Dr. Abani Samal (USA) commended MPDP's growth and encouraged expanding participation across Asia. He suggested integrating more modules on mineral economics and mineral processing.

Participants expressed that the program was exceptionally enriching, blending practical case studies with modern trends such as AI, IoT, and data-driven mining. They shared that it offered valuable insights into industry legislation and emerging mining technologies, making it highly beneficial for their professional growth.

Shri. M. Narsaiah, SG, thanked Shri. D. B. Sundara Ramam, Shri. Dhananjaya G. Reddy, Dr. Pukhraj Nenival, Shri. K. Madhusudhana, and Shri. Lalit Moha Soni for their continuous support in organizing the MPDP program and thanked the supporting organizations—NMDC Ltd, Tata Steel Ltd, Vedanta Ltd, MSPL - Baldota Group, ERM Group, BGR Mining & Infra Ltd, Karnataka State Minerals Corporation Limited (KSMCL), JSW Steel Ltd, and Rai Bahadur Seth Shreeram Narasingdas Private Limited (RBSSNPL)—for their commitment to professional growth and well-being in the mining industry.

Especially appreciated the esteemed faculty, including experts joining from across the world, and the dedicated MEAI team for ensuring seamless online sessions.

BANGALORE CHAPTER

Workshop on "Implementation of Indian Mineral Industry Code for Reporting Mineral Resources and Reserves in India"

The Bangalore Chapter of the Mining Engineers' Association of India (MEAI) organized a workshop on "Implementation of the Indian Mineral Industry Code (IMIC) for Reporting Mineral Resources and Reserves in India" in association with the Department of Mines and Geology (DMG), Government of Karnataka, on 23 December 2025. The event was held from 10:00 a.m. to 1:30 p.m. in the Auditorium of the Department of Mines and Geology, Khanija Bhavan, Bengaluru, and was attended by about 80 participants from DMG, industry, and MEAI.

The workshop aimed to sensitize government and industry professionals to the need for effective implementation of IMIC in India. It highlighted how IMIC aligns reporting of mineral resources and reserves with globally accepted CRIRSCO-aligned reporting standards and best practices while being tailored to the Indian context, thereby helping to attract both domestic and international investment in exploration and mining.

Dr. P. V. Rao, Co-Chair of NACRI, conducted the technical session and delivered a detailed presentation covering the roles of CRIRSCO, NACRI, and MEAI; the development of IMIC; and its key features and benefits for India. The presentation was well received and helped clarify for participants the current status of reporting under the MEMC Rules, the mineral and coal block auction regime, and the implications of adopting an internationally recognized IMIC Code for enhancing confidence and investment in the mineral sector, particularly in the context of the government's heightened focus on critical mineral discovery in India and securing such assets through acquisitions and joint ventures overseas. The session concluded with an interactive question-and-answer segment, during which several queries from the participants were addressed.

Dr. M. Basappa Reddy, former Director, DMG, and former Chairman, Bangalore Chapter, inaugurated the workshop. Shri S. Rangappa, FCA, IAS, Director, Department of Mines and Geology, delivered the closing remarks and assured wholehearted cooperation in pursuing the implementation of IMIC in India. Shri Dhananjay G. Reddy, Vice President-I, MEAI, presided over the workshop, while Dr. T. N. Venugopal and Dr. C. V. Raman, Chairman and Vice-Chairman of the Bangalore Chapter, respectively, co-chaired the proceedings. Shri Sitaram Kemmannu, Secretary of the Bangalore Chapter, coordinated the workshop and proposed the vote of thanks.

The workshop concluded at 2:30 p.m., followed by a lunch hosted by the Bangalore Chapter.

Shri S. Rangappa, FCA, IAS, Director, Department of Mines and Geology with the participants

Dr. M. Basappa Reddy (sitting in the center), former Director, DMG, and former Chairman, Bangalore Chapter, with the participants while Dr. P.V. Rao (first from the right) conducts the technical session.

Shri S. Rangappa, FCA, IAS, Director, Department of Mines and Geology & Dr. M. Basappa Reddy flanked by Dr. T. N. Venugopal (left) and Mr. Dhananjaya G. Reddy (right) in the concluding session.

Shri S. Rangappa, FCA, IAS, and Dr. T.N. Venugopal presenting a Memento to the speaker of the technical session, Dr. P.V. Rao

BELGAUM CHAPTER

On 1st Nov, Chairman Dr. Hanamgond, VP III Shri Rachappa S, Dr. Purandara, Shri D. A. Hiremath, and Mr. Ravi Hiremath attended the IMD online event organized by CHQ.

On 6th Nov, our student chapter members, with Mr. Suraj Mense, Jt. Secretary, had a Geology Awareness Program for pre-university students of Gomatesh Vidyapeeth, Belgaum. The students were enlightened with geological processes and the identification of common rocks and minerals.

Mr. Suraj Mense and MEAI student chapter members with the principal and staff of Gomatesh PU College, Belgaum.

