ISSN 0975 - 3001

Mining Engineers' Journal

SPECIAL ISSUE
NLCIL's CSR activities

Official Publication of
Mining Engineers' Association of India

Price ₹100/-

Vol. 23 | No. 6 | MONTHLY | January - 2022

Mining Engineers' Association of India
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ISSN 0975 - 3001

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this issue contains...

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President's Message.....

Dear members,

I wish to put forth the activities undertaken during last month....

I am delighted to share with you that the Union Minister Shri Pralhad Joshi addressed the **5th National Conclave on Mines & Minerals organised on 23rd November 2021 at New Delhi** and spoke on encouraging Exploration Activities, Auction Regime and Sustainable Mining Practices. 52 Potential mineral blocks were handed over to 15 State Governments to accelerate the process of exploration and bring the blocks to the auction stage within a short period. This will help in generating employment in the respective states and ensure an uninterrupted supply of raw materials to the industry. We appreciate the efforts of Ministry of Mines in propelling the mining sector towards better days.

On this Occasion, the Ministry of Mines and the Indian Bureau of Mines conferred Five Star rating awards to Mining Leases. The assessment rating is done based on the Sustainable Development Framework, which is a Comprehensive evaluation format with scientific mining, environmental management, contribution to the society, the welfare of employees & people of the local area, quality Accreditations, adherence to global standards, safety and compliance with mining and environmental Laws.

This is a national recognition conferred on a few mining companies in the country, which gives special status for these mining companies. Hearty congratulations to all those mines that were qualified for the five-star rating for three consecutive years. Myself, Dr. Meda Venkataiah, MEAI former President, Sri. D.B. Sundara Ramam, Vice president-III, many Chapter Chairmen & Secretaries, Council Members and Life Members of MEAI were present on this proud occasion. I, on behalf of our Association, would like to thank the Ministry of Mines for appreciating and recognizing the efforts of mining companies. This will have a positive impact on the mining sector and motivate the other mining companies to compete and improve their performance.

In an effort to convert my insights in to action plans, various committees of the Association started meeting and finalising the action plan/ road map for achieving MEAI Mission. The Editorial Board of Mining Engineers' Journal (MEJ), Training development & program committee and Minor Mineral committee held virtual meetings and established guidelines for publishing articles in MEJ, MEAI Professional Development Programme (MPDP) first series frame work and dates; and released a brochure in our Journal MEJ. Minor Minerals committee also finalised the action plan.

Our Association has conducted a '***National Webinar on Statutory Amendments in 2021***' on 8.12.21. I thank the presenters and the Chief Guest and congratulate them for holding an informative webinar through which mining fraternity got enlightened on the recent amendments made to MCDR, MCR, and Mines Auction Rules.

Happy to note that some of our Chapters also conducted technical talks and workshops.

I would like wish you all a Happy, Prosperous and Safe New year 2022.....

Regards,

K. MADHUSUDHANA
President

Mining Engineers' Association of India

Regd. Office : Rungta House, Barbil (Odisha)

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EDITOR'S DESK

Dr. P.V. Rao
Editor, MEJ

International Council on Mining and Metals (ICMM) is dedicated to a safe, fair and sustainable mining and metals industry. It strengthens environmental and social performance and serves as a catalyst for change, enhancing mining's contribution to society by bringing together 28 mining and metals companies and over 35 regional and commodities associations. The collective commitment of its members to net zero scope 1 and 2 GHG emissions by 2050 is a pivotal moment in its history.

Committee for Mineral Reserves International Reporting Standards (CRIRSCO) became a Strategic Partner of ICMM in October 2009. ICMM considers the work of CRIRSCO important both to society and to ICMM because if companies don't transparently report their Mineral Resources and Reserves in a standardized manner, stakeholders cannot accurately assess the risks associated with the project, an issue that will likely lead to increased distrust in the mining industry. As of 2021, membership of CRIRSCO stands at 14 National Representative Organisations (NROs) from many of the major mining jurisdictions, including India.

