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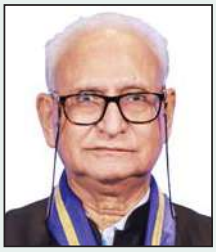

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President's Message.....

Dear members..

Hon'ble Shri G Kishan Reddy, an MP from Hyderabad, has been appointed as the Minister of Coal & Mines in the new Cabinet constituted by the Hon'ble Prime Minister Shri Modi. We congratulate Shri Reddy and welcome him to the Mines Industry of the Nation. We wish, with him in the responsible chair, the MEAI will be able to bring up mining Industry's issues to his kind notice and favorable consideration.

Its matter of great pleasure that the NACRI has successfully conducted the IMIC-V Training Program at MEA HQ Hyderabad from 6th to 10th May 2024 with 64 participants from different industries, 12 Indian faculties and 5 Overseas faculties (from Australia, Brazil, South Africa, UK & USA). Dr. P V Rao and his team deserves a large applause.

Recently, on 20th May2024, a meeting of the Inter-Ministerial Committee (IMC) was held under the Chairmanship of Dr. V K Saraswat of NITI Aayog. Later the Ministry of Mines, Govt. of India also conducted a workshop on "Granite and Marble Mining" at Bengaluru on 29th May 24. Dr. C H Rao and Shri Deepak Gupta along with Shri Dhananjay Reddy, VP II from our Association attended these events and made some good representations covering points related to the difficulties faced by minor mineral industries. These points were well received by the authorities. But we need to rigorously follow up these matters with the concerned authorities for a fruitful outcome.

The Bellary Hospet Chapter has conducted yet another Training program on First Aid with a batch of 50 participants. By now they have trained over 625 persons. A real good job done by the BH Chapter. Other Chapters should also follow them. I feel we should develop at least one such DGMS recognized First Aid Training centre at one of the Chapters, in each zone.

Heartiest Congratulations to the Ahmedabad Chapter that celebrated its 28th Foundation Day on 14th June 2024 with the BK Antia Memorial Lecture delivered by Shri Rajnath Ram, Advisor (Energy) NITI Aayog, followed by a technical session with the theme topic "Application of Artificial Intelligence in Mining". This was followed by Chapter's AGM in the evening with traditional family Get-together & brief entertainment programs. A real good practice which other Chapters may also replicate.

Some good activities are being organized by different chapters. They include the celebration of World Environment Day on 5th June '24, a Program 'ECO VISTA 24 organized by Bara Jamda Chapter, and a National Mineral Conclave 24 being organized by the Mines Safety Association of Karnataka in association with MEAI and with the blessings of the DGMS on 28th & 29th June. Wish the program a great success.

As the Association President, I would like to visit all the Chapters to have interactions with the Chapters' Executive Committee. Some of the Chapters I was able to visit when they hosted the Council Meetings. But the Chapters which are not likely to host Council meetings in near future will be on my priority list. I will try to plan at least one such visit every month and request the Secretary General to coordinate.

Before I conclude, heartiest congratulations from the entire MEAI to Shri Shailesh Nayak, a Geologist and currently Chancellor TERI School of Advance Studies for being honored with the prestigious "Padmashree Award". It's an honour bestowed not only upon Shri Nayak but the entire mining fraternity as well.

S.N. Mathur
President

Mining Engineers' Association of India

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EDITOR'S DESK

Dr. P.V. Rao
Editor, MEJ

Let me recollect a remarkable incident that happened in the year 2014 when the then vibrant and visionary President of Mining Engineers' Association of India (MEAI) Mr A Bagchhi set forth a novel idea that led to the development of an internationally recognised 'Made in India' Mineral Resources and Mineral Reserves (MRMR) reporting code for India. This obviously exemplifies that India did not have MRMR reporting standard of its own till then. Arguably, he could visualise the imminent need for such a reporting standard, far ahead of his times, because even after a decade since 2014 the professional bodies representing the mineral industry professionals continued to look up to the bureaucrats for directions even on critical technical matters of national importance associated with the mineral sector, on which they are supposed to be the authority. They need to come out of this centuries' old colonial mind set of waiting for instructions from the government officials and ascertain their expertise while proactively advising the government in the arena of discovery and development of mineral deposits in the country.

Since the announcement of National Mineral Policies (NMP) in 1993 & 2008 that powerfully advocated the requirement for attracting Foreign Direct Investments (FDI), and the extant Mineral Acts and Rules in India until the enactment of the MMDR Act in 2015, several world class mineral deposits were discovered in India by reputed international exploration companies, at no cost to the government exchequer. These companies established their exploration units in India, embedded with the latest technologies and funding, and carried out limited but high-quality modern integrated exploration including airborne and ground geophysics, sophisticated remote sensing geochemistry, and detailed drilling programs were the most successful in making many discoveries of kimberlites – the source rocks for diamonds. Rio Tinto's Bunder diamond discovery is hailed as one of the largest clusters of diamond deposits found in the last two decades, globally. Additionally, a few gold and base metal deposits were also discovered (Brookings India, April 2020).

The introduction of MMDR Act 2015, which paved the way for the introduction of the Auction system for the grant of mineral concessions, was not entirely regarded as conducive for private investments in the high risk mineral exploration activities in India by the international exploration companies and they decided to exit. This has necessitated the government to execute the costly and yet risky mineral exploration activities on its own with the funding support from National Mineral Exploration Trust (NMET). In the absence of profound interest emerging from the private companies, the Indian government was forced to delegate the task of G4 to G2 level prospecting/exploration, for bulk as well as surficial minerals, to the government owned exploration agencies and thereby identify mineral blocks for auction. This approach, adopted since 2015, has inadvertently led to shifting of focus away from the exploration of deep seated, concealed, high value and strategic/ critical mineral deposits which has been amply reflected by zero mineral discoveries and consequential opportunity loss. While India's cumulative exploration expenditure since 2015 was around USD 250 Million, the leading mineral exploration countries such as Australia or Canada spent, on an average, over USD 2000 Million in a year.

The amazing initiative pursued by MEAI since 2014, which no other professional bodies in India could ever thought of, has led to the formation of the National Committee for Reporting of Mineral Resources and Reserves in India (NACRI), developed the Indian Mineral Industry Code (IMIC) and obtained its recognition from the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) on August 1, 2019. IMIC is considered at par with all other 14 CRIRSCO compliant reporting standards that are recognised by the Global Stock Exchanges as the ONLY public reporting standards for the disclosure of Mineral Resources and Mineral Reserves for the listing of companies to raise money from the public and the financial institutions, world over.

Thus the above details demonstrate that India needs and requests private investments in mineral exploration and mining. The international investors, private equity players and financial institutions understand ONLY the MRMR reports based on the CRIRSCO compliant standards such as IMIC. Made in India IMIC Code is readily available for the government to adopt, which has been recognised at par with all other 14 CRIRSCO compliant international reporting standards since August 2019. The MEAI and NACRI have been in regular communication with the government (including SEBI) since 2016, persistently seeking formal recognition of IMIC as the mandatory reporting standard in India to disclose MRMR for the listing of exploration/ mining companies on Indian stock exchanges. ***The Indian government appears to be appreciating the rewards associated with the implementation of IMIC but somehow constrained to formally recognise it as the mandatory MRMR reporting standard in India***. No cues available to us yet on how to overcome this impasse and assist the sustained growth of the Indian mineral sector!

- Editor

NEWS FROM THE MINERAL WORLD

➤ Looking To Push Up Critical Mineral Supply, India Seeks Graphite Mines In Sri Lanka

Balama Graphite Mine in Mozambique

India has initiated discussions with Sri Lanka to acquire graphite mines in the island nation. The discussions are part of the broader push for securing critical mineral supplies.

Graphite, also known as plumbago, blacklead, or mineral carbon, is a naturally occurring, stable form of carbon. This soft, lustrous mineral is used in lubricants, refractories, brake linings, pencils, and electrodes.

Demand for high-purity graphite is increasing steadily as it is the primary material for anodes in lithium-ion and other batteries. In fact, graphite typically constitutes the largest component by weight in lithium-ion batteries, with up to 70 kilograms used in an average electric vehicle (EV).

Recognising its crucial role in the clean technology supply chain, graphite has been included in the government's list of 30 critical minerals released last year.

"Some discussions are under-way. Modalities are being worked on," said a senior official with knowledge of the matter.

Sri Lanka has a long history of mining and exporting graphite, achieving annual exports of 35,000 metric tonnes. Sri Lanka's vein graphite is notable for its exceptional purity, flawless crystal structure, and high electrical conductivity, making it ideal for various commercial applications.

Currently, China is the world's leading producer and exporter of graphite, refining more than 90 per cent of the global supply used in nearly all EV battery anodes, which are the negatively charged components of a battery.

Swarajya Staff / May 24, 2024

➤ India cancels 14 out of 18 critical mineral block auctions launched in second tranche, notice shows

India has cancelled the auction for 14 blocks of critical minerals launched in the second tranche of such auctions, a notice by government agency MSTC showed.

India, in February, had launched the second part of its critical minerals auction worth an estimated $362 billion, listing 18 critical mineral blocks across eight states. The auctions are a part of Prime Minister Narendra Modi-led government's bid towards clean energy transition.

In a notice dated June 21, the ministry of mines said that the auction process for five blocks in states of Arunachal Pradesh, Maharashtra and Rajasthan was annulled as no bids were received. These blocks contained minerals such as vanadium, graphite, chromium and potash. Separately, auction process for nine blocks, including those containing tungsten, limestone and cobalt, were annulled as bids received were fewer than the minimum requirement of three.

These blocks are spread across Chattisgarh, Karnataka, Maharashtra, Tamil Nadu and Arunachal Pradesh states.

Reuters / Jun 24, 2024

➤ CIL's coal auction premium to decline further with more coal availability: Source

As the production of coal from commercial and captive coal mines increases, the premium realised by CIL through e-auction will continue to decline, said sources.

New Delhi: As the production of coal from sources other than Coal India Limited (CIL) — commercial and captive coal mines — increases, the premium realised by CIL through e-auction will continue to decline, said a source in the Ministry of Coal. During FY 2022-23, the average premium realised by CIL through e-auction was 252 percent. During FY 2023-24, the average premium realised by CIL was 72 percent. "This trend is continuing and is likely to see a further decline during FY 2024-25. This would mean cheaper availability of coal for the non-regulated sector. This will help in

reduction in the cost of production and accordingly will contribute to checking inflation," said the source.

Captive, commercial coal mines to contribute over 16% to coal production in FY25

The government opened up the coal sector for commercial coal mining in 2020. "The policy of opening up the coal sector without end-user restriction has resulted in faster operationalisation of new coal mines. There are many mines auctioned for commercial purposes, that have got required clearances, faster than stipulated. Accordingly, the share of coal being produced by captive/commercial mines is increasing year on year," the source said. During FY 2023-24, 153 MT coal has been produced by captive/commercial mines which is 15.34 percent of the total production, whereas in FY 2022-23, these mines produced 122 MT coal which was 13.67 percent of the total production. During FY 2024-25, captive/commercial mines are likely to contribute over 16 percent.

"This is helping in higher availability of coal in the open market. Enhanced production from captive/commercial mines is adding to the self-sufficiency of some of the larger FSA (Fuel Supply Agreement) holders. Therefore, dependency on CIL is reducing. This is helping in the reduction of the auction price of coal," said the source.

Shalini Sharma, PSU watch | 24 May 2024

➤ Villages in WKH protest against iron ore mining

The residents of Mallangkona in West Khasi Hills have opposed a company's drilling activities to extract iron ore at Chual Napram village (Werang Abri) under Nonglang Sordarship. Earlier, they expressed surprise when the operators reached the village and claimed they had permission for iron ore mining.

Led by senior citizens and youth organizations, the locals from at least 25 villages visited the site on May 23 and saw the drilling machines digging deep. The villagers asked the firm to stop drilling as permission was not obtained from them. Another reason behind the resistance was that iron ore mining could impact the environment and the water table. The site of drilling is close to the catchment area that supplies water to the villages in the area. "When we contacted the prospectors, they said they had prospecting permission from the state and the mining department. However, other than one village headman, Madan Jira, who provided permission, the others were never consulted. This is a very serious matter and concerns the entire local population. We told them that we would not allow such a transgression in our area," Enos G Momin, a local, said.

The villagers found that drilling was done for around 57 meters. Various depths showed various colours of stones and mud. The prospectors failed to produce the documents of permission when the villagers had asked for the same. They promised to come back another day with all the documents. On Monday, a large number of villagers gathered at the Mallangkona outpost to discuss the matter with the prospectors. During a meeting, they raised their objection, stating that the environment would be irreversibly damaged if mining was carried out in the area. Later, the prospectors produced a prospecting license which showed that a composite mining license was issued for a period of 50 years with a mining area of 496 hectares. "If mining is carried out in our area for 50 years, we will have nothing to live on. Our children will have nothing to live on. The catchment we have will be gone and no matter what they give us in return, we will not get back what we will lose," a member of Garo Students' Union, Aradonga unit, said.

He and some others from the union took part in the talks. The prospectors assured that they will consult the villagers before taking any steps in the future. However, the villagers were not amused. The prospectors said it is only the first phase of the activities and as such, they do not have other documents."We will take all NOCs required and hold public meetings. If there is any objection, then we will not proceed further," one of the prospectors said.

However, the members of the Mallangkona Area Development Organization (MADO) said they will not allow iron ore mining in the area. "They may get all the permissions which are required but we will still not allow iron ore mining in our area. We care about our flora and fauna as well as the future of our children and our lives. We urge the state government to look into the matter and ensure that our lives are not threatened," a member of MADO said.

The Mallangkona Youth Multipurpose Society also expressed opposition. The members of the society said they stand firm against the desecration of their lands for the profit of a few. The villagers decided to lodge complaints with various departments and the office of the Chief Minister. They threatened to launch an agitation if their concerns are not addressed.

The Shillong Times | May 28, 2024

➤ Centre asks Telangana govt to auction at least six mineral blocks by June 30

The mines ministry has flagged that the Telangana government failed to auction any mineral blocks in past

nine years and asked the state to put at least six mines on sale by the end of this month. According to sources, geological reports of eleven blocks have been handed over to the government of Telangana for auction. These blocks consist of five iron ore mines, five limestone blocks and one manganese block.

Till date not even a single block has been put up for auction by Telangana even though the mines ministry has sent repeated reminders to the state government. The process of allocating mineral blocks through auctions began in 2015. In a recent letter to the Telangana government, the mines ministry asked the state to notify a minimum of six blocks from the 11 for auction by June 30, sources said. The ministry warned that failure to do so will force the Centre to begin the auction process.

As per the amendment in mining rules made in 2021, the Centre has the power to put on sale the mineral blocks in case a state government fails to auction the mines within the mutually agreed period.