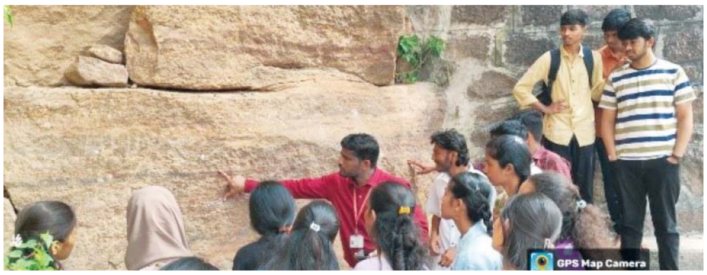
On 14th Nov, our members visited the SUMS NABL Accredited Analytical Lab of Shri Prabhakar Reddy at Hospete.

On 14th and 15th Nov, our student chapter members, with Mr. Suraj Mense, Jt. Secretary, had a Geology Awareness Program at three colleges for pre-university students: Maratha Mandal College at Khanapur on 15th November, Maratha Mandal College, Belgaum campus, and DMS Mandal's Jyoti PU College, Belagavi. The students were enlightened with geological processes and identification of common rocks and minerals. In all, over 600 students attended these events.

On 24th Nov, SG Balekundri Institute of Technology arranged a 3-day workshop for BE Civil Engineering students on "Application of Geology & GIS in Civil Engineering," in association with Dharti Geoinsight Pvt Ltd., Belgaum; GSS College, Belgaum; and MEAI Belgaum Chapter. At the outset Chairman Dr. P. T. Hanamgond was the chief guest and gave an inaugural keynote address on "Applications of Geology in Civil Engineering." Mr. Rahul Lohar, MEAI Bgm member and faculty of the Civil Engg Dept of SGBIT, was the coordinator for the event and conducted field visits to nearby geologically important areas at Bhootnath Granite Hill and Kaladgi Formations exposed at Siddeshwar-Rameshwar, Belgaum. Shri Sagar Waghmare (Secretary), Mrs. Priyanka Shinde, and Mr. Suraj Mense (Jt. Secretary) of the MEAI Belgaum chapter were present as resource persons for conducting a talk on GIS and a visit to the Geology Museum at GSS College Belgaum.

Chief Guest, Dr P T Hanamgond, felicitated

Mr Rahul Lohar, LM MEAI and coordinator conducted field visit to Granite hill at Bhoothnath and Kaladgi formation around Kanbargi near Belgaum



Mrs Priyanka Shinde (LM) and Mr Suraj Mense (Jt Secretary, Belgaum Chapter), conducted museum visit and a talk on GIS applications to Civil Engineering.

On 7th Dec we had an exhibition of coins, currency, and stamps at Bharatesh English Medium School, near Fort Belgaum. Over 350 students from 8th to 10th standard visited the exhibition.

BELLARY-HOSPET CHAPTER

Celebration of Indian Mining Day - 2025 & Kannada Rajyotsava - 2025

Date: 22nd November, 2025 **Venue:** MGVTC, Sandur
Time: 9.00 AM
Attendance: 95 Members On the occasion of Kannada Rajyotsava, the flag was hoisted by the Chief Guest, Sri Nagendra Kumar Sriram, DDMS, Ballari Region–1, along with the Guests of Honor—Sri Shreedhar Hegde**,** Sri K. Prabhakara Reddy (CEO, M/s SUMS Ltd.)**,** Sri SHM Mallikarjuna (Chairman, MEAI BH Chapter)**,** Sri P.V. Rao (Secretary, MEAI BH Chapter)**,** Sri J. Srikanth (Treasurer, MEAI BH Chapter)**,** GM, M/s ZTC, and other distinguished dignitaries—with great respect and enthusiasm. The Karnataka flag stands as a symbol of pride and unity, commemorating the formation of the state on 1st November 1956, and celebrating the rich cultural heritage, history, and language of the Kannada people.

The Kannada Rajyotsava and Indian Mining Day Celebration 2025 were marked with great pride and enthusiasm. The Chief Guest, Sri Nagendra Kumar Sriram, DDMS, Ballari Region–1**,** along with the Guests of Honor**—Sri** Shreedhar Hegde**,** Sri K. Prabhakara Reddy (CEO, M/s SUMS Ltd.)**,** Sri

SHM Mallikarjuna (Chairman, MEAI BH Chapter), Sri P.V. Rao (Secretary, MEAI BH Chapter), Sri J. Srikanth (Treasurer, MEAI BH Chapter), GM, M/s ZTC, and other distinguished dignitaries—graced the occasion with their esteemed presence. All the dignitaries were warmly welcomed on stage, adding grace and dignity to the celebration.

Sri K. Prabhakara Reddy, CEO of M/s SUMS Ltd., delivered an inspiring address on the occasion of the Kannada Rajyotsava and Indian Mining Day Celebration 2025. He highlighted the importance of preserving Karnataka's rich cultural heritage while embracing modern advancements in the mining sector. He emphasized the need for responsible mining practices, innovation, and continuous improvement to support the state's growth. He also appreciated the collective efforts of industry leaders, employees, and stakeholders in contributing to sustainable development.