As the fresh aspects are evolving in the mineral industry, the Pan- European Reserves and Resources Reporting Committee (PERC) Standard 2021 for the Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves incorporated new features that were not part of CRIRSCO Template 2019. In the governing principles of PERC reporting standard, 'Accountability' has been included as the fourth principle in addition to Transparency, Materiality and Competence. PERC Standard also added 'Risk and Uncertainties' in its Scope and an exclusive Chapter on ESG (Environmental, Social & Governance considerations). The new features of PERC standard relevant to Public Reporting are highlighted below.

Public Reports are reports prepared for informing investors or potential investors and their professional advisers on Exploration Results (including Exploration Targets), Mineral Resources or Mineral Reserves. Public Reports include, but are not limited to, company annual reports, quarterly reports and other reports to regulatory authorities, or as required by law. The Public Reports must include sufficient context and cautionary language to allow investors to understand the nature, importance, and limitations of the data, interpretations, and conclusions summarized in the Public Reports. They must make readers aware of any risks and uncertainties that may affect the reliability of the data, interpretations, and estimates presented. Consideration of risks and uncertainties must include identifying events or situations that may have a negative effect (threat) or positive effect (opportunity) on anticipated outcomes. Public Reports that present the results of Technical Studies must include details of any risk assessments carried out, including planned risk management actions.

Stock exchanges and financial regulators are putting an increasing emphasis on the disclosure of risks and uncertainties associated with financial reporting by businesses, including: financial, legal, technical, reputational, and ESG. To ensure that the risks and uncertainties associated with the estimation of Mineral Resources and Mineral Reserves, and the prediction of financial outcomes for mining projects or operations are not overlooked and such aspects should be presented clearly and transparently in Public Reports.

Mineral Reserves must include the consideration and reporting of the ESG context and factors that could have a material effect on the outcome of the project or operation. Consideration of the ESG context and factors should include consideration of established global principles, standards and guidelines. The ESG includes all aspects of sustainability and Licence to operate relevant to the success or failure of a Minerals project or operation. The ESG aspects of a project or operation affect shareholder and stakeholder assessments and decision-making, employees and contractors. The Competent Person(s) should include available relevant information on the changing internal and external context for a project or operation, including environmental, social and governance Modifying Factors related to the project or operation.

The assessment of the reasonable prospects of eventual economic extraction of Mineral Resources and that extraction could reasonably be justified for Mineral Reserves at the time of Public Reporting must include a written consideration of the direct and indirect environmental and social cost of extraction, processing, and end-use in terms of environmental degradation, ecological diversity, cultural destruction or climate change.

- Editor

NEWS FROM THE MINING WORLD

➢ 4 Emerging Trends Driven by the Global Mining Boom

The future is bright for the global Natural Resources industry.

The future is bright for the global Natural Resources industry; we have seen advancements in innovative solutions and technology implementation. Companies are experiencing breakthroughs in Safe operations through big data, improvements in water management, material handling, and automation enablement. Miners and Oil and Gas producers are streamlining contractor engagement, improving project management, off siting technical support, and expanding their use of external "local" resources. We see new business models, financing solutions, talent management, and an employee engagement focus supported and enabled by adopting digital and analytics tools that help front-line decision-making.

These measures improve the operator's License to Operate and deliver ESG outcomes which enhance operational resilience. The Mining Industry is preparing now to meet the future challenges - the demands of the global economy in a decarbonized, connected, post-COVID-19 world with a new focus on electrification and production of electric vehicles. Poised for continued recognition and growth, the mining industry in Australia is expected to hit gross revenues of some US$28.75 billion according to Hong Kong-based South China Morning Post;1 industry experts anticipate a global "mining boom," primarily driven by greater demand for copper (electrification) and iron ore (infrastructure) in China and mirrored in the United States.

Given the rising demand for renewable energy and other green technologies, new low-emission solutions are expected to see increased uptake in the next five years, translating to higher demand for lithium, nickel, and copper.2 Speaking to the Guardian in February, Daniel Major, an analyst at UBS, identified the increasing popularity of electric cars and clean energy3 as "the key megatrend for commodities," stimulating employment in mining in the years ahead.