Since the introduction of the auction regime, 354 major mineral blocks have been auctioned in the country. Of these 354 auctioned blocks, production has begun in 48 mineral blocks, amounting to significant increase in the revenue earnings to those states which have auctioned the mineral blocks, sources said.

Expeditious auction of the available mines will fully harness the mineral potential of the state for economic growth and welfare of the people as the revenue generated will accrue to the state government. Moreover, this will also create additional employment in the state, the sources added.

Telangana PTI": June 16, 2024

➤ **Centre introduces rules for offshore minerals ahead of the auctions**

Now, G2 needed for mining leases, while G4 must for obtaining composite licences. The Rules Also Define The Stages Of Exploration, Feasibility Studies, Economic Viability Assessments, And Classification Of Mineral Resources And Reserves.

In a bid to kick-start the nation's offshore mineral auctions, the Centre has introduced the Offshore Areas (Existence of Mineral Resources) Rules, 2024. This comprehensive regulatory framework mandates rigorous exploration standards to ensure accurate assessment and sustainable development of offshore mineral resources.

According to the new rules dated June 6, a minimum of general exploration (G2) is required to grant mining leases, while general exploration (G4) is necessary for obtaining composite licences. These standards are designed to provide a clear and structured approach to evaluating the presence and potential of mineral resources before advancing for extraction.

The new regulations come shortly before the Centre's scheduled launch of the inaugural round of offshore mineral auctions. Former Union Minister Pralhad Joshi had told Business Standard in March about plans to auction the first batch of offshore mineral blocks by June-July of this year. The Ministry of Mines has identified 10 offshore mineral blocks for potential auction and is currently engaged in inter-ministerial consultations to secure the required approvals for conducting the auctions at the earliest opportunity.

The regulations set specific exploration norms for a variety of deposits and minerals, including construction-grade silica sand, non-construction-grade calcareous sand, calcareous mud, phosphatic sediments, deep sea minerals, rare earth element (REE) minerals, hydrothermal minerals, and nodules.

This tailored approach ensures that each type of mineral deposit is thoroughly assessed according to its unique characteristics and potential impact. "The introduction of these rules is a significant step towards responsible and efficient utilisation of our offshore mineral resources," said a senior official from the Ministry of Mines.

The rules also define the stages of exploration, feasibility studies, economic viability assessments, and classification of mineral resources and reserves. The rules define exploration for any mineral deposit in four stages: reconnaissance survey (G4), preliminary exploration (G3), general exploration (G2), and detailed exploration (G1). These stages help establish the precise state of mineral exploration, classified as reconnaissance mineral resource, inferred mineral resource, indicated mineral resource, and measured mineral resource, respectively. Each stage reflects an increasing degree of geological assurance.

Nitin Kumar New Delhi | Jun 17 2024

➤ **Coal India awards 23 discontinued underground blocks to private miners**

The cumulative peak rated capacity of these mines is 34.14 million tonnes per year while the total extractable reserves are estimated at 635 MT.

State-owned Coal India on Wednesday said it has awarded 23 discontinued underground blocks to private miners through an auction route on revenue

sharing model. The cumulative peak rated capacity of these mines is 34.14 million tonnes per year while the total extractable reserves are estimated at 635 MT, the miner said in an exchange filing.

"Coal India Limited (CIL) in a bid to tap the latent coal reserves of some of its closed and discontinued underground mines has awarded 23 such mines on revenue sharing model to successful bidders of the private sector," it said. Earlier, CIL had identified a total of 34 discontinued mines where good quality coal reserves are lying dormant but may not be financially viable for CIL to mine them. Hence, the company said it decided to tender and offer these mines to willing private sector players who are prepared to operate and produce the dry fuel and share part of the revenue with the company.

"Successful bidder is the one who offers the maximum revenue to the authority, which is the coal company. The minimum revenue to be shared is 4 per cent. The contract period is for a maximum of 25 years," CIL said. This will help in the conservation of resources, effective substitution of imported coal for the non-regulated sector with good quality coal locked up in these mines and provision of livelihood to the local communities where these mines are revived. Further, there would be no land degradation as the mining infrastructure is already in place.

CIL is also identifying a few more mines for the purpose of attracting wider participation with relaxed bid norms. Of the 34 identified mines, the West Bengal-based Eastern Coalfields Ltd and Jharkhand-based Bharat Coking Coal Ltd account for 10 each. Western Coalfields Limited (5 mines), South Eastern Coalfields Ltd (4), Mahanadi Coalfields Ltd (3) and Central Coalfields Ltd (2) add up the remaining.

Press Trust of India New Delhi | Jun 19 2024

➤ Mining M&A stokes coal race against cleaner power

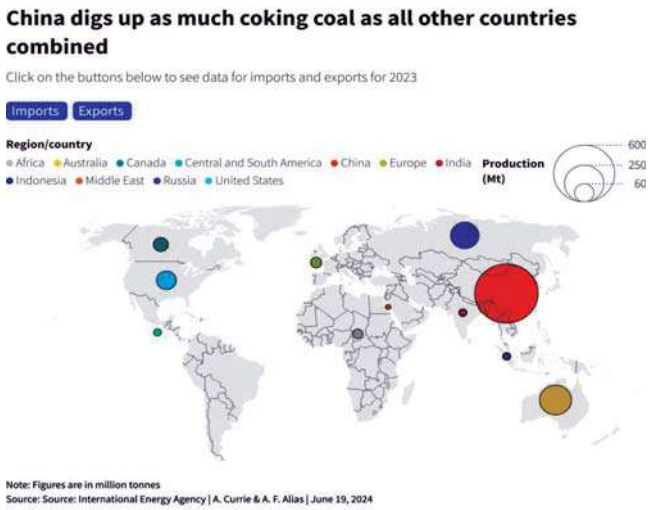
Glencore currently operates 26 mines in 21 thermal and coking coal mining complexes across Australia, Colombia and South Africa.

Coal is doomed, or so the energy thesis goes. Many banks, insurers and investors have backpedaled from or abandoned the carbon-belching fossil fuel, prompting companies that excavate it to complain they cannot get mainstream or affordable financing. One corner of the industry, however, is burning strongly: the coking, or metallurgical, variety used to make steel. For sellers, it's a diamond underneath the growing pile of mining M&A. Buyers, however, are in a race against low-emissions alternatives to justify their strategies.

The black rock's lingering sparkle is good news for Anglo American boss Duncan Wanbland. His company's Australian coal operation probably will be offloaded soon as part of the overhaul designed to help thwart rival BHP's unsolicited $49 billion takeover attempt last month. Recent transactions suggest there will be no shortage of suitors.

Glencore is in the process of acquiring 77% of Teck Resources' coal business in a deal that values the enterprise at $9 billion, or more than 4 times next year's estimated EBITDA, according to LSEG data. In Australia, which accounts for roughly half of all coking coal exports, there is more activity. A BHP-Mitsubishi Corp joint venture, for example, just sold two mines for about 3 times EBITDA, or $3.2 billion, to Whitehaven Coal, which may flog a minority stake to a steelmaker.

Coking coal has what for now is a unique pitch. It provides the heat and carbon necessary for blast furnaces to turn iron ore into molten iron, used to produce about 70% of the world's 1.8 billion tons of steel each year. The rest comes from scrap metal refashioned in electric-arc furnaces, like ones at the heart of Nippon Steel's fraught plan to buy United States Steel. This lower-energy process, whose furnaces use less if any coal, is projected to become as much as half the market by 2050. The dirtier method is set to keep growing in India and other parts of Southeast Asia, where production could jump 50% over the same span, according to Wood Mackenzie analysts.



The open secret, however, is that coking coal is more toxic than what gets shoveled into power plants. Thermal coal accounts for about a fifth of the world's

greenhouse gas emissions, double what steelmaking spews. But coking coal, which is responsible for most of the metal's pollution, does so with just a fifth of the tonnage mined. Its significant methane content means toxins emitted from pits alone are almost three times higher than from thermal coal, Wood Mackenzie has estimated.

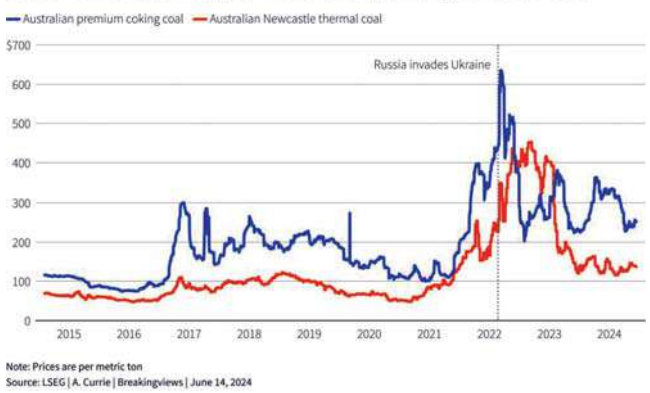
There are also no functional alternatives in the same way that solar, wind and other renewable sources are supplanting fossil-fuel power stations. Plenty are in the works, however. Green hydrogen is one, heavily funded by Andrew Forrest's iron ore miner Fortescue and others. Rival Rio Tinto is also working on using biomass and microwave energy. Boston Metal – backed, among others, by BHP, steelmaker ArcelorMittal and German carmaker BMW – aims to commercialize the molten oxide electrolysis process.

These options may not be ready to compete at a significant level for a decade. This helps explain the reduced stigma attached to unearthing coking coal compared to its electricity-generating thermal cousin.

It's also why the recent increase in deals does not seem to be particularly contentious. Even BHP boss Mike Henry touted coal mines as one of Anglo American's main attractions after having spent four years as CEO pivoting to "future facing commodities" such as copper. The basic idea is that Anglo's mines mostly hold the same premium-grade hard coking coal as BHP's remaining pits just down the road. The variety has fewer impurities and usually lower emissions.

Profitability helps, too. Premium hard coking coal sells for around $250 a metric ton, with BHP spending roughly $100 and Anglo $115 to dig it up. Soft coking coal sells for around a third less. Thermal coal, meanwhile, fetches less than $140 a ton, with costs ranging from $50 to more than $100.

Steelmakers usually pay more than power plants for coal



Note: Prices are per metric ton
Source: LSEG | A. Currie | Breakingviews | June 14, 2024

Small wonder that thermal coal producers were the buyers in the two largest coking coal deals. Of the 113 million tons of coal Glencore excavated last year, less than a tenth was destined for blast furnaces. Teck's met coal unit will double that proportion and contribute a third of revenue, based on last year's figures. The idea is that combined, the business will be worth more in a spinoff planned by Glencore CEO Gary Nagle.

With BHP-Mitsubishi's volume, Whitehaven will more than double its overall production and catapult the top-line contribution from met coal to about 70% from less than 10%. The merger also should boost its EBITDA margin and eventually inspire investors to value the enterprise at more than just 3 times those expected earnings over the next 12 months, per LSEG data. The deal also takes the company tantalizingly close to the threshold – 25% of revenue from thermal coal – that can make it easier to tap mainstream banks and insurers.

Some of the deals look like steals, at least on paper. Glencore's return on its mooted Teck investment could be as high as 19%, based on last year's showing. And if BHP were to pay, say, $5 billion to buy Anglo's coal mines, or around 4 times 2025 EBITDA per Visible Alpha data, and then cut its target's costs by a tenth, it might generate 14% on its capital, Breakingviews calculates.

All else being equal, Glencore might recoup its outlay in just five years, far sooner than even the chirpiest projections for green hydrogen and other technology to compete. A putative BHP acquisition of Anglo's metallurgical assets would take seven years to pay off.

If coal prices drop by a third to their pre-Ukraine war band, though, a crude calculation indicates the deal payback timeline would roughly double. That's assuming costs don't rise. Many mines in Australia's chief coking coal region already have been hurt directly or indirectly from flooding worsened by climate change. Such events will increase as more fossil fuel emissions are pumped into the atmosphere.

The more such disasters, the greater impetus there may be to curb pollution, putting a bigger target on steelmaking. BHP and others anticipating that premium coal will be more durable sound optimistic: Teck has pointed out that increasing hard coking coal's volume in the furnace to 70% from 50% reduces carbon emissions by less than 7%.

Moreover, climate-linked import duties, including Europe's carbon border adjustment mechanism, will be fully up and running before long. Dealmaking is stoking

the embers of coking coal, but also the chase against cleaner replacements.

Reuters | June 20, 2024

➤ Graphite can come from a surprising source: methane

Molten co-founders Kevin Bush and Caleb Boyd. (Image: Molten)

Graphite is key to manufacturing the lithium-ion batteries that power everything from electric cars to smartphones. While China is the world's top producer and exporter of the crystalline carbon, there's been a push to grow a US supply chain.

Oakland-based startup Molten Industries is working to build it by relying on something that's cheap and abundant in the US: natural gas. The company has developed a specialized technique to break methane into graphite and hydrogen, the latter of which can be used as a source of clean energy. The effort is funded in part by a $25 million Series A financing round led by Bill Gates's Breakthrough Energy Ventures (BEV).

"This is at the intersection of two really important climate tech theme areas for us at Breakthrough: making batteries scaleable and more cost-effective to drive EV sales to grow, and on the other side, low-cost clean hydrogen," said BEV managing director David Danielson.

Big automotive companies are hungry for low-cost, reliable domestic graphite due to international supply chain issues, he added. Graphite is typically mined or made synthetically from fossil fuels, and China controls about three-quarters of the world's graphite anode supply chain, according to data from mineral intelligence firm Benchmark.

Higher freight costs like those experienced during the pandemic and China's temporary export restrictions have raised concerns in the US and elsewhere about the risk of largely relying on one source of the valuable material. Boosting domestic production is a key priority of the Biden administration, which in 2022 invoked the Defense Production Act to fund the industry.

To create graphite, Molten relies on pyrolysis, a technique that involves heating methane until it breaks into its constituent components of carbon and hydrogen. If there's no oxygen or water present during this process, the methane gets split without any resulting CO2 emissions.

Other pyrolysis companies exist but most create products like soot or carbon black that can't be used in battery production. Those companies also often rely on microwave or plasma-based heating, techniques that can be very energy-intensive. By contrast, Molten's reactor is like a toaster: It uses resistive heating, which is more efficient, according to co-founder and chief executive officer Kevin Bush.

Molten says its graphite will be cost-competitive with other sources. It's also banking on the fact that customers will want a lower-emissions synthetic graphite than the kind currently on the market, which is made by treating fossil fuel-based feedstocks using a process that emits methane and air pollutants. The only potential sources of emissions in Molten's process are from producing the natural gas it uses as feedstock or the grid electricity powering the pyrolysis.

Graphite wasn't a big part of the startup's vision when it was founded in 2021. "Our original focus was just to make the lowest-cost hydrogen with the most energy-efficient reactor possible," said Bush. "We did figure out along the way that we could actually make battery-grade graphite rather than just an amorphous carbon soot."