In commemoration of Indian Mining Day, a Blood Donation Camp was organized with the noble objective of supporting local hospitals and blood banks. The camp was conducted in collaboration with Y. Umamaheshwar Rao Rotary Blood Center, a unit of the Hospet Rotary Charitable Trust, Hospet. The initiative received an encouraging response from employees and volunteers, reflecting their commitment to social welfare and community service. A total of 22 units of blood were collected during the camp, contributing significantly to saving lives and strengthening healthcare support in the region.

A special felicitation ceremony was organized to honor Sri Shreedhar Hegde, an ex-SMIORE employee, for his valuable contributions to the mining industry over the years. He was presented with a token of respect and appreciation in recognition of his exemplary service and dedication to the profession.

A special cash prize was awarded to honor the academic toppers for the year 2024–25: Mr. Mohamed Afzal C. A., Diploma in Mining Engineering from TMAES Polytechnic, Hosapete, and Ms. Rumana A., M.Tech. in Mineral Processing from VSKU, Nandihalli, Sandur. Both students received a cash prize of 5,000 each, along with a Certificate of Excellence.

The MEAI Premier League was conducted on the occasion of Kannada Rajyotsava and Indian Mining Day 2025. The cricket tournament was held on 09 November 2025 at the SRS Ground, Sandur, with around 75 members actively participating and making it a grand and energetic celebration. Trophies were awarded to both the winners and runners-up teams in recognition of their outstanding performances. The event not only showcased sportsmanship and teamwork but also strengthened the camaraderie among professionals and students in the mining community. It served as a memorable platform to encourage unity, fitness, and enthusiasm among all participants.

Indian Mining Day 2025—Student Competitions at TMAES Polytechnic and VSKU PG Centre Nandihalli

On the occasion of Indian Mining Day 2025, the TMAES Polytechnic, Diploma in Mining Engineering Department, in association with the VSKU PG Centre Nandihalli, Mineral Processing Department, organized a series of academic and creative competitions for the MEAI Bellary–Hosapete Student Chapter. The events included essay writing, quiz competition, and poster presentation, aimed at encouraging technical understanding, innovative thinking, and student engagement in the mining and mineral processing fields. Students from all the semesters participated with great enthusiasm, showcasing their knowledge, analytical skills, and creativity. The best performers were recognized, and prizes were awarded to the first-, second-, and third-place winners in each category.

The event provided an excellent platform for students to interact, learn, and share ideas, fostering a spirit of healthy competition and professional growth.

The Vote of Thanks was delivered by Sri P. V. Rao as the concluding note of the Indian Mining Day celebrations. He expressed his heartfelt gratitude to all the dignitaries, participants, and mining companies who actively took part in the event. He specially acknowledged the support of M/s JSW, M/s Baldota, M/s ZTC, M/s BKG, M/s SMIORE, M/s VESCO, and other organizations whose involvement ensured the successful execution of the celebrations.

He also extended his sincere thanks to the Y. Umamaheshwar Rao Rotary Blood Center, a unit of the Hosapete Rotary Charitable Trust, for organizing the blood donation drive, and appreciated all the blood donors for their valuable contribution. Sri

P. V. Rao concluded by thanking every participant and supporter who contributed to the successful celebration of Indian Mining Day and Kannada Rajyotsava.

COACHING CLASSES FOR MINING MATE ASPIRANTS - 2025 ORGANISED BY MEAI & MGVTS

The Bellary-Hospet Chapter, in association with “Mines Group Vocational Training Society (MGVTS), Sankalapur, Hosapete”, arranged free Coaching Classes for the candidates appearing for the “Mining Mate” Certificate Competency Examination conducted by the Director General of Mines Safety, Dhanbad scheduled to be held in December 2025.

Like every year, the Classes conducted from 24/11/2025 to 29/11/2025 at the training centre of Mines Group Vocational Training Society, Sankalapur, Hosapete. These classes were held daily from 9:30 am to 4:30 pm for 6 days. 12 candidates appearing for the competency examination have attended the classes.

The classes were inaugurated by Sri. Mallikarjuna SHM, the Chairman of MEAI, BH Chapter. The Chairman told all the candidates to utilize the coaching in best way to clear the examination as there are mor e vacancies of Mining Mate in the mines of this region. He also appreciated the efforts of MEAI & MGVTS for organizing free coaching classes for the past 3 years successively.

All the candidates that attended the classes appreciated the efforts made by MEAI B-H Chapter & MGVTS, Hosapete to conduct free training program for Mining Mate.

The classes were conducted by Sri K. Krishnudu, the Vocational Training Manager at MGVTS, Hosapete, he explained more than 1,000 Multiple Choice Questions (MCQs) covering all syllabus and other relevant subject.