Mining growth is also helping to drive4 job creation and foreign trade income in Russia, the world's second- largest platinum producer,5 and neighboring Kazakhstan, home to plentiful hydrocarbon resources and a flourishing fintech scene. Here, we explore four trends accompanying the global mining boom.

1. Acknowledging the financial impact of carbon neutrality

To become more carbon-neutral, mining companies are accelerating the roll-out of renewables, expanding electrification programs, and driving operational efficiency. This is part of an increasing focus on highly innovative and cost-efficient methods in creating sustainability.

The consequences of not committing to a decarbonization agenda can be considerable. For instance, companies that did not honor obligations under the Task Force on Climate-Related Financial Disclosures were denied access to COVID-19-centered relief funds in Canada.6

Emissions intensity is something of a hot topic as well. In August last year, to support sustainable metal production, the London Metals Exchange announced plans to create a spot-trading platform for low- carbon aluminum.7 The platform aims to enable price discovery and trading of sustainably sourced aluminum, and later, other metals.

This is especially true of the mining industry, which is under pressure to become greener, cleaner, safer, and more productive. As White and Case, a global legal firm, observes: "One of the most pervasive themes today is that mining brands and culture need to be B2C-friendly while remaining B2B-focused." In today's climate, integrating ESG into business value creation and management and operating models is critical to a business both doing the right thing and remaining profitable

2. Building success through socially sustainable outcomes

The Natural Resources industry can significantly positively impact local, regional, and national outcomes by reducing poverty and improving education, health, and diversity. Whether the focus is on sourcing parts, developing products for local suppliers, or delivering a sustainable product in a unique market, sustainability has a substantial impact on expanding mining solutions. Cooperation and close collaboration with all stakeholders, including indigenous societies, artisanal miners, local communities, regional and national governments, is essential in planning, growing, and maintaining safe, productive operations.

Dialogue and transformation leading to socially sustainable outcomes require organizations to adapt their practices and operations. As mining companies engage with their communities on the ground and other stakeholders, they can pool their thinking to forge transparent and traceable processes and foster supply

chain assurance across borders. To achieve the best possible results for everyone involved, mechanistic improvements must be paired with people-centric processes and engagement improvements. At Proudfoot, we've always believed that people lie at the core of a successful business; this hasn't changed.

3. Achieving zero-harm outcomes

For any mining project, weighing safety and environmental risks is essential. The potential losses — reputational, fiscal to talent — are too high a price and could destabilize growth and development. Working differently and smarter is part of digitization, which means designing and implementing digital solutions to suit customers' needs. Apart from improved ESG and Safety regulations, data and technology are being leveraged to enhance safety and efficiencies across operations, whether traditional or semi-autonomous/ autonomous.

The industry is adopting Integrated Planning Process (IPP) - planning across the operations from pit-to- port. These help to improve coordination and efficiencies while delivering zero fatality outcomes and prevent catastrophic events. After all, planned work is safe work, and safe work is productive work - planned work is 30 times less likely to result in an Accident or Incident than unplanned work, and unplanned work is ten times more expensive than planned work. Our partners can track safety and compliance issues in real-time with a Digital Integrated planning process, making operations and maintenance safer, seamless, more efficient, and sustainable.

A fair and legitimate mining industry supports local communities, improving working standards and protections at the mine, supporting secondary businesses, and increasing economic activity — in the long run, this is good for business too.

4.Tackling long-term supply chain disruption

Although COVID-19 created much of the supply chain disruption within mining, more recently, the focus has shifted back to prevailing trade tensions between the United States and China,9 as well as other trade tensions — many of which have not abated. These and other factors have resulted in a slower delivery of capital projects.

New tools that can assist with risk evaluation, rerouting around crises, and measuring economic, operational, and geopolitical insights, are helpful when managing supply chain disruption. In addition, more agile and trackable supply chains can be monitored through supply chain visibility tools that strengthen resilience and align with trade policies and embargoes — many companies are exploring blockchain for this purpose.