Molten has built a pilot reactor in Oakland and is constructing a full commercial-scale unit the size of a shipping container that Bush said he expects to be operational next year. That unit will be able to produce 500 kilograms (1,100 pounds) of hydrogen and 1,500 kilograms of graphite daily, he said.

Whether there will be demand for the latter in the coming decades remains to be seen, though. Other materials like silicon, lithium and hard carbon may begin to compete with graphite as the default material in battery anodes, according to BloombergNEF. The shift could potentially halve demand by 2035.

The market for hydrogen may also be challenging because of high costs to produce and use it and policy uncertainty, according to Payal Kaur, a BloombergNEF hydrogen analyst.

"It's a story that follows pretty much every market," Kaur said. "You have way more supply than you do offtake."

Bloomberg News | June 20, 2024

(Continued on Page 21)

NEW-AGE MINING IN TATA STEEL: RESPONSES TO AUTOMATION & DIGITALIZATION

Rajeeb Kumar Mohanty*, Swapnendu SR Panda, Pankaj Satija*****

Abstract

Mining over the ages has progressed by adoption of latest technologies and has been the major contributor in the economic growth of nations. In the knowledge economy governed by digitalization and automation, mining industries are responding vigorously in contributing to economic growth. They are undergoing transformation. In view of emerging circumstances, an attempt is being made to comprehend the nature of transformation and its repercussions in the functioning of mining industries. At this juncture, it would be fruitful to discuss the challenges emerging out of the response to the changing demands of the information age. Complete automation and digitalization may be utopian, but minimizing the unskilled and semi-skilled workforce in managing routine mining activities will be challenging. Digitalization and automation are mandated responses to the new age. But they can best be described as a transformation of the existing structure.

While discussing the adoption of automation in some aspects of mining viz. mineral exploration, Mine planning, Mining operation, Mine mapping through Drone, Quality prediction, monitoring & blending, equipment maintenance, ore dispatch, safety as adopted by Tata Steel Limited, the concomitant issues as a measure of preparedness by the industry will also be discussed.

Key words: *Automation, digitization, exploration, quality control, mine planning*

1. INTRODUCTION

In the age-old pursuit of extracting valuable resources from the Earth, the mining industry is undergoing a transformative evolution. With the integration of cutting-edge technologies, traditional mining practices are giving way to innovative methods that promise productivity, efficiency, sustainability, and safety like never before. From rudimentary tools wielded by ancient civilizations to the sophisticated machinery and digital innovations of the present day, the story of mining technologies is a testament to human ingenuity and our relentless quest to unearth the Earth's treasures efficiently and sustainably.

In the wake of the digital revolution, the mining industry is undergoing a profound transformation, ushering in the era of Industry 4.0. Characterized by the integration of advanced technologies such as artificial intelligence, Internet of Things (IoT), robotics, and data analytics, Industry 4.0 represents a paradigm shift in how goods are produced, distributed, and consumed. This article explores the evolution of mining towards Industry 4.0 and its implications for businesses, economies, and society at large.

The Age of Mechanization (Industry 1.0): The journey towards Industry 4.0 begins with Industry 1.0, also known as the Industrial Revolution, which saw the mechanization of production processes using water and steam power. Innovations such as the steam engine and mechanical looms paved the way for mass production and fueled the growth of industries such as textiles, iron, and coal mining.

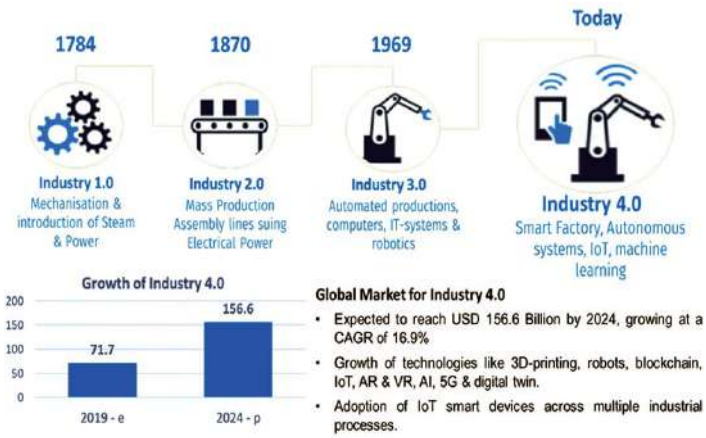


Fig 1: Timeline - Transition from Industry 1.0 – Industry 4.0

The Age of Mass Production (Industry 2.0): The advent of electricity in the late 19th century heralded Industry 2.0, characterized by the assembly line and mass production techniques pioneered by Henry Ford and others. Standardization and specialization became key principles, enabling economies of scale and the production of goods on a vast scale.

**Head Mine Planning & Geology Chrome, NRD, Tata Steel; **Area Manager Mine Planning, FAMD, Tata Steel; ***Executive In-charge, FAMD, Tata Steel*

The Age of Automation (Industry 3.0): The rise of computers and digital technologies in the latter half of the 20th century gave birth to Industry 3.0, also known as the Digital Revolution. Automation became widespread, with programmable logic controllers (PLCs) and computer-aided design (CAD) systems revolutionizing mining processes. Robotics began to play a prominent role in HEMM manufacturing, automating repetitive tasks and enhancing productivity.

The Age of Smart Mining (Industry 4.0): Industry 4.0 represents the convergence of physical and digital technologies, blurring the lines between the physical, digital, and biological worlds. At its core are advanced technologies such as artificial intelligence, IoT, cloud computing, and data analytics, which enable interconnected, intelligent, and autonomous manufacturing systems. Smart factories equipped with sensors and actuators can communicate and collaborate in real-time, optimizing production processes, reducing downtime, and enhancing flexibility and agility. More of a nuanced approach to summaries top technological innovations today can be represented as follows.

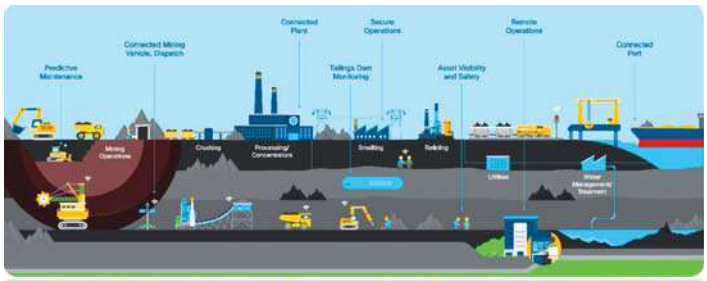
2. KEY TECHNOLOGIES DRIVING INDUSTRY 4.0:

Internet of Things (IoT): Connected sensors embedded in machines, products, and infrastructure enable real-time monitoring, predictive maintenance, and data-driven decision-making.

Artificial Intelligence (AI) and Machine Learning: AI algorithms analyze vast amounts of data to identify patterns, optimize processes, and make autonomous decisions, leading to increased efficiency and productivity.

Robotics and Automation: Collaborative robots (cobots) work alongside human workers, performing tasks that are repetitive, dangerous, or labor-intensive with precision and efficiency. Automation in the mining industry involves the integration of advanced technologies such as robotics, artificial intelligence, and remote-controlled machinery to streamline operations and enhance efficiency. It includes the use of automated drills, trucks and loaders etc. guided by algorithms and sensors to extract minerals with precision and speed. Automation improves safety by reducing the need for humans in hazardous environments and enhances productivity through continuous operation and predictive maintenance. While it presents challenges such as capital investment and workforce retraining, automation also offers opportunities for environmental stewardship by optimizing operations and reducing waste. A holistic view of mining automation in a nutshell has been presented below.

Additive Manufacturing (3D Printing): 3D printing technologies enable on-demand production of customized parts and prototypes, reducing waste, lead times, and costs.



Machine Uptime & Predictive Maintainance	Safety & Security	Worker Productivity	Autonomous/Semi Autonomous Operations
❖HEMM Operation ❖Crush/Convey/Process Instrumentation Sensors ❖Remote SCADA data collection ❖DCS/PLC connectivity ❖Asset Monitoring	❖Cybersecurity ❖Physical security ❖Worker location ❖Gas & leak detection ❖Minimize environmental impact ❖Tailing pond monitoring	❖Work order processing ❖Employee location ❖Dynamic scheduling ❖Work tickets via tablets	❖Digital dispatch ❖Autonomous drilling/hauling ❖Workforce optimization ❖Wireless to mobile machines ❖Edge compute

Fig 2: Mining automation in a nutshell

Exploration & Planning	Mining & Processing	Supply Chain & Logistics	Marketing & Trading
1. Big Data "Digital twin" (advanced simulation tool) Precision planning and operations scheduling	2. Real-time Data Remote operations Predictive maintenance	3. Logistics Trains from mine site to port Cargo ships managed globally	4. Blockchain Product provenance documentation Information access for customers
5. Interconnected Sensors Drones with InSAR sensors performing in-situ scanning	6. Advance Analytics Integrated processing system Product tracking and instant communicate	7. Quantum Computing Integrated supply chain planning Route optimization and interaction	8. Market Intelligence Digital channels that expand arbitrage opportunities

Fig 3: Integration of Key Technological innovations with Mining Process Cycle

Cloud Computing and Big Data Analytics: Cloud-based platforms and analytics tools provide scalable infrastructure for storing, processing, and analyzing manufacturing data, unlocking insights, and driving continuous improvement.

Integrated intelligent mining processes refers to the seamless integration incorporation of all the above advanced technologies and data driven solutions throughout the mining operation. By integrating these intelligent technologies into the mining process, companies can achieve higher productivity, improved safety standards, reduced operational costs, and minimized environmental footprint, leading to a more sustainable and profitable mining operation. A blueprint of various layers of the mining process is illustrated as follows.

Fig 4: Various Industry 4.0 layers covering mining process

India, with its vast and diverse mineral reserves, stands at the threshold of a new era in mining technology. Mining sector, being one of the key drivers of the Indian economy, produces as many as 95 minerals including fuel, metallic, non-metallic, and minor minerals that contribute around 2% of GDP. The country's mining industry is undergoing a significant transformation, driven by advancements in technology, changing regulatory landscapes, and a growing emphasis on sustainability.

In this article, we delve into the new age mining technology practiced in Tata Steel, exploring the innovations, opportunities, and challenges shaping the industry's future.

3. NEW AGE MINING TECHNOLOGIES IN TATA STEEL

The spectrum of adoption of industry 4.0 in the state-of-the-art mines of Tata Steel across various geographical locations of India can be classified into following broader categories.

1. Advances in Mineral Exploration
2. Mine planning & Scheduling
3. Advances in Drone survey applications
4. Geotechnical monitoring
5. Advanced practices in mine operation
6. Mines safety

3.1 Advances in Mineral Exploration

Any mineral exploration campaign fundamentally targets the establishment of the existence of minerals of interest through various steps in exploration, gradually narrowing down the target area and converting a Potential Target to Reserve.

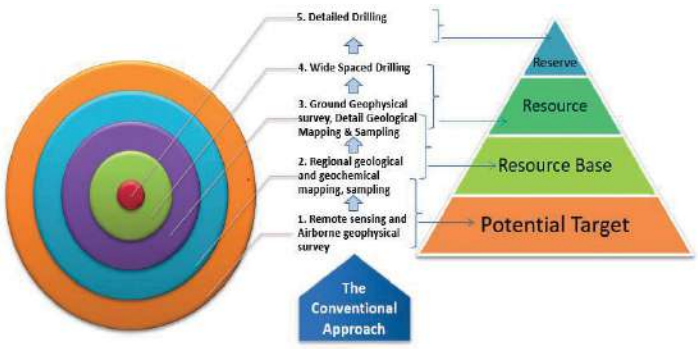


Fig 5: Process of Mineral Exploration

Some of the evolved technologies practiced in Mineral Exploration as follows.

i. Introduction of high-capacity drill rigs
ii. High accuracy GPS system and survey equipment
iii. High resolution (<1m) and multispectral satellite imageries with wider spectral band range
iv. Advancement of EM, IP, and radiometry methods of geophysical exploration

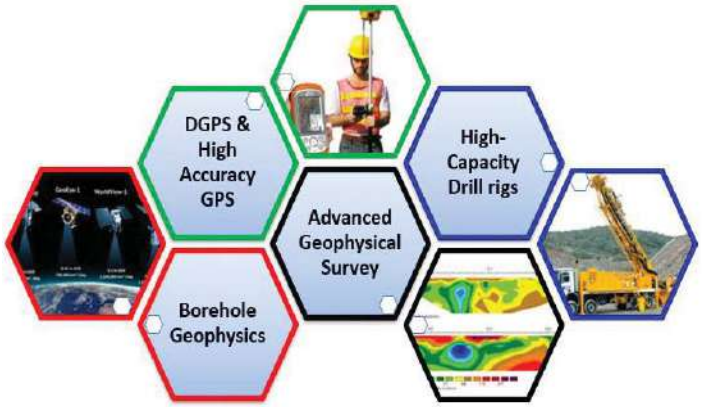


Fig 6: Evolved technologies practiced in Mineral Exploration

v. Easy data collection in borehole geophysics and analytics
vi. GIS platforms to integrate all forms of data
vii. Data analytics for effective analysis of large data bank
viii. Simulation technology for decision making
ix. Digital core logging using Tough book, thus reducing cycle time in logging database creation

Fig 7: New Age Core Logging Setup

x. Digital core orientation technique instead of conventional spear mark technique for core orientation

Fig 8: Digital core orientation technique

xi. Co-relation based on oriented core

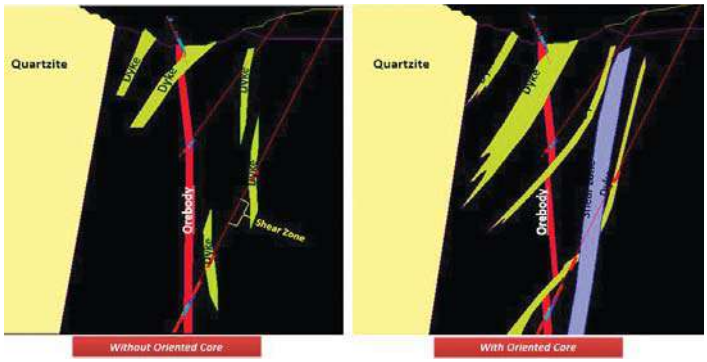


Fig 9: Before and After Cor Orientation

3.2 Mine Planning and Scheduling

The broader spectrum of Mine planning & scheduling follows two distinct approaches.

a. Long Term

b. Short Term

The process flow of mine planning in a nutshell is provided below.