As per the advice of Sri. K. Prabhakarareddy, Council Member of MEAI & CEO, M/s SUMS Pvt. Ltd. a desktop computer was provided to the candidates to practice on the computer that were not familiar with the use of computer.

The Secretary of MGVTS, Sri. G. Laxminarayana, Council Member of MEAI & G.M., M/s RBSSN Pvt. Ltd. appreciated the support extended by Sri. K. Madhusudhana, Past President MEAI & CEO, M/s MSPL Ltd., Sri. K. Prabhakarareddy, Council Member of MEAI & CEO, M/s SUMS Pvt. Ltd. & Sri. S.H.M. Mallikarjuna, Chairman of BH Chapter and Sri. P.V. Rao, Secretary of MEAI, BH Chapter.

KOLKATA CHAPTER

Technical Session on Orebody Modeling and Mine Planning

A distinguished technical session was held on 18 December 2025 for the Geology and Mine Planning team of Hindustan Copper Limited (HCL) under the banner of the Mining Engineers' Association of India (MEAI)—Kolkata Chapter. Hosted at HCL's Corporate Office, the event marked an important organization-wide knowledge-sharing initiative aimed at strengthening technical rigor and promoting professional excellence in mining. The session brought together senior leadership, domain experts, and professionals across disciplines to deliberate on two interlinked yet distinct technical papers addressing the core pillars of modern mining—mineral resources and reserves, and orebody modeling and mine planning.

All HCL units participated enthusiastically through seamless virtual connectivity, making the event a truly inclusive, well-coordinated, and organization-wide engagement that strengthened collective learning and collaboration. The session also reflected strong industry–academia collaboration and reaffirmed MEAI's commitment to knowledge sharing and professional excellence in mining and allied disciplines.

The session was addressed via video conferencing by two eminent domain experts: **Dr. P. V. Rao**, FGS, FAusIMM, and Co-Chair, NACRI; and **Dr. B. S. Choudhary**, Professor and Head, Department of Mining Engineering, IIT (ISM) Dhanbad. The event was graced by the presence of **Shri Sanjiv Kumar Singh**, Chairman and Managing Director, HCL, and Chairperson, MEAI–Kolkata Chapter, along with **Dr. Sanjeev Kumar Sinha**, Director (Operations) and Director (Mining)—Additional Charge, and esteemed patrons of MEAI from across the country. **Dr. Pukhraj Nenival**, Controller of Mines, Kolkata Region, Indian Bureau of Mines, and Vice President-II, MEAI, along with his colleagues, participated online from his office.

The first technical paper, presented by **Dr. P. V. Rao**, focused on the theme of *Mineral Resources and Reserves*, emphasizing their role as the foundation for all mining-related decisions. He underscored that defining tonnage and grade is a critical milestone in the transition from exploration to production, directly influencing forecasting, investment decisions, and operational planning. Dr. Rao highlighted the central role of geostatistics—particularly kriging and semivariogram analysis—in resource estimation, stressing that the reliability of estimates is intrinsically linked to data quality, sampling density, and transparency of assumptions.

The presentation critically examined current reporting practices, noting the underrepresentation of co-product and by-product metals, including strategically important and critical minerals. Such omissions can distort the true value of mineral deposits and adversely affect assessments of global metal supply. Dr. Rao traced the evolution of international reporting frameworks such as JORC and NI 43-101, explaining how these codes emerged from past industry crises to restore credibility and trust. India's initiatives through MEAI/NACRI and IMIC were highlighted as significant steps toward strengthening domestic reporting standards aligned with international codes. The presentation concluded with an emphasis on ethical responsibility, cross-disciplinary communication among geologists, engineers, and geostatisticians, and the dynamic nature of resources and reserves as they evolve with new data, economic conditions, and technological advancements. Above all, Dr. Rao reinforced that transparent mineral reporting is central to building trust in the mining industry.

The second paper, presented by **Prof. B. S. Choudhary**, focused on *orebody modeling and mine planning,* highlighting contemporary techniques, integration strategies, and future directions. He positioned orebody modeling as a dynamic, iterative process that transforms geological understanding into three-dimensional visualizations forming the basis of mine design and scheduling. Prof. Choudhary discussed modern approaches, including geological domaining, structural interpretation, and the use of implicit and explicit modeling techniques supported by advanced software tools and real-time data integration.

Mine planning was presented as a multidisciplinary optimization exercise requiring the integration of geology, geostatistics, economics, safety, and environmental considerations. Emphasis was placed on aligning short-term, medium-term, and life-of-mine plans while effectively managing uncertainty and operational constraints. Looking ahead, Prof. Choudhary underscored the growing role of digitalization, automation, AI-assisted analytics, and risk-based planning—alongside a stronger focus on sustainability and responsible resource utilization—as the defining trends for the mining industry.