Finding alternative and broader sources of supply to reduce reliance on a limited number of vendors and exploring collaboration on supply chain hubs are also viable tactics for the mining sector to manage trade disruption. Proudfoot, for example, has helped global organizations extract more value from their vendors, find alternative local suppliers' solutions, and create vendor/ supply chain risk strategies for any potential disruptions.

We understand that the Supply chain is not just Consumables, MRO parts but also services. We work with your suppliers and procurement group, implementing supplier development and rapid scouting through AI tools, such as the ones provided by our strategic partner, scoutbee.

A resilient supply chain is a must to attain success in supply chain flow. The resilient supply chain manages risks and speedily adjusts and recovers from unforeseen supply chain disruptions. If you can streamline your supply chain to deliver more, you can exceed sales targets and increase cash without sacrificing quality.

The future for mining

Compliant, collaborative, and timely delivery of capital projects will differentiate those in the mining industry that succeed. The demands of the ESG agenda will require that firms navigate local sustainability considerations and produce new ways of design and operations. In turn, this garners capital and stakeholder support, which is crucial to being a successful mining company. Bringing together heightened safety, efficiency, and innovation and adopting digital technologies will build the intelligent, integrated mining firm needed to tackle Industry 4.0.

Proudfoot works with our boots on the ground to design new and integrate existing systems to increase adoption, implement and accelerate operational and digital transformation through people when it comes to digital transformation.

After all, nothing moves until people move! Along with our leading worldwide technology partners, we jointly help our clients design their optimal operating models, implement a technology that is suited for the business and its long and short-term strategies, and develop and implement the multi-stakeholder engagement - from internal to external communities - to ensure everyone is engaged in the transformation from the start.

Mining firms of tomorrow will need to continue expanding & optimizing capabilities, including organizational and digital transformation, and better understand tools for strengthening risk management and supply chain management.

In doing so, we accelerate the going from digital-ready to digital-steady. To do that, and as an element to any digital transformation, we deploy a tactical blend of aerial and stakeholder mapping, change-readiness, and employee adoption to enable holistic transformation. This includes collaborative and systems-driven capabilities, results tracking, and full-fledged incentivized innovation.

Partners, Proudfoot | 18 November 2021

➢ Needed: Discoveries to feed green economy ESG is an opportunity not a hinderance.

A paradox of the mineral exploration sector is that it is both distinct and inseparable from the broader mining industry. Although the odds of a greenfields exploration project ever becoming a mine have been estimated at around one in one thousand, every mine begins life as an exploration project. With this in mind, explorers should always be mindful of the challenges facing the industry. In the coming decade, there will be no two greater challenges than the need to consistently demonstrate strong sustainability credentials, including appropriate environmental, social and governance (ESG) principles and practices, and to meet the growing material needs of the world economy and emerging green economy.

ESG: An opportunity, not a hindrance

More projects than ever are failing to advance not because of technical issues, but because of environmental and social issues. It is incumbent on the exploration sector to address sustainable work practices, including ESG, early in project life cycles rather than set it aside for when projects reach a development stage. Integrating sustainability into decision making right from the start of an exploration project provides the foundation for constructive long-term engagement with all stakeholders, thereby serving to significantly de-risk a project. Therefore, sustainability should be viewed not as a hindrance to exploration but as an opportunity.

Establishing a respectful, open, engaged and supportive relationship with the local community, where shared values can be established, is critical to establishing a sustained social licence to operate (or explore). While part of the engagement may include highlighting the types of activities involved in exploration, and thereby highlighting the differences between exploration and mining, there are many other aspects to this engagement - responsible behaviour, being open to considering alternatives (e.g., non-invasive versus invasive activities, moving around properties, etc.), looking for collaborative opportunities, understanding the Needed: Discoveries to feed green economy rights and perspectives of various stakeholders and maintaining open, regular and effective communication, just to note a few.

Establishing a positive and constructive track record at the early stages builds trust and respect and helps lay the foundation should discovery and exploration success occur. Establishing success in this area, coupled with discovery success, should lead to better outcomes with investors (and by extension, exploration funding).