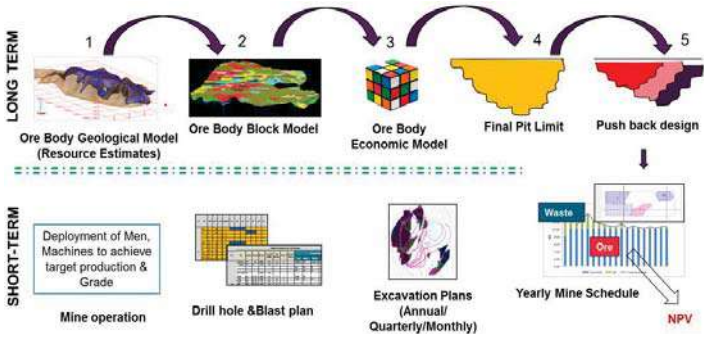


Fig 10: New Age Mine Planning Process

Modern software for Mineral modelling such as SURPAC & Minex are used for reserve & resource estimation. Scheduling software such as MineSched, XPAC and XACT are extensively used for mine scheduling requirements. Similarly, for working out mine economics software such as Whittle is being used.

MPoP – Mine Plan on Phone

Mine Plan on Phone app has been developed indigenously with following objectives.

I. Monitoring excavation compliance

i. Monitoring aerial compliance of mining activities

ii. Real time feedback in overall mine development activities

Fig 11: Mine Planning on Phone

3.3 Advances in Drone Survey Applications

i. Application of drone survey in Mineral exploration through geological information from high resolution photographs

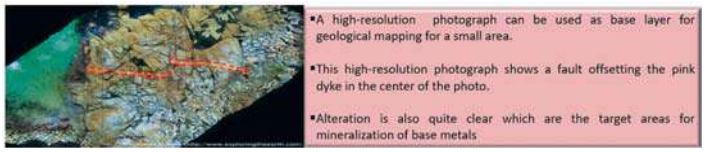


Fig 12: Advanced Drone Mapping

ii. Application of drone survey in GIS based land use planning

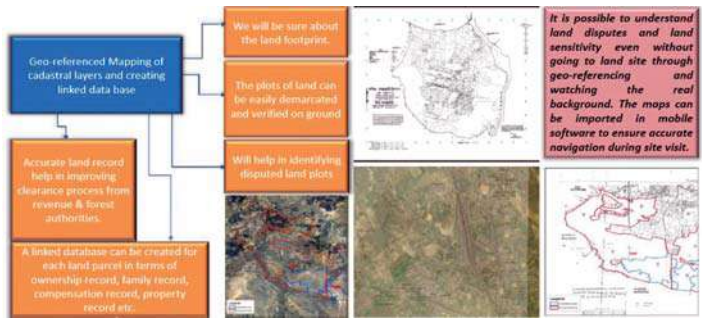


Fig 13: Drone survey in GIS based land use planning

iii. Application of Drone Survey in Pre-Mining Period

Fig 14: Application of Drone Survey in Pre-Mining Period

iv. Application of Drone Survey in Haul Road parameter monitoring

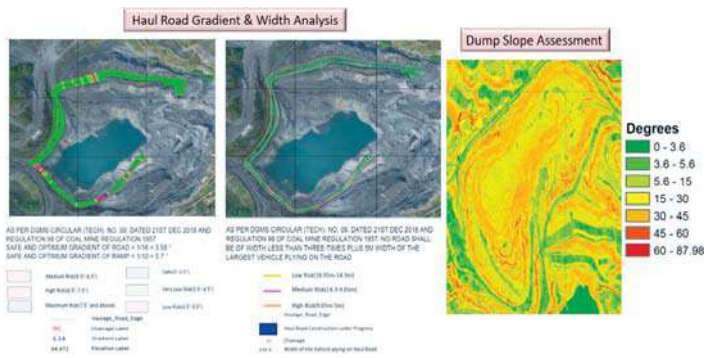


Fig 15: Application of Drone Survey in Haul Road parameter monitoring

v. Application of Drone Survey in Stock Volume Estimation

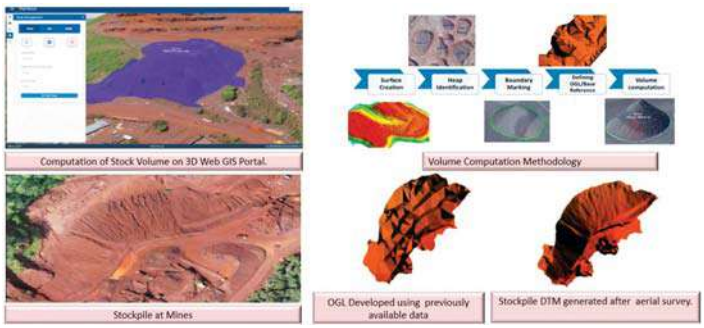


Fig 16: Application of Drone Survey in in Stock Volume Estimation

3.4 Geotechnical Monitoring

Real time monitoring involves a complex process of interpreting the deformation graphs. Slope Stability Radar monitors the minor displacements occurring in the slope on a 24 x 7 continuous/ real time basis and is capable of giving an advance warning to the mine operator in the event of an impending landslide.

Deformation: Deformation is the displacement of the wall based on the measurement of phase change in the signal beam between two consecutive scans.

Amplitude: Amplitude graph displays the signal strength of the returning radar signal; it is a measurement of signal strength that bounce back from the wall face. Strong amplitude represents good data and vice versa.

Range: Range is the distance between the radar dish and monitoring wall pixels. Size of the pixel depends on the range.

Coherence: Coherence displays a combination of how much range and amplitude has changed from the preceding scan. The value should be 1 for real displacements.

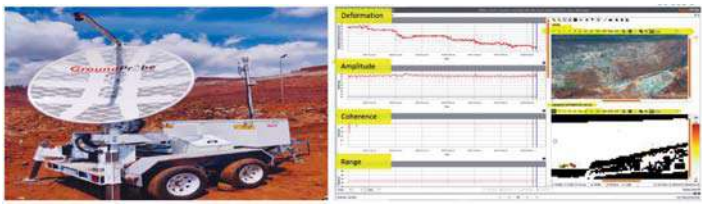


Fig 17: Real Time Monitoring through Slope Stability Radar

Failure prediction: After analyzing the deformation graph, if we find any deformation which is progressive failure prediction can be done by using inverse velocity methods. We can analyse the data for different time periods to predict the failure time. Deformation velocity is analysed for a longer period to get the onset of failure (The point from which progressive movement is started) and short period is taken into consideration for prediction of failure time to get a more precise prediction. Once failure prediction is done trigger action response plan can be initiated and person and machinery can be evacuated.

3.5 Advanced practices in mine operation

Advanced practices in mining operations encompass a range of technological, environmental, and safety advancements. Some of the state-of-the-art practices are illustrated below.

3.5.1 Fleet Management System

This aids in tracking of real time performance, grade control and blending, fulfilling dynamic dispatch requirements and automatic report generation.

Fig 18: Fleet management System

3.5.2 Digital Intervention in Quality Control

A unique amalgamation of state-of-the-art technologies to track quality on a real time basis during material handling from mine faces.

Fig 19: Digital Intervention in Quality Control

3.5.3 IOT Based Complete Water Monitoring & Analyzing in Mines & Plants

Tata Steel has implemented a smart water management system in collaboration with Fluxgen through its Aquagen solution at mining and plant locations which uses IOT for smart water management and audit. Snippet of the process flow is illustrated below.

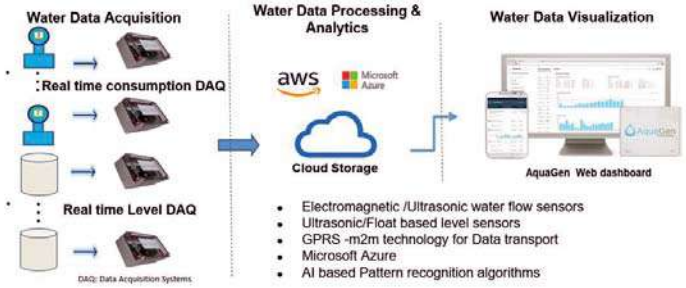


Fig 20: IOT Based Complete Water Monitoring & Analyzing

3.5.4 Integrated operation center (IOC) & Integrated Remote Supervision Center

Integrated control center at mines and central remote Supervision for better control and real time analytics of Safe operation.

Fig 21: Integrated operation center (IOC) & Integrated Remote Supervision Center

3.6 Mines Safety

3.6.1 Ensafe

A safety management system to capture safety KPI (Lead indicators and Lag indicators), depository of SOPs, and monitor the safety performance of individual as well as department, division and corporate level.

3.6.2 e-Work Permit

E-work permit system is a replacement of manual work permits and permits can be digitally signed or approved for achieving cent percent compliance of work permits to ensure zero harm across the organization.

3.6.2.1 Salient Features

- Online availability of all permits issued/cancelled.
- Optimizing time of issuing permit.
- Customizable for mobile devices.

3.6.3 Connected Workforce Technology

An amalgamation of Contractor Labour Management System (CLM), RFID based gate pass system, Biometric attendance system and IoT tracking devices to monitor, analyze and ensure safety inside mine premises.

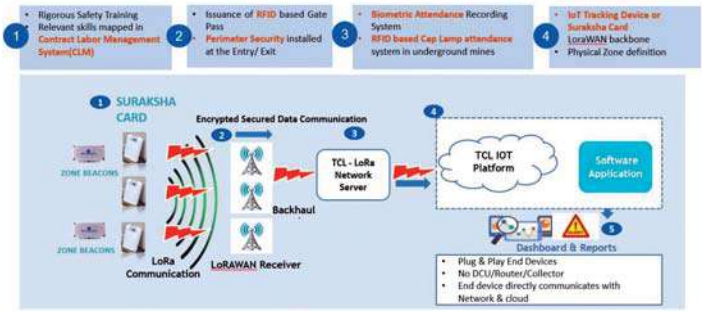


Fig 22: Connected Workforce Technology in a nutshell.

3.6.4 Smart Signaling System

AI based detections, wireless signaling and remote status views to ensure safety through smart signaling systems at junctions & crossings.

Fig 23: Smart Signaling System

3.6.5 WISE (Web based illumination surveying equipment)

WISE is altogether a first-move product having the capability of industrial IoT to automate the time consuming & manual process involved in illumination surveying.

It has capabilities to provide data-acquisition, digital storage, mapping, and analytics.

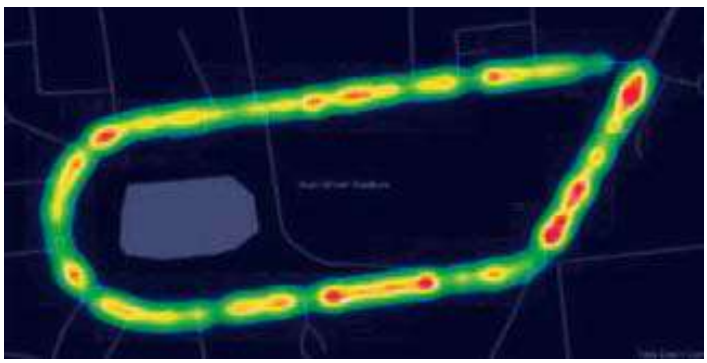


Fig 24: WISE

4. CONCLUSION

The advent of Industry 4.0 is revolutionizing the mining sector, ushering in an era of unprecedented innovation, efficiency, and sustainability. By embracing automation, artificial intelligence, IoT, and digitalization, mining

companies can enhance safety, optimize operations, and minimize environmental impact, thereby achieving greater competitiveness and resilience in a rapidly evolving global landscape.

Despite the promising benefits of Industry 4.0 in the mining sector, several challenges must be addressed to realize its full potential. These include the need for skilled workforce training and upskilling, cybersecurity concerns related to data privacy and asset protection, interoperability issues in integrating diverse technologies and systems, and regulatory barriers to adopting innovative solutions. A holistic partnership among industry stakeholders, government agencies, academia, and technology providers will be essential in realizing the following way forward.

- Mining sector needs to contribute around 10% for India. India should aim to reach the levels of South Africa where mining contributed 7.5% to GDP, and Australia where it is 10.4% to GDP. Currently mining contributes around 2% of its GDP. Automation and Digitalization are one of the prominent pathways to achieve the same.
- Industry must attract and retain diversified talent by adopting more technologically driven solutions.
- Industry to encourage innovation in everyday operations.

5. DISCLAIMER

The article is an amalgamation of data collected from various sources and authors' own views and thoughts. Tata Steel Ltd does not necessarily subscribe to the views and thoughts expressed in the article and should not be held responsible for the same.

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(Continued from Page 14)

➤ Vale expects tentative dam collapse settlement with Brazil authorities this month

The November 2015 dam collapse at the Samarco iron ore mine near the town of Mariana, Minas Gerais state, caused a vast flow of mud and mining waste that buried a nearby village, killing 19 people. (Image: Corpo de Bombeiros/MG)

Brazilian miner Vale expects to reach a tentative agreement by the end of this month with Brazilian federal and state authorities to settle reparations over the deadly 2015 collapse of a tailings dam, an executive said on Thursday.

The Mariana dam collapse caused a wave of toxic tailings that killed 19 people. It left hundreds homeless, flooded forests and polluted the entire length of the Doce River.

"It doesn't mean that (an agreement) will be signed by the end of June, because that depends on the construction of the definitive documents, but by the end of June we hope that there will be a consensus," said Alexandre D'Ambrosio, Vale's executive vice-president of corporate and institutional affairs, at an event in Rio de Janeiro.

A definitive agreement could take at least another month, he said. D'Ambrosio's remarks come a day after Vale, Australian miner BHP and their joint venture Samarco presented Brazilian authorities with a new offer to settle reparations for the dam collapse after Brazil rejected its previous one.

The miners' proposal totals 140 billion reais ($26.08 billion), which breaks down to 82 billion reais to be paid to the federal government and the Minas Gerais and Espirito Santo states over 20 years, 37 billion reais they have already spent and 21 billion for future obligations, such as the removal of tailings from the Doce River. In 2019, another Vale-owned tailings dam in Brumadinho, Brazil collapsed, killing 270 people.

($1 = 5.3674 reais)

Reuters / June 13, 2024

➤ Gemfields fetches almost $69 million at ruby auction

Ruby in the rough. (Image courtesy of Gemfields | Facebook.)

Coloured gemstones miner Gemfields (LON: GEM) (JSE: GML) said on Wednesday it sold almost $69 million of mixed-quality rubies at its June auction, with 97% of the offering gone.

The auction marked the 10th anniversary of Gemfields' first sale of rubies from the Montepuez mine in Mozambique, the world's richest known deposit of the precious red stones. The operation is 75%-owned by Gemfields and 25% by its local partner, Mwiriti.

"While auction results should not be directly compared, our team is proud to have crossed the milestone of an average selling price of $300 per carat at this auction," Adrian Banks, Gemfields' MD of product and sales, said in the statement. The total was still lower than the $80.4 million Gemfields collected around the same time last year and slightly below the $69.5 million obtained from December's ruby sale.