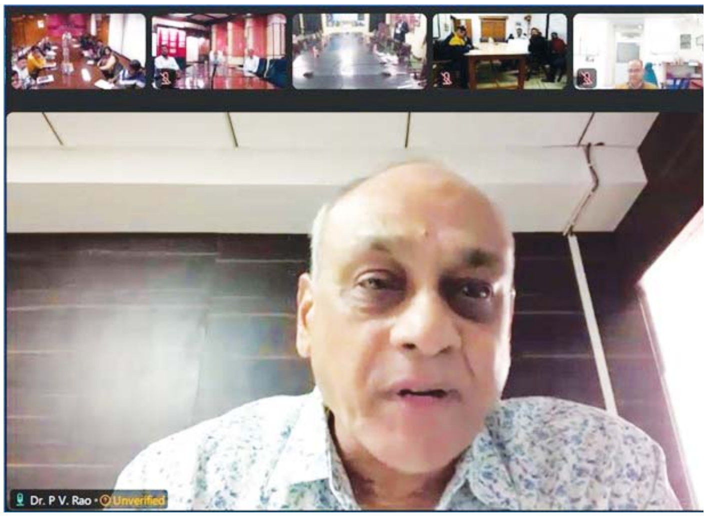
A key highlight of the session was the enthusiastic participation of professionals from all HCL units, enabled by seamless virtual connectivity, which enhanced cross-functional learning and professional collaboration across locations.

In conclusion, the technical session reflected MEAI's enduring commitment to industry–academia collaboration, knowledge dissemination, and professional excellence. By distinctly addressing two technical aspects—credibility and transparency in mineral resource and reserve reporting and advanced orebody modeling with integrated mine planning—the session reaffirmed the importance of sound science, ethical practices, and collaborative effort in shaping a sustainable and globally respected mining sector in India.

The session concluded with eloquent closing remarks by **Dr. Pukhraj Nenival**, who expressed his gratitude to HCL management for their support in reviving the Kolkata Chapter's activities for the benefit of the mineral industry fraternity. He also thanked **Prof. B. S. Choudhary** and **Dr. P. V. Rao** for accepting the invitation and delivering insightful, technically rich presentations.

Shri Sanjiv Kumar Singh (Right), CMD, HCL & Chairman, Kolkata Chapter facilitated by Dr Sanjeev Kumar Sinha, Director (Operations), & Director (Mining), HCL

Dr Pukhraj Nenival, Controller of Mines, IBM & Vice President-II, MEAI, with his colleagues



Dr. P.V. Rao, speaking (online) in the Technical Session

HCL Executives participating in the Technical Session from Kolkata Headquarters

HCL Executives participating in the Technical Session from different units of HCL

RAJASTHAN CHAPTER-JAIPUR

INDIAN MINING DAY CELEBRATION

The Rajasthan Chapter—Jaipur celebrated Indian Mining Day at the Mining Welfare Centre, Jaipur, on 1st November 2025 with active participation from members, invited guests, and their families. The celebration was organized around the theme "Digital Mining for Sustainability—Mining Today for a Greener Tomorrow," reflecting the mining industry's increasing focus on digital transformation, regulatory compliance, and environmentally responsible mining practices.

Shri Akshaydeep Mathur, Honorary Secretary General, Federation of Mining Association of Rajasthan, graced the occasion as the Chief Guest. He hoisted the Indian Mining Day flag, symbolizing the collective commitment of the mining fraternity towards safe, ethical, and sustainable mining. This was followed by the Indian Mining Day pledge, which was taken by all members present, reaffirming their dedication to responsible mining and professional excellence.

Dr. Vivek Laul, Secretary of the Chapter, welcomed the gathering and formally received the Chief Guest. In his address, he highlighted the significance of Indian Mining Day in recognizing the contribution of the mining sector to nation building and economic development. He also briefed the members on the objectives of the event and outlined the program schedule.

Shri Akshaydeep Mathur opened the proceeding, followed by group discussion. Drawing upon his vast experience in mining laws, forest regulations, and statutory compliances, he shared valuable insights on the challenges faced by the mining industry in matters related to forest clearances, legal procedures, and regulatory frameworks. Several experienced and knowledgeable members actively participated in the discussion, sharing creative views, practical suggestions, and field-based experiences, making the session highly interactive and informative. Shri Lalit M. Soni, Chairman, MEAI Jaipur Chapter, addressed the delegates online and shared his perspectives on the theme of the event.

On the occasion, family members of esteemed MEAI members also joined the celebrations at the Mining Welfare Centre, Jaipur. The chapter extends its special thanks to them for graciously accepting the invitation and adding warmth and enthusiasm to the event.

Subsequently, Dr. Vivek Laul briefed the members on the forthcoming International Seminar scheduled to be held during 13–15 February 2026. He emphasized the need for active involvement of members to make the event a grand success, particularly through participation, support in mobilizing sponsorships, and contribution of technical papers. He also apprised the members of the progress and developments achieved so far in this regard.

The program concluded with a vote of thanks, followed by lunch. On the occasion, family members of esteemed MEAI members also joined the celebrations at the Mining Welfare Centre, Jaipur. The chapter extends its special thanks to them for graciously accepting the invitation and adding warmth and enthusiasm to the event.