Uptake of non-invasive and lower impact, more environmentally sustainable on-site technologies will serve to make projects more environmentally friendly and assuage fears from communities who may only know about mining from negative depictions in film or the wider media.

These non- to less invasive technologies include:

- Drones, in low impact acquisition of geophysical or other remote sensing imagery;
- Passive-geophysics, techniques that allow for a greater understanding of subsurface geology and structure without the use of disruptive seismic or electrical sources;0
- Non-invasive geochemical surveys, most surface geochemical surveys are relatively non-invasive, but the use of technology such as ionic geochemisty allows for rapid anomaly detection with the smallest of impact possible;
- Deep 3D geophysics inversion modelling, utilising new geophysical techniques to assess deep signatures coupled with using geological models to assist in constraining them during inversion modelling;
- Remote sensing and hyperspectral platforms, greater use of these tools early on to guide exploration ensures fewer areas require invasive exploration; and
- Downhole monitoring, using downhole tools and probes to maximise data capture and utilise every borehole to its full extent.

Greater adoption of non-invasive technologies offers the added benefits of reducing costs and improving

technical efficiency-KPIs that will only grow in importance as explorers go to increasingly greater depths to discover the minerals needed to fuel the post-COVID economic recovery and assist in the decarbonisation of the global economy.

Better technical efficiency reduces risk

The exploration sector is also a rare case of an industry that becomes harder the more successful we become. As the number of viable deposits near surface dwindles, especially in well-established mining jurisdictions, explorers need to go undercover in search of new discoveries, increasing uncertainty and risk. This will increase our reliance on new technology and geological concepts such as system science. This is where technical efficiency and effectiveness becomes critical.

Adoption of non-invasive technologies like those mentioned above will help. So too will new invasive technologies such as coil drilling, which reduces the cost and increases the speed of drilling, allowing us to drill at greater depths where the next Tier 1 deposits are more likely to be found. Coil drilling technology also provides an added benefit by reducing the drilling footprint and thereby minimising environmental impacts. Couple this with new lab-at-rig technology and other developments like portable XRFs and PhotonAssay and we have the potential to dramatically speed up mineral exploration.

Data science, and specifically machine learning, is another important growth area for the exploration sector and mining industry in general. Today, our industry collects vast quantities of data, too much for any geologist or team of geologists to efficiently analyse in a reasonable timeframe. A machine learning model can be trained to examine reams of data - whether that be proprietary company data and/or historical pre-competitive data in jurisdictions where such a thing is available - in a much shorter period of time. It is important to note however, that machine learning is not a silver bullet; it performs the grunt work for the geologist, much like a paralegal does for an attorney. But it is also much more than that, having, for example, the ability to potentially detect connections between disparate data sources that would be virtually invisible to the human eye.

Discovery success is not just about having a large geological team with access to these technologies. Better efficiencies will also require the adoption of certain organisational principles. Having a technically strong team is fundamental to exploration success, as Robert Friedland has demonstrated with Turquoise Hill Resources and Ivanhoe Mines and others have shown with various exploration ventures. Coupling technical capabilities with a strong team culture has also been a successful combination, as the leaders of Western Mining Corporation (later acquired by BHP) knew in the late 1960s to 1990s when they made numerous discoveries including Kambalda and St Ives in Western Australia and the giant Olympic Dam copper-uranium deposit in South Australia.

Finally, the need to improve technical efficiency demands new ways of thinking. One potential new approach is scenario planning, a strategy of planning for multiple future scenarios pertaining to one's business. Building on this concept, researchers at the University of Western Australia's Centre for Exploration Targeting are developing a 'multiple hypothetical reserves' approach whereby explorers would develop multiple scenarios about currently undiscovered mineral accumulations that could be extractable in the future.

Discovery rates must improve

Countless observers have noted that the continued growth of the world economy and particularly low-carbon technologies like batteries, wind turbines and solar panels will require much larger quantities of certain commodities - such as copper, cobalt, lithium and graphite - than can be produced from existing (or known) resources and reserves. It is for the exploration sector to meet this growing need from the new green reality, and to do so, our success and discovery rates must improve. Together with adequate funding this will require the sector to embrace and successfully integrate new technologies and new mindsets with sound geological knowledge and thinking.