The company, which also produces emeralds at the Kagem mine in Zambia, acknowledged the precious gemstones industry, particularly the diamond sector, continues to face headwinds. The diamond industry faced substantial challenges last year, with a global decline in demand for roughs gemstones that affected prices. Economic challenges in key markets included China and the US, coupled with increased supply of lab-made diamonds, prompted jewellery retailers to adopt a cautious approach. This impacted diamond and coloured gemstones sales, contributing to the overall profit decline of top producers.

Gemfields' pre-tax profit nose-dived 86% last year, due partly to the cancellation of an emerald auction in November, a lower number of carats sold overall and a write-down in its platinum group metals investments.

Confidence

The company, which has just appointed former De Beers chief executive Bruce Cleaver as chair and independent non-executive director, remains optimistic about the market direction. "We've announced another strong result demonstrating the confidence that loyal customers have in our product offering and auction platform," Banks said. "We hope this result provides good comfort to other stakeholders in our sector."

Gemfields believes the coloured gemstone market is relatively safe from the emergence of lab-grown alternatives, as man-made rubies and emeralds have existed for more than 120 years and haven't taken market share away from the mined gemstones segment. Shares in the precious stones miner jumped more than 5% on the news and were trading at 13p in London mid-afternoon. The stock closed 4.9% higher Johannesburg, leaving Gemfields with a market capitalization of 3.49 billion South Africa rand (about $195m).

Cecilia Jamasmie, Mining.Com | June 19, 2024

➤ India's coal import rises 13% to 26 MT in April

India's coal import rose by 13.2 per cent to 26.10 million tonne (MT) in April 2024 as buyers took fresh positions amid early onset of summer. The country had imported 23.05 MT of coal in the year-ago period, according to data compiled by B2B e-commerce company mjunction services ltd. This comes amid coal and mines minister G Kishan Reddy stating that India should increase domestic production of the fossil fuel and reduce coal imports. "India's coal and coke imports in April 2024 through the major and non-major ports increased by 13.2 per cent over April 2023," the data showed.

Of the total import in April, non-coking coal import stood at 17.40 MT against 15.15 MT in the year-ago month. Coking coal import was 4.97 MT against 4.77 MT. "There was an increase in volumes...Going ahead, there may be continued demand from both the power and non-regulated sectors due to pre-monsoon restocking," mjunction MD & CEO Vinaya Varma said.

Coal imports in April were up by 8.93 per cent as against March when imports stood at 23.96 MT. India's coal import rose by 7.7 per cent to 268.24 MT in FY24 driven by softness in seaborne prices and likelihood of increase in power demand during summer.

The country's coal import was 249.06 MT in FY23.

PTI | Jun 16, 2024

TIME TO START LITHIUM MINING IN INDIA

Dr. T. M. BABU

Abstract

Lithium is a recently discovered modern metal, found just about two centuries ago. Unlike copper, gold, tin and other metals it is not known to people of ancient civilizations. Its importance and demand was realized due to its light weight and after discovering its capability to store more electricity in rechargeable batteries. This metal is found in almost all continents. But its production is limited to a very few selected countries only.

The world is producing more than one hundred thousand tonnes of lithium metal per year at present. Australia, Chile, China are the main lithium producers. It is estimated that the world has about 22 million metric tons of reserves and nearly hundred million tons of resources from about 150 occurrences identified.

In India presence of lithium metal is discovered right from north in Himalayan Mountain ranges of Jammu and Kashmir, central states and down below to south India in Karnataka and Andhra Pradesh. About 105 lithium prospects have been found in the country. But ironically, there is no single lithium producing mine in India due to more than reasons. The first reason is certain government restrictions and controls for mining this metal by any Indian individuals and companies till recently. Non-development of technology, methods and not prioritizing to recover lithium economically within the country from the known prospects and resources are other reasons.

Now the government of India relooked, realized, and removed many undue restrictions and opened the doors for the Indian public for lithium exploration, mining, and production. Thus, there is scope now and high hope to start the first mine to produce lithium in India in near future.

***Key words**: Lithium, exploration, occurrences, mining, production, world, India.*

1. WHITE GOLD

Lithium is a silvery-white metal which could float on water. It is a soft metal that could be cut into pieces even by a kitchen knife (Fig.1). It is one of the rare metals in the world which is being produced from underground salty water sources. It is highly reactive and flammable and has to be stored in vacuum, inert liquid like kerosene or mineral oil. It corrodes quickly when exposed to air, tarnishes and turns into black color. It is not found in nature in free form as metal. Due to its recently developed high demand for making lithium-ion batteries for use in electrical cars and other vehicles, some people started calling it "White Gold."

It is not a common metal like iron, copper, aluminum, lead and zinc which are found on earth in adequate quantities. But it is also not considered very rare or scarce like gold, platinum, tin, tungsten and such other strategic sporadic metals. The earth's crustal rocks in general are estimated to contain 0.0020% or about 20 parts per million of lithium. That means a kilogram of normal rocks overall contain about 20 milligram of lithium metal. It is estimated that the entire sea water contains about 230 billion tonnes, which is more than the lithium available in the rocky continental earth crust. But lithium metal content in sea water is less than 0.0001% or <1 ppm making it difficult and not economically viable to produce. Lithium forms certain minerals which are concentrated in a few types of rocks to enable mining and extraction.

In Greek "Lithos" means stone. As the first discoverers found this metal in a stone, they considered it proper to name it as stone metal- the lithium. Its chemical symbol is Li. Atomic number 3, atomic weight 6.94 and specific gravity of 0.534 nearly half of water. Its hardness in Moh's scale is 0.6, indicating it is a very soft metal, less hard than soapstone. In the periodic table, it is in Group 1 (Ia) in the alkali metal group.

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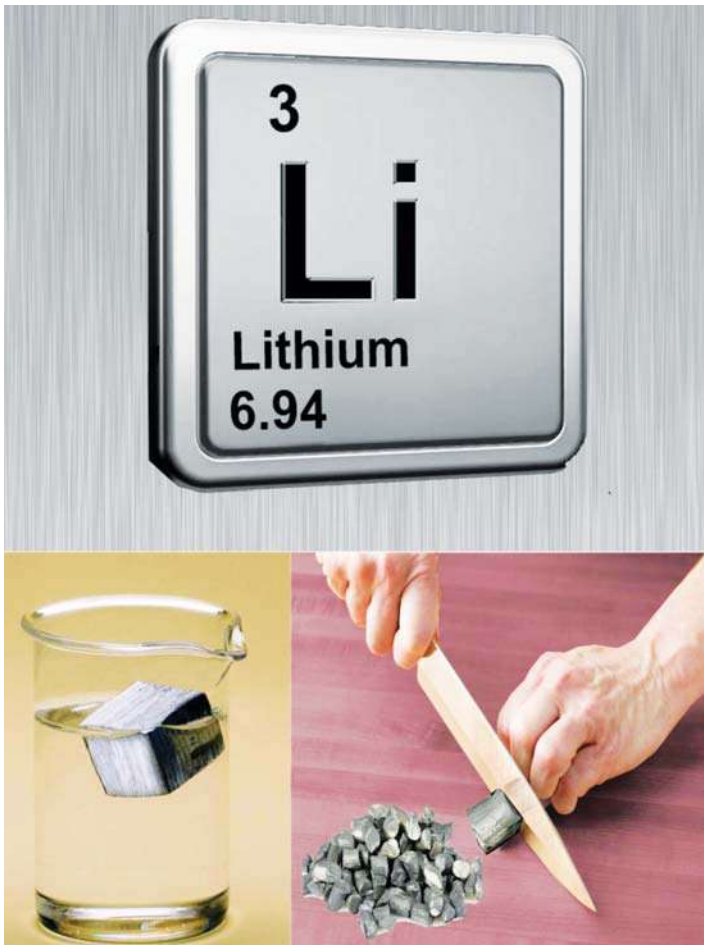

Fig. 1 Lithium, silvery white metal with Atomic No:3, Atomic weight: 6.94 with very low specific gravity which makes it float on water and soft enough to cut to pieces with a kitchen knife.

2. USES: CELL PHONES TO PACEMAKERS

Lithium because of its low specific gravity- lightweight has many industrial applications. However, due to its reactive and flammable characteristics, it is not used directly as a separate individual metal. It is mixed with aluminum and sometimes magnesium to make it a tough lightweight alloy and used in making aerospace-aero-nautical engineering parts and many industries where ever low weight is required. In production of iron and aluminum metals, lithium compounds are used as flux additives. It is used in manufacturing heat-resistant glass and ceramics to store hot liquids and food materials so that the cups and earthenware containers will not crack and break due to high heat. Lithium grease lubricants are used in automobiles for wheel bearing and chassis applications as it has good water and temperature resistance. It is the most popular grease deployed in most lubrication requirements as it has adhesive ability to metals and stays long. Lithium is also used in wind turbines.

In medical fields, lithium compounds are used for psychiatric treatment. Its compounds are given to patients to treat mood disorders like mania, frenzied and abnormally excited mood, bipolar disorders, episodes of depression, and other excitements. Lithium compounds work in decreasing the abnormal activity of the human brain like rushed speech, aggression, and anger. The protective effective use of lithium against cancer treatment is due to its influence on body cells. Lithium modulates oxidative stress, inflammation, mitochondrial dysfunction, and cellular homeostasis relating to the aging process.

Now the largest demand for this metal is in manufacturing lithium metal batteries and lithium-ion batteries. Lithium metal batteries are primary batteries that have metallic lithium as anode. Tiny lithium cells can produce voltage from 1.5 to 3.7 Volts. Lithium-ion or Li-on batteries are rechargeable. It uses reversible intercalation of Lithium positive ions into electronically conducting solids to store energy. It is found to have high specific energy, high energy density, efficiency, and long cycle life. There is a great global demand for rechargeable lithium batteries for cell phones, laptops, cameras, automobiles and many other electronic devices including life-saving Pacemakers for the heart(fig.2).

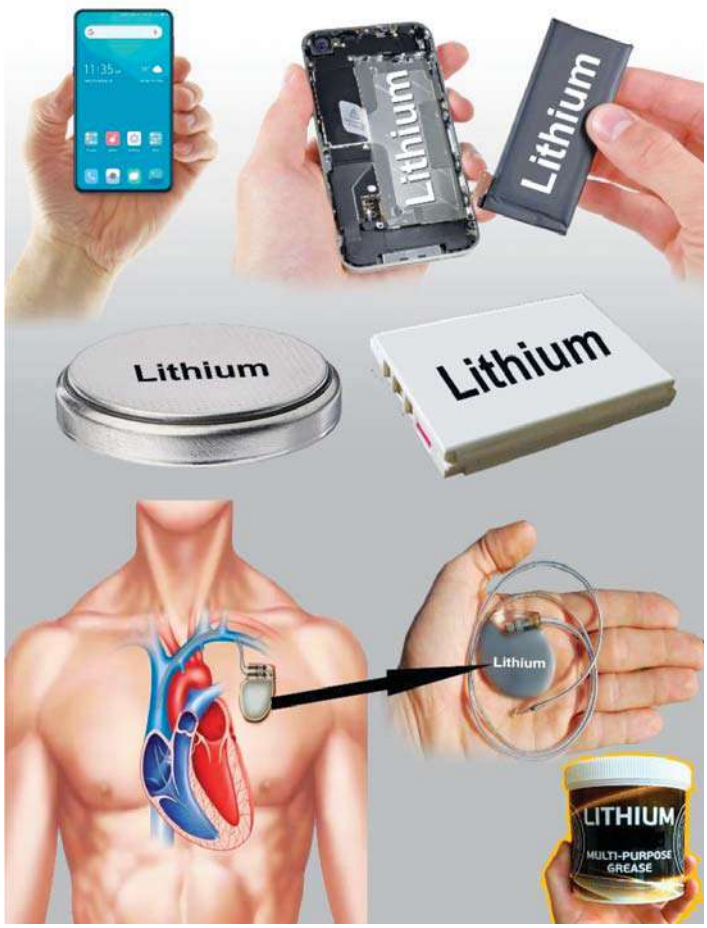

Fig.2. Lithium is used in various applications right from mobile phones, button cells, rechargeable batteries, all-purpose lubricant to life saving pacemakers for the human heart.

Demand for lithium multiplied for manufacturing electrical cars. in which rechargeable batteries are used instead of diesel and petrol. For its weight, it stores more energy than any other metal or material. Now on a global scale lithium is used nearly 75% for making batteries, 14% for lubricating greases, 3% for making continuous casting mold flux powders, and the rest for other applications.

3. HISTORY

Lithium is not known to the ancient world like gold, copper, tin, and other metals which were discovered several centuries back. None of the people of great old civilizations like Babylonia, Egypt, Greece, Rome or Indus Valley were aware of this metal. It was totally an unknown and unidentified metal even 250 years ago. About 220 years back in the year 1800, in an island of Uto, in Sweden, Jose Bonifacio de Andrade e Silva, a Brazilian naturalist discovered a new mineral and named it as Petalite. Seventeen years later in 1817, Johan August Arfedson (Fig. 3), a Swedish chemist found a new metal in that Petalite mineral. He discovered that the new element-formed compounds like that of sodium and potassium were well-known elements during that time. Bezelius, the chemist named that lithium-bearing compound of that product as “lithion-lithina”. As this new material found within a rock, he chose to name it as a rocky metal. Thus, the metal got the name finally as “Lithium”

Arfedson further investigated and found that metal is also found in other minerals like spodumene and lepidolite. But he could not succeed in separating out and isolating lithium as a pure metal from its compound or from the mineral Petalite which was Lithium-aluminum-silicate. In 1821 William Thomas Brande finally succeeded in obtaining pure lithium by electrolysis process of lithium oxide.

Fig.3 Bonifacio, Brazilian naturalist discovered Petalite lithium mineral in 1800 and Johan August Arfwedson, Swedish chemist found lithium in it in 1817.

4. OCCURRENCES

There are two main sources from which lithium is being recovered now in the world. The first one is from lithium-bearing hard rocks and minerals by regular mining. The second important source is underground brine water deposits. In addition to these two main sources, lithium is also found in geothermal oilfield brines and volcano-sedimentary basins which could become future resources. Lithium oxide content from which the metal is extracted generally ranges from 0.5 to 1%. But from brine deposits it could be extracted even from a low concentration of 0.1%. Main lithium bearing minerals are 1) Spodumene, 2) Lepidolite, 3) Petalite and 4) Amblygonite.