Group photograph after Flag Hoisting – 1st November 2025

Group Discussion on theme of Indian Mining Day

RAJASTHAN CHAPTER-UDAIPUR

Blood donation Camp

"One unit of blood can save many lives." Blood donation is not only a noble deed but also one of the greatest services to humanity. Embracing this spirit, a blood donation camp was organized on 23 November 2025 at Tulsi Niketan Residential School, Sector-4, Udaipur, under the joint auspices of Mahaveer International Udaipur, Sundar Devi Kothari Trust Udaipur, Tulsi Niketan Residential School, and the MEAI Rajasthan Chapter – Udaipur.

A dedicated team from the blood bank conducted the collection process. A total of 55 units of blood were donated by MEAI members and other participants.

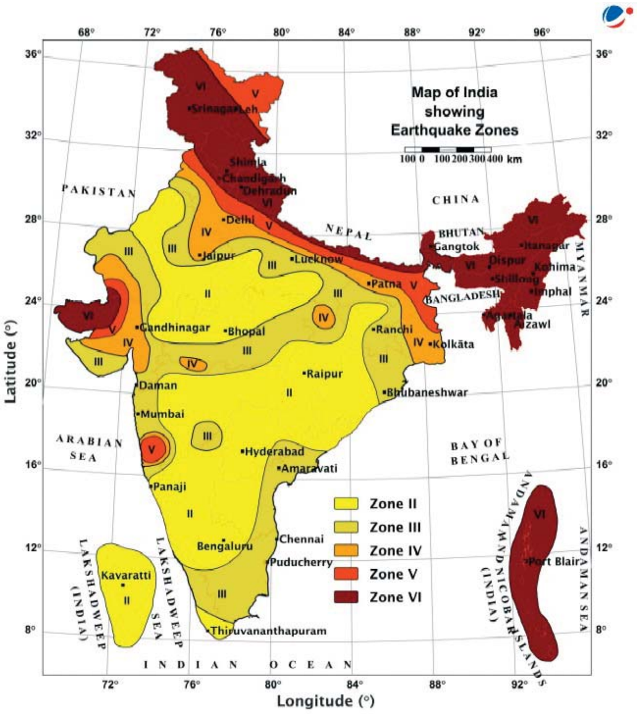
On this occasion, Shri Asif M Ansari, Secretary of the Chapter; Dr Hitanshu Kaushal, Joint Secretary; and Satya Narayan Joshi, Office Assistant, along with several other members, generously donated blood. Former President of MEAI, Shri Arun Kumar Kothari; National Council Member, Dr Sunil Kumar Vashisht; Shri Maqbool Ahmed; Shri Om Prakash Agal; and Dr. Mukesh Jagetia were also present and encouraged the noble cause.

All blood donors were honored with gifts and certificates by Mahaveer International in appreciation of their humanitarian contribution.

(Continued from Page 29)

- Boundary towns between zones: Now automatically fall in the higher-risk category.
- Hazard mapping: Prioritises geological conditions over administrative boundaries.

India's Earthquake Vulnerability:



- 61% of India's land now lies in moderate to high hazard zones (earlier: 59%).
- 75% of India's population is now in seismically active regions.
- Implications of New Map: Nudges to retrofitting in high-risk regions, halting expansion on soft sediments or near active faults, enforcing uniform building standards in Himalayan states, etc.
- Government strategies:
  - o National Disaster Management Authority (NDMA) & State Disaster Management Authority (SDMA): NDMA is responsible for setting disaster management policies and SDMAs are in charge of creating and implementing disaster plans
  - o National Seismological Network: Monitors earthquake activities and conducts research on developing earthquake early warning systems.

News Today | 29 Nov 2025

OBITUARY

Shri Pramod Kumar Soni
LM- 1196
(Ahmedabad Chapter)
(1951–2025)

We deeply mourn the passing of Shri Pramod Kumar Soni on 22 Nov, 2025. He was an accomplished mining professional whose dedication, integrity, and technical excellence left a lasting mark on the mining and geological fraternity. Born on 28 June 1951 in Amritsar, and raised in Agra where he completed his early education, Shri Soni went on to pursue Mining Engineering at the prestigious Benares Hindu University (BHU), graduating in 1973. He distinguished himself early in his career by securing the First-Class Manager's Certificate of Competency in his very first attempt in 1975.

He began his professional journey with TISCO in 1973, rising through positions of increasing responsibility—from Assistant Manager to Deputy Manager—while contributing significantly to production and safety across West Bokaro and Jamadoba operations.

In 1982, he joined Singareni Collieries Company Limited (SCCL), serving as Manager, later as Superintendent of Mines, and ultimately as Deputy Chief Mining Engineer. Working through a demanding labour environment impacted by Naxal activity, he led multiple mechanized underground mines. He headed the fully mechanized RK New Tech Mine, producing 1.5 MT annually, and in 1984 was sent to Poland for extensive training in advanced coal mining technologies, including longwall methods. For transforming the RK New Tech mine, he earned the Best Manager Award (1987), and his work at Kalyani Khani Incline was recognised through the Best Production Award, presented by Hon'ble C.M. Shri N. T. Rama Rao.