Spodumene mineral with composition of lithium-aluminum silicate is the main source of lithium. It was first discovered by Jose Bonifacio de Andrada e Silva, a Brazilian naturalist. Its name is derived from Greek which means burnt out ashes as it appeared like that when he first found it. Spodumene also occurs in different colors such as grey, pink, violet, yellow or green. Rare transparent form of this mineral could even become a gemstone. It occurs in elongated prismatic form in the monoclinic crystal system. It is found in silica rich acidic rocks like granites, pegmatites. Large quantities of Spodumene in pegmatites were found in the Manono area, in DR Congo, Central Africa. Later, spodumene was reported in several countries like Australia, Afghanistan, Madagascar, Quebec in Canada, North Carolina and California in USA, India, Pakistan and many other countries. Now most of the lithium from Australia is recovered from spodumene minerals. Of all other minerals spodumene which could contain about 8.1% lithium oxide emerged as the main ore mineral. The beneficiated spodumene concentrate used for lithium extraction generally ranges from 6 to 7% Li2O.

Lepidolite is a lithium bearing mica mineral with chemical composition of Potassium-lithium-aluminum- silicate containing rare elements like rubidium and fluorine. It is another source for lithium. **Petalite** is also a lithium-aluminum-silicate mineral with a chemical formula as Li-Al-Si4-O10. It is formed in a monoclinic crystal system with eye-catching bright pink, blue, green, yellowish color shades. As mentioned above, lithium is discovered first from this mineral. **Amblygonite** is a fluorine-lithium-sodium-aluminum phosphate mineral that occurs generally as white-creamy-pale yellow-green grey-brown or pink colors. It occurs in pegmatite rocks along with spodumene and lepidolite.

It is projected that in future, lithium is likely to be produced from hectorite and jadarite minerals found in some sedimentary basins. In addition to these common lithium minerals there are some minerals like **zinnwaldite, triphylite, eucryptite** and others which are rare and are of academic research interest at present.

5. ABC-LITHIUM TRIANGLE

In addition to the lithium minerals found in hard rocks, there are salty saline underground water basins enriched with lithium. Such lithium bearing brines are found mostly in the South American continent. Those saline ground water deposits enriched in dissolved lithium salts are in closed basin systems at few places. Those occurrences developed in certain geological settings, arid climatic conditions and enabled economic extraction of this metal. That type of deposits are also known as salt lakes or salt flats. Such deposits are found in the Andes in the South American continent spread out in three countries **A**rgentina, **B**olivia and **C**hile called the ABC lithium triangle.

Main lithium resources are found at Salar de Arizaro in Argentina, Salar de Uyuni in Bolivia and Salar de Atacama in Chile. Of these three countries the Atacama of Chile has the highest concentration of lithium up 0.15% by weight. It is claimed that more than half of the world's lithium resources are locked up here.

In addition to the continental brine deposits, there are geothermal-hot water deposits rich in lithium content found mostly near tectonic plate boundaries. Such types of deposits accounts for about 3% of world lithium resources. Salton Sea in California geothermal fields is claimed to supply about one third of world lithium demand. Rhine valley in Germany is another example. Deep oil reservoirs also contain lithium bearing brines as found in oil fields of North Dakota, Wyoming, Oklahoma, Arkansas and Texas in the USA. Such oil field brines, found to have from 150 to 700 milligrams of lithium per liter.

Recently it is found that from those brines, along with lithium even potassium and boron could be extracted as by products. In general, the brines containing 200 to 4000 milligrams per liter could be recovered economically. All the brines deposits are dated to be of 2.6 million years of Quaternary to Recent geological time period. 5.0 Worldwide distribution

Lithium occurrences are found practically in all continents all around the world. About 156 lithium occurrences were identified till now from more than 30 countries (Table No. 1 and fig.4). Australia, Brazil and Zimbabwe extract lithium from hard rock pegmatites and granites. In Argentina, Bolivia and Chile, lithium is recovered from salt water- brine deposits. In China lithium is being recovered both from hard rocks, minerals and brines. Extraction of lithium from other sources like geothermal brines and sedimentary basins are considered as future possibilities. Now the world is estimated to have nearly hundred million tonnes of lithium resources as per United States Geological Survey Mineral Commodity Summaries published in January-2023. Australia, Chile and China are main lithium producers. Argentina, USA, Bolivia and Brazil are the next significant lithium producing countries. Many countries are exploring now to start lithium production in the future realizing its importance.

Fig. 4 Lithium deposits and potential prospects in various countries in the world. Main lithium producers are in red and other lithium bearing countries in green color titles.

6. WORLD RESOURCES AND PRODUCTION

Bolivia is reported to have the largest established lithium reserves in the world. As per USGS Mineral Commodity Summaries it has 21 million tons of lithium resources followed by Argentina with 17 million tons, Chile with 9 million tons and Australia with 6.3 million tons. Recently India projected about 5.9 million lithium ore resources from Jammu-Kashmir in Himalayan Mountain ranges.

Now the world is producing about 130,000 tonnes of lithium per year. Australia is the leading country mining the largest quantities of lithium followed by Chile, China and Argentia. There are about 11 significant lithium producing countries in the world as shown in table No. 2.

There are many companies acquired skills and involved in lithium production. 1) Albermarle Carolina based in North Carolina is top lithium producer. 2) SQM company operations are in Chile, 3) Gangeng Lithium is mainly in the electric vehicle battery supply chain. 4)Tianq Lithium of China is the world's hard rock lithium producer. 5) Pilbara Minerals owns Pilangoora lithium-tantalum asset in Western Australia, 6) Min Res - Mineral Resources of Australia is involved in Mount Marion lithium operations, 7) Allkem of Argentina is operating in the Puna region of Northern Argentina. In addition to these main seven there are several other companies like Jiangxi Special Electric Motor, Yongxing, Sinomine Resource, Livent and Youngy in trading and marketing of lithium.

Table No. 2. Lithium producing countries in the world as per Mineral Commodities summaries 2023-United States Geological Survey-USGS. Production in tonnes.

Table No. 1 Lithium bearing countries with 156 mines and potential prospects

No	Countries	Lithium mines/ occurrences	No. of mines/ prospects
1	Australia	1)Finniss, 2) Pilgangoora-Pilbara, 3)Pilangoora-Altura, 4) Wodgina, 5) Kathleen Valley, 6)Mount Holland, 7) Greenbushes, 8) Mount Cattlin, 9) Mount Marion, 10)Bald hill, 11) Buldania, 12) Narraburra, 13)Earl Grey, 14)Silver Peak, 15)Potosi	15
2	Chile	1)Salar Atacama, 2)Salar de Aguilera, 3) Salar de Pedernales, 4)Salar de Maricunga	4
3	China	1)Zhabuye Salt Lake, 2) Dangxiongcuo, 3) West Taiji Nai'er, 4) East Taiji Nai'er, 5) Xitai Ji Naier -Qinghai Salt Lake, 6)Xinjiang 7) Sichuan Aba, 8) Maerkang, 9)Jiajika, 10) Ningdu, 11) NW-China, 12)Tibet, 13)Inner Mongolia, 14)Dongtai, 15)Chaidamu basin, 16)Sichuan, 17)Henan, 18)Jiangzi and 19)Hunan	19
4	Argentina	1)Salar de Olaroz, 2) Salar de Caucharí, 3) Salar del Rincón, 4) Salar de Pozuelos, 5) Salar de Pastos Grandes, 6) Salar de Ratones, 7) Salar de Diablillos, 8) Salar del Hombre Muerto, 9) Catamarca, 10)Antofalla-Albermarle	10
5	U.S.A	1)McDermit, 2) Kings Valley, 3) Clayton valley-Silver Peak, 4) Bonnie Claire, 5) Boron, 6) Salton Sea, 7) Clayton North, 8) Magnolia, 9) Kings Mountain, 10) Thacker Pass, 11) North Paiute, 12) Western-Shoshone-Nevada continental brine operations, 13) North Carolina, 14) California	14
6	Brazil	1)Mibra, 2) Mina da Cachoeira, 3) Jequitinhonha, 4) Volta Grande, 5) Grota do Cirilo-Minas Gerais, 6) Xuxa deposit, 7) Barreiro, 8) Nezinho do Chicao,	8
7	Zimbabwe	1)Kamativi, 2) Zulu, 3) Bikita-Masvingo province, 4) Arcadia,	4
8	Portugal	1)Mina do Barroso+ 3 Others, 5) Barroso-Boticas, 6)Covas do Barroso, 7) Alijo	7
9	Bolivia	1) Salar de Coipasa, 2) Salar de Uyuni, 3) Salar de Pastos Grandes,	3
10	Canada	1)Tanco, 2) Separation Rapids, 3) James Bay, 4) Rose, 5) Whabouchi, 6) Val-d'Or, 7) Manitoba, 8) Winnipeg River-Cat Lake,	8
11	Namibia	1)Uis, 2) Karibib, 3) Omaruru, 4) Brockmans, 5) Karlsbrunn, 6)Xinfeng.	6
12	DR Congo	1) Manono, 2) Kitotolo,	2
13	Mali	1)Bougouni, 2) Goulamina,	2
14	Spain	1)Valdeflórez/San José, 2) Alberta I,	2
15	Afghanistan	1)Parun area, 2) Nuristan area	2
16	New Zealand	1) Ohaaki,	1
17	Mexico	1)Sonora	1
18	Peru	1) Falchani, 2) Lake Titicaca region	2
19	Finland	1)Lantta, 2) Kaustinen-Western Finland and 4 others)	6
20	United kingdom	1)United Downs, 2) Chedeville	2
21	France	1) Chédeville, 2) Beauvoir mine-Allier dept. and 4 other prospects, 6) Rittershoffen	6
22	Germany	1)Upper Rhine Valley, 2) Zinwald and 4 others	6
23	Czech Republic	1)Cinovec,	1
24	Austria	1) Wolfsberg,	1
25	Serbia	1) Jadar	1
26	Ukraine	1) Polokhovskoe and 2 other prospects	3
27	Ghana	1) Ewoyaa	1
28	Ethiopia	1) Kenticha	1
29	South Africa	1)Blesberg-Northen Cape	1
30	Russia	1)Murmansk region	1
31	India	1)Jammu-Kashmir-Salal-Haimna:Reasi and others, 2)Ladakh, 3)Himachal Pradesh , 4) Rajasthan state prospects, 5)Bihar state prospects, 6)Arunachal Pradesh state prospects, 7)Assam, 8)Nagaland prospects, 9)Meghalaya, 10)Gujarat, 11)Madhya Pradesh, 12) Jharkhand, 13) Chhattisgarh, 14)Odissa, 15)Karnataka, 16)Andhra Pradesh state .	16
		TOTAL	156

No	Countries	Production (tonnes/year)
1	Australia	61,000
2	Chile	39,000
3	China	19,000
4	Argentina	6,200
5	United States	5000
6	Brazil	2,200
7	Zimbabwe	800
8	Portugal	600
9	Bolivia	540
10	Canada	500
11	Namibia	500

7. LITHIUM IN INDIA

India has more than hundred lithium bearing areas from North Himalayan Mountain ranges of Jammu-Kashmir-Ladak, to Peninsular cratonic regions of Central to South Indian states as shown in fig. 5 and table No.3. Though lithium occurrences were discovered in India long back, no efforts were made to mine and produce the metal.

About hundred years back, in pre-independent colonial rule of India, H. Crookshank, Superintending geologist of Geological Survey of India (GSI) located lithium from Bastar district which is now in Chhattisgarh state of Central India. More than fifty years ago in 1967, GSI published his classical work as Memoir No. 87. In that publication lithium bearing lepidolite is reported in pegmatite near Mundval village which he declared that lithium could be extracted. He reported that the area is richer than the material used in Germany. He investigated two lepidolite bearing pegmatites. The first one is about 400 yards south of Mundval and another 600 yards southwest of it. He laid a shallow trench cutting across and exposing 30 feet wide pegmatite in a 15 feet central part containing the lithium ore. He reported that the pegmatite has 70% lepidolite and 30% quartz and felspar. GSI lab analyzed 3.34% of Li O and 4.48% fluorine from the samples he collected from that area. He wrote that it should be possible to get about 15 tons of rock containing about 30% lithia mica for every foot in depth to which pegmatite is quarried. According to him about 200 tons of ore could be extracted from that area per year and could be shifted to the major nearby town Rajahmundry.

Around the year 1975, while carrying out an investigation for lithium from that area tin-niobium-tantalum rare metals-mineralization was discovered in the pegmatites. Later such lepidolite bearing pegmatites were found around Govindapal, Chuirwada, Chitalnar and adjoining villages. Further exploration revealed widespread extensions of pegmatites in the adjoining state at Mundaguda-Koraput district of Orissa. In the book Tin in India published in 1994 by Geological Society of India, lepidolite bearing pegmatites have been reported. With time all information about lithium found in that area was ignored and forgotten.

During the field season report 1996-97 of GSI, lithium was reported in bauxite in Salal-Ransuh area at the banks of Chenab river in Udhampur district. At places the bauxite-the aluminum ore analyzed up to 3529 ppm lithium in Jangalgali and Subathu formations in Jammu and Kashmir. In February 2023, the Ministry of Mines of Government of India highlighted about 5.9 million tonnes of lithium ore resources in Salal-Haimana area of Reasi district in Jammu-Kashmir state. It is reported by GSI that the area was taken up initially for investigating limestone. But in turn, in addition to the limestone, aluminum-ore- bauxite and lithium presence have come to light. After locating lithium in the Salal area, exploration was extended in and around Panasa-Dugga-Baldhanun-Chakar-Sangarmarg (Saro-da-Bas) areas in Reasi district of Jammu and Kashmir during the field season 2023-24. Government officials in Jammu-Kashmir announced that the process of public auctioning lithium bearing Reasi block for detailed exploration will be taken up soon.

In Rajasthan state in 2023 Geological Survey of India reported that pegmatites emplaced in Rewat hill, Degana, Nagaur district have lithium and tungsten of economic significance. Even the old mine tailing dumps were found to contain up to 6701 ppm (0.67%) of lithium. It is published by GSI that Rewat Hill tailing dumps have “enormously high values of tungsten and lithium along with tin, molybdenum and tantalum” and reported that “economic viability of tailing dumps is feasible.”

Then in South India in Karnataka state lithium reserves of about 1600 tonnes have been projected from Maria-galla, Allapatna in Mandya district. Another lithium prospect was found at Amareshwar area, about 14 km west of Hutti Gold mines in Raichur district. This area lies in between Guntgol-Devarbhupur-Parampur. Spodumene bearing pegmatites are found within an oval shaped schist belt. Perennial Krishna River flows on the north side of the schist belt. Lithium is mainly in a spodumene mineral. From here a sample analyzed up to 1.85% of Li2O.

In India lithium is invariably associated with tin-niobium and tantalum in Govindpal-Mundval area in Chattishgarh and

Nako- Kinnaur District in Himachal Pradesh. In other states like Rajasthan, Bihar and Jharkahnd it is associated with tungsten, molybdenum, and rare earth elements. In Gujarat lithium is associated with cesium. In Kesmar-Mendakheda area, Betul District of Madhya Pradesh along with lithium, scandium enrichment was reported. Thus, lithium could be recovered along with other rare metals to make it economically viable.

Union Minister of Mines of Government of India on 15th March, 2023 has given a written reply in Lok Sabha in Parliament house, New Delhi a long list of 40 "lithium deposits" found in the country. Mainly based on the present published reports and information available there are more hundred possible target areas for lithium in India which are summarized and in table No. 3 and fig. 5.

Table No. 3 Lithium bearing prospects and potential areas in India which could be developed as production mines after detailed exploration and feasibility studies.

No.	State	Prospect Names	No. of prospects
1	Jammu-Kashmir	1)Salal-Haimna:Reasi Dt, 2)Sersandu, 3) Kherikot 4)Rahotkot, 5)Darabi:Reasi-Dt, 6)Salal-Panasa, 7)Sangarmarg 8)Saroda Bas), 9)Dugga, 10)Baldhanun-11) Chakar:Reasi,12)Jangalgali fm.: Udhampur Dt.	12
2	Ladakh	1)Tsokar,2) Pangong, 3)Tsomorari, 4)Kyagar, 5)Kyun Tso: Leh Dt.	5
3	Himachal Pradesh	1)Nako : Kinnaur Dt.	1
4	Rajasthan	1)Degana, 2)NW-Rewat-hill, 3)SE-Rewat hill, 4)Mohangarh:Nagaur Dt, 5)Kotariya-Pipaliya-Gurha:Ajmer+Pali+Nagaur Dts, 6)Siwana-granite-:Nagaur-Dt. 7)Ajmer and Pali. 8)Saraswati River Paleochannel:Jodhpur, 9) Barmer Dt. 10)Sahela-11)Karola 12) Siras, 13)Bassi14)Parana: Tonk Dt+ Sawai Madhopur Dts, 15)Sibagaon, Uttara-Balda: Sirohi Dt. 16)Khuna-Merpur-Pandibor : Udaipur Dt	16
5	Bihar	1)Pichhli, 2)Meghatari:Nawada Dt., 3)Bijaia, 4)Monghyr Dt Mica belt, 5)Parmania-Tetariya:,Jamui Dt, 6)Harni–7)Kalwadih-8)Charkapthal : Jamui Dt	8
6	Arunachal Pradesh	1)Nafra :West Kameng Dt, 2)Pullung, 3)Paniduriya, 4)Borduria, 5)Kaimoi : Tirap Dt	5
7	Assam	1)Dhirbil- Dhubri Dt, 2)Goalpara Dt,	2
8	Nagaland	1)Hutsu, 2)Satuza and 3)Phor : Ri-Bhoi	3
9	Meghalaya	1)Umlyngpung, 2)Mylliem and 3)Lailynkhwir : East Khasi Hills. 4)Williamnagar- 5) Nengkhra, 6)Mangsang- 7)Niangbrakithim : East Garo Hills	7
10	Gujarat	1)Jodhsar-Unchidhanal:Banaskantha-Sabarkantha 2)Pathora-Digthali: Banaskantha and Sabarkantha Dt	2
11	Madhya Pradesh	1)Kesmar, 2)Mendakheda : Betul Dt	2
12	Jharkhand	1)Dhorakola, 2)Kusahna, 3)Pirha, 4)Tilaiya block: Koderma Dt, 5)Dhidhakola-Kusuma belt, 6)Gawan block of Giridih Pihra belt.7) East Singhbhum and 8)Hazari-bagh Dts	8
13	Chattisgarh	1)Govindpal, 2) Mundval, 3)Chuirwada, 4)Chitalnar: Bastar area, 5)Katghora Nagar, 6)Rampur, 7)Tarma Pahar, 8)Konkona: Korba Dt. 9)Tamta, 10)Raghunathur, 11) Sureshpur, 12)Raigarh, 13) Jashpur Dt. 14)Kilkila, 15)Diwanpur, 16)Manguru hills, 17) Maheshpur of Nawagaon	17
14	Odisha	1)Mundaguda-Koraput Dt, 2)Keonjhar, 3)Mayurbhanj 4)Deogarh Dt.	4
15	Andhra Pradesh	1)Tatireddi-palle, 2)Tadimarri, 4)Ellanuru, 5)Parnapalle, 6)Lopata-nuthala:Kadapa Dt. 7)Dadihota, 8)Turakavari-palli, 9)Nayanapalli :Anantapur Dt.	9
16	Karnataka	1)Amareshwar-Hutti, 2) Gurugunta schist belt Raichur Dt, 3) Maria-galla, 4)Allapatna: in Mandya district	4
		TOTAL	105

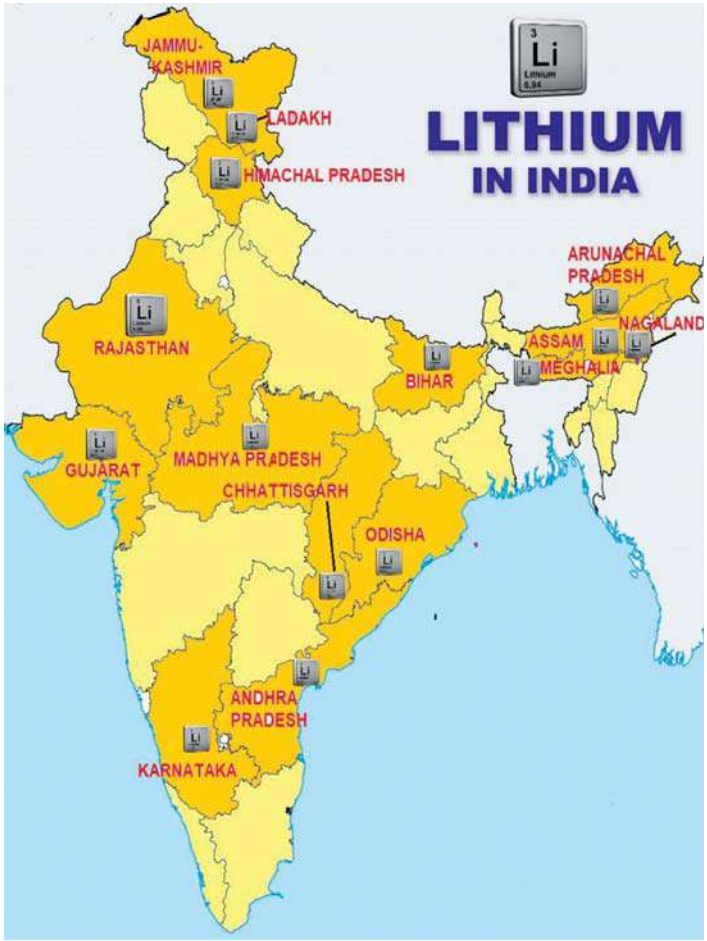

Fig.5 Lithium bearing prospects identified in Indian states from Northern Himalayas to South India as locations listed out in Table No. 3.

8. PRESENT STATUS IN INDIA

At present there is no single lithium producing mine in India. Total lithium requirements of the country are being imported. But, as cited above there are more than hundred lithium bearing areas in the country waiting to be developed and taken up for production.

Discovering the presence of lithium or any mineral commodity in any country is just a beginning and certainly not the last step. That first initial finding has to be followed up quickly with preliminary exploration to determine its length, width, depth, aerial extent and boundary limit extensions of the deposit. Then detailed exploration has to be taken up for finding the grade, resources and then reserve estimation progressively with more accuracy nearer to the truth. The approximate-possible-probable-inferred preliminary assessment of "resources" has to upgraded into proved-measured- "reserves" with highest level of confidence. Recoverability studies and mine planning are next steps. Pre-feasibility and final Feasibility studies are to be carried out about the economic viability and marketability of the product for taking up mining and metal production. These steps take several years to complete to bring the deposit into production state. In addition to these crucial steps "the political will and determination" is also necessary to move forward.

Geological Survey of India is an earth science organization which carry out geological mapping, identify a mineral bearing areas and carry out the preliminary assessment works. But it is not oriented to carry out the follow up steps like mine planning, metal extraction procedures, and economic feasibility studies to convert an occurrence into an economically mineable production center. Mineral Exploration Corporation of India is created for such follow up works. National Mineral Development Corporation objective is to develop the mineral deposits. There are several national metallurgical laboratories in India to develop metal recoverability studies. As indicated earlier, now there is no single lithium occurrence in India which reached final economic feasibility stage to take up mining and produce lithium metal. Some people point out that in India left hand doesn't know what the right hand is doing which needs to be corrected.

9. FUTURE DEMAND

In future there is high demand for lithium in India and in the entire world. The first Lithium-ion cell manufacturing Gigafactory with production capacity of 20 GWh is being established in Gujarat by Tata Group in collaboration with state government. Manikaran Power Limited is setting up lithium refinery in Gujarat. The company will be importing lithium ore from Australia for re-processing in Gujarat. TDS Lithium-ion battery Gujarat Private Ltd is first lithium-ion battery manufacturing plant. It is being set up in collaboration with Japan's Toshiba Corporation, DENSO corporation and Suzuki Motor Corporation to manufacture and supply batteries to Suzuki Gujarat plant in Hansalpur. Reliance Industries Ltd (RIL) announced plans to set up an Advanced Energy Storage Giga Factory. There are plans for building lithium-ion cell manufacturing plants in India by Adani Group, Bharat Heavy Electricals Ltd, Larsen and Toubro Ltd and Greenko Group. Thus, there is great demand for lithium in India. It is unfortunate that India signed an agreement with Argentina state owned enterprise of Catamarca province to explore and develop five lithium mines there ignoring and overlooking presence of lithium bearing prospects and resources within India.

10. NO ACTION IS NOT AN OPTION

It is paradoxical to discover and keep that discovery in idle condition. It is like a person or country having money and starving for food not knowing how to use it for betterment. The country will grow rich if it could develop the capacity,

capability to develop the technology, value addition to the mined-out product. Simple mining will only create employment of hard-working poor labor force who live on hand to mouth condition. Typical examples are several African countries in spite of mining metals and minerals like gold, diamonds, platinum and rare elements for several decades are still remaining poor, while only a handful of people got benefitted. The Western and European countries on the other hand who import the mined-out material from African countries and carry out value addition have accumulated more wealth became rich, mighty and powerful. In India mineral rich Bihar state is typical example of not making lives of locals better benefitted from extensive mining activities from coal to iron ore.

11. CONCLUSIONS- GOOD SCOPE AND HOPE

Lithium is emerging as the most sought-after future metal. More than a hundred lithium bearing areas have been identified in the country which is a good beginning. But those are to be explored for mine production with careful long-term planning rather than taking up the Argentina, Australia and other prospects for exploration investments and collaborations in far off countries. It is rightly reiterated by Dr. P.V. Rao in April-2024 editorial of MEJ. India has good talented persons and capable entrepreneurs to take up challenges in mining ventures. There are many national metallurgical and ore dressing laboratories which could develop techniques for economic extraction of lithium and associated minerals from several places in the country. Now the government of India removed the restrictions and controls of mining and production of lithium which was earlier under exclusive ownership and jurisdiction of government. Thus, there is ample scope, good hope and is right time to start the first lithium producing mine in India right now.

12. ACKNOWLEDGEMENTS

I thank Dr. P.V. Rao for his encouragement to write an article on present status of lithium prospects in India and the scope for future development.

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Dr LINGAMPALLY SAI VINAY'S REPORT ON VISIT TO GERMANY

Singareni Chapter

Dr. Lingampally Sai Vinay, Life Member of MEAI presented his work on "Mine Closure: Repurposing of Closed and Abandoned Mines and Diversification of Local Economy" at 17th Mining Forum Berlin, Germany, Europe. Dr Vinay was honoured with the Speaker's Award at the event.

The 17th Mining Forum 2024 in Berlin, was organized by DMT Group, and supported by the Federal Ministry for Economic Affairs and Climate Action, European Union. This biennial event was honoured with the presence of Hildegard Bentele, Member of the European Parliament, and other prominent personalities across the globe. The event focused on sustainable practices in the mining and raw materials industry and featured prominent speakers in various lecture sessions and panel discussions. The forum also includes an exhibition with more than 45 exhibitors from the industry, making it an excellent networking opportunity for professionals, researchers, and policymakers.

Dr RAGHUPATRUNI BHIMA RAO WINNER OF FEIAP ENGINEER OF THE YEAR – 2024 AWARD

Dr R Bhima Rao (second from Left) receiving the Award

Dr. Raghupatruni Bhima Rao, a Life members of MEAI-Bhubaneswar Chapter and a former CSIR Chief Scientist, is coveted with FEIAP ENGINEER OF THE YEAR AWARD FOR 2024, by the Federation of Engineering Institutions of Asia and the Pacific (FEIAP).

The FEIAP is an international non-profit organisation founded in 1978. It is an international member of WFEO and has 23 member economies. It invited nominations for FEIAP Engineer of the year award 2024 from the member economies. The purpose of this award is to encourage the engineers of young and veterans' great contributions to Engineering within Asia and Pacific Region.

This year the President of the Institution of Engineers of India (IEI), Kolkata, has nominated Dr. Raghupatruni Bhima Rao for the FEIAP ENGINEER OF THE YEAR AWARD-2024. The President of FEIAP was pleased to announce that Dr. Raghupatruni Bhima Rao has been selected for this Award. Though he has been invited to receive the award on 3rd May 2024 with his spouse at Taipei, Taiwan, he could not receive the same for want of VISA. Finally he received the award from the hands of the President of IEI, Kolkata during the semi council meeting.

Congratulations to Dr R Bhima Rao for the achievement!

MEAI NEWS

BELLARY-HOSPET CHAPTER

NATURE WALK AND SWACHHTA PROGRAMME

Date: 02.06.2024
Location: Sandur, Bellary, Karnataka

On 02.06.2024 a nature walk was organized in the picturesque hilly region of Bheema Theertha. The purpose of the nature walk was to explore the natural beauty of the area and promote environmental awareness among the participants. Chairman Shri. SHM Mallikarjuna, Secretary Shri. P Venkateswara Rao and other office bearers of the Chapter participated. Additionally, a Swachhta (cleanliness) programme at Surroundings of Narihhali Dam was conducted simultaneously to address the issue of littering and promote cleanliness in the region.

Nature Walk

The nature walk commenced at 6:00AM from Bheema Theertha Temple (bottom) with 47 enthusiastic participants, including nature enthusiasts, students, and local volunteers. Led by experienced guides, the group traversed through lush forests, meandering trails, and cascading streams, immersing themselves in the serene ambiance of the hilly landscape. Participants had the opportunity to observe diverse flora and fauna native to the region, including rare species of birds, vibrant wildflowers, and towering trees.