Shri Soni continued his professional journey with GMDC from 1993 to 2011. As General Manager, he led major lignite operations at Rajpardi and Panandhro, and later oversaw Bauxite Mining Operations, Internal Safety Organisation, CSR initiatives, and Planning at GMDC Head Office. His leadership during the 2001 Bhuj earthquake—coordinating large-scale relief and recovery efforts—was widely appreciated across the corporation.

Following his retirement, Shri Soni actively pursued his other passion, stock markets. He also made valuable contributions to the professional community by serving as the Chairman of the Ahmedabad Chapter of MEAI. In 2018, he was felicitated by MEAI Ahmedabad Chapter got his contributions.

Shri Pramod Kumar Soni will be remembered for his pioneering contributions to mining in Gujarat and the guidance he offered to countless colleagues and young engineers. He is survived by his loving wife, Smt. Mala Soni, Daughter Antra and Son Ashish. May his noble soul rest in peace.

CONFERENCES, SEMINARS, WORKSHOPS ETC.

INDIA

9-10 Jan 2026: **Odisha Mining & Infrastructure Conclave**. Organized by Futurex Trade Fair & Events Pvt Ltd, India.

10 Jan 2026: National Seminar on Rare Earth Mining in India: Opportunities and Challenges. Organized by the Belgaum Chapter at Regenta Resorts, Belagavi 590014. For more details, contact Belgaum Chapter's Chairman, Dr. Pramod T. Hanamgond.

10-11 Feb 2026: **Mining & Critical Minerals India Conference India Expo 2026**. Organized by at JW Marriott Mumbai Sahar. Contact: Spire Events Pte Ltd, 38 Maxwell Road, Airview Building, Singapore 069116. enquiry@spire-events.com.

13-15 Feb 2026: International Seminar on Vision 2047: Mining and Minerals Perspective. Organized by the Rajasthan Chapter-Jaipur at Hotel Clarks Amer, JLN Marg, Jaipur. For more details, contact MEAI—Jaipur Chapter at meaijpr2010@gmail.com.

ABROAD

25-26 Jan 2026: **International Conference on Geological and Earth Sciences ICGES (ICGES 2026)**. Paris, France. Website URL: https://waset.org/geological-and-earth-sciences-conference-in-january-2026-in-paris. Organization: World Academy of Science, Engineering and Technology.

9-12 Feb 2026: **Mining Indaba 2026 in CTICC**, Capetown, South Africa. Contact Birgit Hupe, Head of Delegate Registration at registration@miningindaba.com

25-26 Feb 2026: **International Conference on Earth Science (ICES 2026)**. Buenos Aires, Argentina. Website URL: https://waset.org/earth-science-conference-in-february-2026-in-buenos-aires.

3-7 Mar 2026: **CONEXPO-CON/AGG 2026**. Las Vegas Convention Center, 3150 Paradise Rd, Las Vegas, NV, 89109, United States. North America's largest construction trade show happens once every three years.

25-26 Mar 2026: **International Conference on Geosciences, Mineralogy and Petrology (ICGMP 2026)**. Madrid, Spain. Website URL: https://waset.org/geosciences-mineralogy-and-petrology-conference-in-march-2026-in-madrid. Contact international@conexpoconagg.com.

11-12 Apr 2026: **International Conference on Mining, Material, and Metallurgical Engineering (ICMMME - 2026)** in Barcelona, Spain. Mail: info@academicsworld.org. Web: www.academicsworld.org.

20-21 Apr 2026: **International Conference on Geosciences, Mineralogy and Petrology (ICGMP-2026)**. New York, United States. Organized by World Academy of Science, Engineering and Technology. Website URL: https://waset.org/geosciences-mineralogy-and-petrology-conference-in-april-2026-in-new-york.

21-22 Apr 2026: **International Mining Geology Conference 2026**. Brisbane Convention and Exhibition Centre, Brisbane, Australia. Contact AusIMM at T: 1800 657 985 or +61 3 9658 6100 (if overseas); https://www.ausimm.com/conferences-and-events/mining-geology/.

5-7 May 2026: **Global Resources Innovation Expo 2026. Perth Convention & Exhibition Centre**, Perth, Australia. Hosted by Austmine and AusIMM.

18-19 May 2026: **International Conference on Mining and Economic Geology (ICMEG -2026)**. London, United Kingdom. Website URL: https://waset.org/mining-and-economic-geology-conference-in-may-2026-in-london.

24-25 May 2026: **International Conference on Mining and Economic Geology (ICMEG 2026)**. in London, United Kingdom. Website URL: https://waset.org/mining-and-economic-geology-conference-in-may-2026-in-london.

24-26 Jun 2026: **The 27th World Mining Congress and exhibition in Peru**. Contact details: Phone: +48 32 324 66 03; e-mail: wmc@gig.katowice.pl.