Throughout the journey, The Chairman/Secretary provided insights into the ecological significance of the area, highlighting the importance of preserving biodiversity and maintaining ecological balance. Participants were engaged in interactive discussions, sharing anecdotes and knowledge about the local ecosystem, fostering a deeper appreciation for nature and environmental conservation.

Swachhta Programme

Concurrently, a Swachhta programme was conducted along the nature trail to address littering and promote cleanliness. Equipped with gloves, trash bags, and other cleaning equipment, volunteers actively participated in removing litter and debris from the trail and surrounding areas.

Emphasizing the principle of "Leave No Trace," participants meticulously collected and segregated waste, including plastic bottles, wrappers, and other non-biodegradable materials.

The Swachhta programme served as a collaborative effort to mitigate the environmental impact of littering and instill a sense of responsibility towards waste management. Participants not only cleaned the immediate surroundings but also raised awareness about the importance of maintaining cleanliness in natural habitats to preserve their beauty and ecological integrity.

The nature walk to Bheema Theertha and Swachhta programme at Narihalli Dam proved to be enriching experiences, fostering a deeper connection with nature and promoting environmental stewardship among the participants. By engaging in immersive nature exploration and proactive cleanliness initiatives, the event underscored the significance of conserving natural landscapes and fostering sustainable practices for the well-being of present and future generations.

As we reflect on the event, it serves as a reminder of our collective responsibility to cherish and protect the beauty of our natural world, inspiring us to continue our efforts towards environmental conservation and promoting a cleaner, greener planet.

PLANTATION PROGRAMME On the occasion of WORLD ENVIRONMENT DAY - 2024

Venue: Government Girls High School & College, Hosapete
Date: 05.06.2024

The plantation drive was organized to commemorate World Environment Day and promote environmental awareness among students and the community. It aimed to instill a sense of responsibility towards nature and foster a greener, more sustainable environment.

Participants

- Around 25 Members and Office Bearers of the Bellary Hospet Chapter.
- Shri. K Madhusudhana, CEO M/s MSPL Limited & Immediate Past President MEAI.
- Shri. Anwar Basha, Principal, Government Girls College, Hosapete.
- Shri. Venkatesh Kulakarni, Principal, Government Girls High School, Hosapete.
- Around 28 Members of Teaching and non-teaching staff of Government Girls High School & College.

The event commenced with an opening address by Shri. SHM Mallikarjuna, Chairman, MEAI BH Chapter, emphasizing the importance of environmental conservation and the role of tree plantation in mitigating climate change. Members of the Chapter provided saplings of indigenous tree species for the plantation drive. More than 50 saplings of various types were successfully planted, contributing to the green cover of the newly constructed school and college premises. 165 Students, along with 28 teaching and Non- teaching staff, actively participated in planting saplings in designated areas within the school premises. The event concluded with a pledge to nurture the planted trees and continue advocating for environmental protection beyond World Environment Day.

MINUTES OF THE EXECUTIVE & DEVELOMENT COMMITTEE MEETING

Date: 19th June 2024
Venue: Hotel Mallige, Hosapete

The Office Bearers, Ex-officio and Council Members, Executive Committee Members, Development Committee Members, First-Aid Committee Members and Special Invitees attended the meeting.

Chairman SHM Mallikarjuna delivered a comprehensive welcome address highlighting significant updates and initiatives discussed in our previous session.

Mr. Mallikarjuna commenced his address by providing an update on the chapter's ongoing plot purchase initiative. He informed the audience that the necessary procedures for land registration are progressing smoothly, marking a significant step towards expanding the chapter's infrastructure and capabilities. Emphasized the significance of professional affiliation by instructing all executive body members to pursue fellow membership in the Mining Engineers Association of India (MEAI). The chairman discussed the chapter's efforts in organizing first aid classes, encouraged active participation in upcoming sessions to enhance knowledge and skills within the community. Then he elaborated on the success of the recent nature walk organized by the chapter. He expressed appreciation for the enthusiastic participation from members and acknowledged the invaluable support received from the Forest Department.

He urged all Mines Managers and representatives to enhance their involvement by sending more delegates to the

upcoming National Mining Conclave 2024. He stressed that increased participation from the Chapter's members is crucial for ensuring the grand success of the conclave

Mr K Madhusudhana emphasized the importance of safety in mining by discussing the implementation of first aid classes. He stressed the need for members to participate actively in these classes. In a proactive move towards community engagement, Mr K Madhusudhana advised the BH Chapter to submit a formal request letter to the Regional Transport Office (RTO) in Hosapete, Sandur, and Hosapete Bus Depot. highlighting the upcoming National Mining Conclave 2024 (NMC-2024).

Mr K Madhusudhana encouraged the mining organizations and other company representatives to increase delegate participation. He emphasized that robust representation from the company is essential for the event's success and for promoting the company's interests on a national platform. Also mentioned the support made by Shri. B Sahoo, during first aid permissions from various Govt bodies.

Mr Prabhakar Reddy has emphasized the critical need to update the MEAI website comprehensively. Recognizing the website as a pivotal platform for communication and information dissemination, his directive underscores the importance of reflecting current activities, achievements, and industry developments accurately. This advisory aims at enhancing transparency and engagement with stakeholders, ensuring that members and the public are well-informed about MEAI's initiatives and contributions to the industry. He also mentioned the financial support extended by Mr B Sahoo

Mr B Sahoo delivered a compelling message urging collective effort towards increasing funds for the organization. Recognizing the significance of financial sustainability, he stressed the need for strategic planning and proactive engagement from members. Mr B Sahoo highlighted the pivotal role of MEAI BH Chapter's own building initiative, inspired by the concept of Madhusudhana, as a cornerstone for future growth and stability. Moreover, he celebrated the achievements of the MEAI BH Chapter, noting numerous accolades received by its members. These awards underscored the Chapter's commitment to excellence and leadership within the industry. Mr B Sahoo's address resonated with a call to leverage these successes as catalysts for broader impact and continued advancement in technology and innovation. He suggested applying new technology in mining and wished the BH Chapter would grow to its greater heights.

The felicitation of Mr B Sahoo was a moment of profound honor and recognition, attended by esteemed figures including Mr K Madhusudhana, Mr Prabhakar Reddy, and office bearers of the Chapter. The event celebrated Mr B Sahoo's outstanding leadership and significant contributions to Mining Industry, highlighting his pivotal role in advancing the organization's goals of promoting industry excellence and fostering innovation.

Mr K Madhusudhana, Mr Prabhakar Reddy, and other office bearers of the Chapter expressed heartfelt appreciation for Mr B Sahoo's exemplary dedication and vision. They emphasized his instrumental leadership in driving strategic initiatives, including efforts to enhance membership engagement and establish MEAI BH Chapter's own building, inspired by Mr Madhusudhana's visionary concept.

Mr J Srikant, Treasurer started discussing agenda points and all the members present in the meeting discussed previous meeting minutes and approved unanimously.

Mr P Venkateswara Rao, Secretary BH Chapter thanked the Members present in the meeting and also thanked Hotel Mallige Staff for the arrangements made for the meeting in their premises.

RAJASTHAN CHAPTER-UDAIPUR

Report on Technical Talk on Basics and Benefits of Acupressure

A workshop on “Basics and Benefits of Acupressure” was held on June 1, 2024, at Terapanth Bhavan, Bhuwana, Udaipur. This event was jointly organized by the Mining Engineers’ Association of India (MEAI), Terapanth Professional Forum (TPF), and Jain Engineers Society (JES).

Muni Sambodh Kumar Medhansh, in his address, highlighted that acupressure is a non-violent, ancient medical system originating from India. He noted that traditional practices such as saying Namaste and shaking hands have integrated elements of acupressure into our culture. However, it is now often perceived as a technique imported from China. He emphasized that acupressure is a unique self-healing system that can be practiced anytime and anywhere.

Dr. Alpana Bohra, former Vice President of Voltas India Limited, served as the keynote speaker. She explained that the hands represent the entire body, and understanding the points on the hands can reveal the secrets of the body and the causes of diseases. Dr. Bohra demonstrated that clapping in the open air early in the morning can stimulate all the points on the body. She provided a live demonstration of acupressure treatments for various conditions, including kidney issues, bone problems, frozen shoulder, high blood pressure, and heart ailments.

Mr. A.K. Kothari, President of TPF and JES, welcomed the attendees and conducted the stage proceedings. He mentioned that the three organizations regularly host such monthly workshops, and this program was part of that series. Mr. Kothari highlighted the cost-effectiveness and lack of side effects associated with acupressure.

The keynote speaker, Dr. Bohra, was honored by several dignitaries, including Mr. M.S. Paliwal, President of MEAI, Mr. B.L. Khamesara, Founder and President of JES, Secretary P. Jain, Patron Member M.P. Jain, R. Chandalia, Secretary of TPF, National Joint Treasurer Mukesh Bohra, and Joint Secretary of MEAI Mr. Sunil Vashisht.

Mr. M.S. Paliwal, Chairman of the Chapter, expressed his gratitude and highlighted the value of the information provided during the live demonstration. He noted that acupressure is very helpful in relieving pain (such as knee and back pain), improving mental health and well-being, promoting better sleep, and reducing blood pressure and heart problems.

Over 50 members participated in the program, learning the techniques of acupressure therapy and resolving their queries. The hands-on approach and practical demonstrations were particularly appreciated by the attendees.

This workshop was a successful endeavor in promoting the understanding and benefits of acupressure among professionals and enthusiasts.

CONFERENCES, SEMINARS, WORKSHOPS ETC.

ABROAD

22-23 Jul 2024: **International Conference on Green Coal Mining Techniques and Waste Disposal ICGCMTWD 2024**. Berlin, Germany. Website URL: https://waset.org/green-coal-mining-techniques-and-waste-disposal-conference-in-july-2024-in-berlin

5-6 Aug 2024: **International Conference on Civil, Environmental and Geological Engineering ICCEGE**. Amsterdam, Netherlands. Website URL: https://waset.org/civil-environmental-and-geological-engineering-conference-in-august-2024-in-amsterdam. Program URL: https://waset.org/conferences-in-august-2024-in-amsterdam/program. Contact URL: https://waset.org

11-15 Aug 2024: **International Mine Ventilation Congress 2024**. The heartbeat of mining, Sydney, Australia. For details contact conference@ausimm.com.

16-17 Aug 2024: **International Conference on Mine Mechanization and Mining Policies ICMMMP 2024**. Tokyo, Japan. Website URL: https://waset.org/mine-mechanization-and-mining-policies-conference-in-august-2024-in-tokyo

29-30 Aug 2024: **International Conference on Geology and Geophysics ICGG**. Sydney, Australia. Website URL: https://waset.org/geology-and-geophysics-conference-in-august-2024-in-sydney. Program URL: https://waset.org/conferences-in-august-2024-in-sydney/program. Contact URL: https://waset.org

29-31 Aug 2024: **International Conference on Graphene and 2D Materials**. Valencia, Spain. Website: https://www.pagesconferences.com/2024/graphene-materials

2-4 Sep 2024: **International Future Mining Conference 2024**. #FutureMining2024, Sydney, Australia. 24 PD Hours. Contact: AusIMM T: 1800 657 985 or +61 3 9658 6100 (if overseas). Po Box 660 Carlton, VIC 3053, Ground Floor, 204 Lygon St, Carlton VIC 3053.

04-06 Sep 2024: **International Fairs EXPO KATOWICE 2024**. plac Slawika i Antalla 1, 40-163, Katowice, Poland. Contact: enquiries@globalminingreview.com

13-15 Sep 2024: **International Conference on Mining, Materials, and Metallurgical Engineering**. Johannesburg, South Africa. Website URL: http://www.cmmme.org. Contact E-mail: contact@cmmme.org

7-8 Oct 2024: **International Conference on Design Methods in Underground Mining ICDMUM 2024**. New York, United States. Website URL: https://waset.org/design-methods-in-underground-mining-conference-in-october-2024-in-new-york

24-26 Sep 2024: **MINExpo INTERNATIONAL 2024**. Las Vegas Convention Center, 3150 Paradise Road, Las Vegas, Nevada, 89109, United States. Contact: enquiries@globalminingreview.com

21-23 Oct 2024: **Mill Operators Conference 2024. #MillOps2024**, Perth, Australia. 24 PD Hours. Contact: AusIMM T: 1800 657 985 or +61 3 9658 6100 (if overseas). Po Box 660 Carlton, VIC 3053, Ground Floor, 204 Lygon St, Carlton VIC 3053.

29-30 Oct 2024: **Mining, Metals, and the Circular Economy 2024**. ICC Sydney, 14 Darling Dr, Sydney, NSW, 2000, Australia. Contact: enquiries@globalminingreview.com

03-05 Nov 2024: **Resourcing Tomorrow 2024**. Business Design Centre, 52 Upper Street, Islington, London , N1 0QH, United Kingdom. Contact: enquiries@globalminingreview.com

7-8 Nov 2024: **International Conference on Geology and Geophysics ICGG**. Istanbul, Turkey. Website URL: https://waset.org/geology-and-geophysics-conference-in-november-2024-in-istanbul. Program URL: https://waset.org/conferences-in-november-2024-in-istanbul/program. Contact URL: https://waset.org

7-8 Nov 2024: **International Conference on Geological Engineering ICGE**. Tokyo, Japan. Website URL: https://waset.org/geological-engineering-conference-in-november-2024-in-tokyo. Program URL: https://waset.org/conferences-in-november-2024-in-tokyo/program. Contact URL: https://waset.org

21-23 Nov 2024: **International Professional Geology. Zaragoza**, Spain. Website URL: http://www.icog.es. Program URL: http://www.icog.es. Contact URL: http://www.icog.es

18-19 Feb 2025: **International Conference on Geology and Geophysics ICGG**. Manila, Philippines. Website URL: https://waset.org/geology-and-geophysics-conference-in-february-2025-in-manila. Program URL: https://waset.org/conferences-in-february-2025-in-manila/program. Contact URL: https://waset.org

23-26 Feb 2025: **MINEXCHANGE 2025 SME Annual Conference & Expo and CMA 127th National Western Mining Conference** co-located with World Gold 2025. Colorado Convention Center, 700 14th St., Denver, CO 80202. Contact: cs@smenet.org

09-12 Mar 2025: **EnviroTech Athens - 2025** - The Gateway to Green Cement. Greece. Contact: enquiries@globalminingreview.com

8-9 Apr 2025: **International Conference on Geological Engineering ICGE**. Rome, Italy. Website URL: https://waset.org/geological-engineering-conference-in-april-2025-in-rome. Program URL: https://waset.org/conferences-in-april-2025-in-rome/program. Contact URL: https://waset.org

21-22 May 2025: **AUSTMINE 2025**. Brisbane Convention and Exhibition Centre. Contact: Jason Berman, Event Director, jberman@etf.com.au, +61 2 9556 7991

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