29-30 Jun 2026: **International Conference on Geological and Earth Sciences ICGES** in Istanbul, Turkey. Website URL: https://waset.org/geological-and-earth-sciences-conference-in-june-2026-in-istanbul.

20-21 Jul 2026: **Accelerating Commercial Exploration, Discovery and Extraction** in Cairo, Egypt. Conference Enquiry: conference@egyptminingforum.com.

REQUEST TO READERS/ MEMBERS OF MEAI

The Editorial Board of the Mining Engineers' Journal (MEJ) requests our esteemed Readers/ Members of MEAI to share their valuable Research work in geosciences/ mining or Best practices developed/ adopted while employed in the mineral industry, for publication in our Mining Engineers' Journal (MEJ), for the benefit of the mineral industry fraternity.

Interested professionals may please contact the Editor, MEJ for obtaining "Author(s) guidelines" for submitting technical papers at **editor.mej.meai@gmail.com**.

Chief Editor, MEJ

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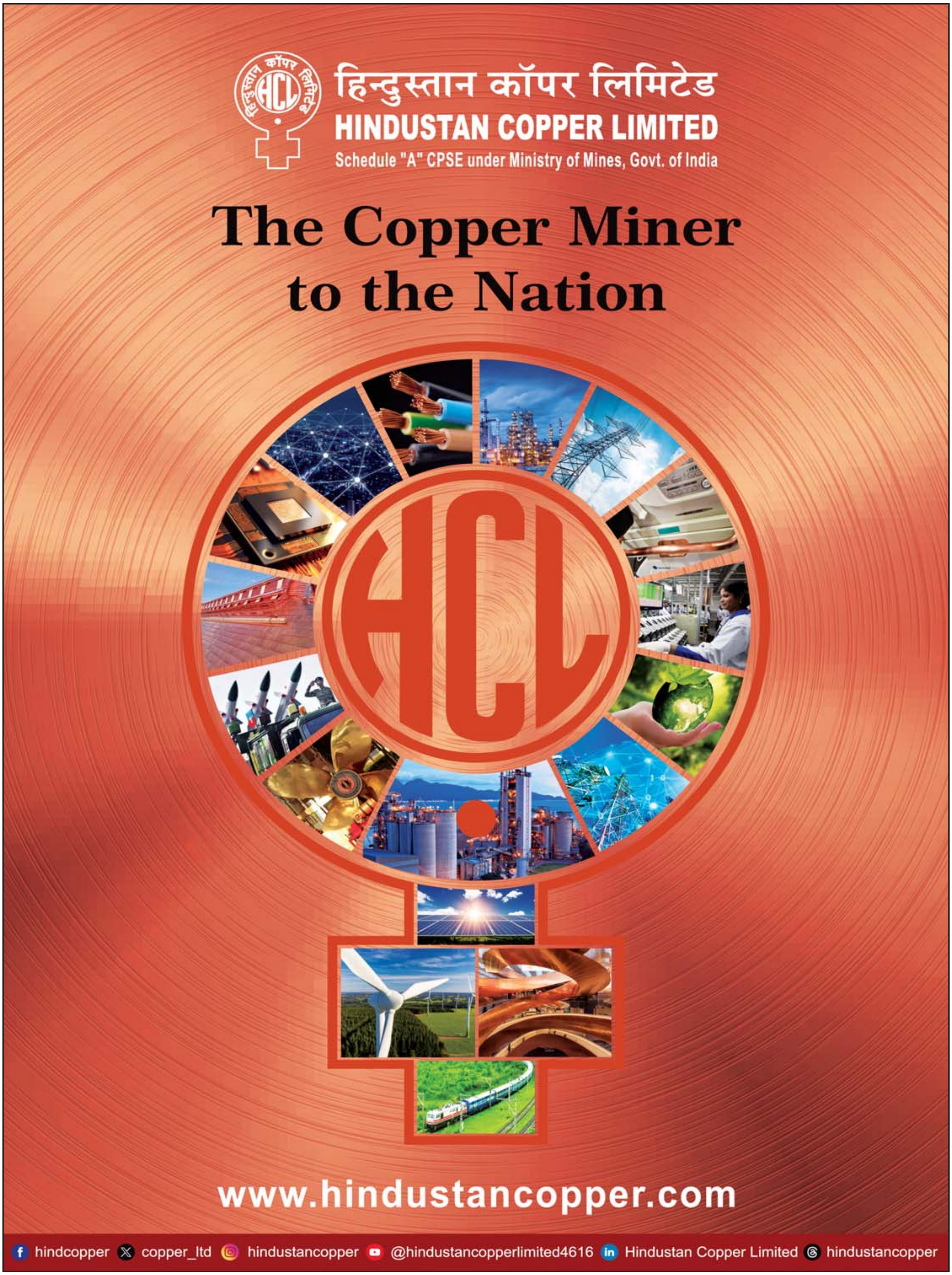
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