Partners, SRK Consulting| 25 November 2021

➢ Miners face talent crunch as electric vehicles charge up metals demand

University of Kentucky undergraduate Jonathan Little is among the legions of students around the world that the mining industry cannot afford to lose, but already has. Little, 20, considered a career in mining, but chose instead to study a branch of engineering that will likely have him designing truck engines. That was much more appealing to him than working in a coal mine, like many of his university peers do after graduation. "That's not a career path I want," said Little.

Choices made by Little and other students foreshadow a talent crunch for the mining industry as it braces for a wave of retirements from aging workers. Later this decade, fewer graduates will have the skills needed to build and run mines producing lithium, nickel, copper and other metals to feed ravenous makers of electric vehicles, solar panels and other renewable-energy technologies. Enrollment in US mining engineering

programs dropped 46% between 2015 and 2020, according to a survey by the Society for Mining, Metallurgy and Exploration (SMME). The same problem afflicts major mining countries such as Canada, South Africa and Australia.

"We are going to end up with untrained people to run mines at a time when you really need to mine for the EV transition," said Mike Armitage, who sits on the board of fluorspar miner Tertiary Minerals Plc. The talent crunch is hitting just as automakers are gearing up to build millions of electric vehicles. Many plan to have fully electric fleets by 2030. Batteries and wiring for all those engines will require major boosts in metals production.

Many students are spooked, professors and industry executives say, by mining's historical reputation as a dangerous industry that pollutes the environment. That stereotype was reinforced just three years ago when 270 people died after the collapse of a tailings dam owned by Vale SA at an iron-ore mine in Brazil.

Aging workforce

More than half of miners are over the age of 45 and 20% are over 60 and closing in on retirement, according to a study from Mercer. The US government is forming a committee to address "public perceptions about the nature of mining" and its aging workforce. Meanwhile, the China University of Mining and Technology – considered that country's best mining school – enrolled more mining engineering students in 2020 than the entire United States, largely to supply China's growing coal sector, according to the SMME survey.

Now, Western universities, trade groups and companies are rushing to recruit new students as high school seniors finalize university applications and many first-year college students begin to choose their area of study. "If you don't know mining, you get these odd perceptions of the industry that we're like Snow White and the Seven Dwarfs with pick-axes," said Emilie Schouten of silver miner Coeur Mining Inc, which has boosted outreach to students.

CEO sees 'tremendous opportunities'

Concern about the looming talent shortage even prompted Freeport-McMoRan Chief Executive Richard Adkerson to meet personally with University of Arizona students this year to sway their career choices. "Today's mining is not the mining that people thought of historically," said Adkerson, who also chairs a global mining industry trade group. "There's just such tremendous opportunities for young, technical people to come in and make a contribution immediately."

Universities are launching or expanding courses teaching data analytics, autonomous driving and computer programming to prospective miners, not just geology and geography. They are also funding research into new ways to process minerals and battle climate change. In the United States, the Colorado School of Mines has built an underground mine for students to train on new technologies. At the University of Kentucky, where Little studies, graduate students have begun researching new ways to extract metals from old electronics. In the United Kingdom, the University of Warwick has launched 50 skills training courses on electrification.

'Commitment to sustainability'

In South Africa, the University of the Witwatersrand – which has trained industry titans such as former Glencore CEO Ivan Glasenberg – this year started offering a climate issues course to mining students to reflect rising interest in the topic, despite coal's import to the national economy. The Western Australia School of Mines (WASM) is phasing out its petroleum engineering program and morphing it to focus on renewable energy. "Our mission is to create thought leaders … (who feel their) moral responsibility is to produce the material that we need to produce sustainable livelihoods," said WASM's Michael Hitch. That mission fueled Tom Benson's decision to join Lithium Americas Corp and help build what the company hopes will be the largest US lithium mine, which aims to be carbon-neutral.

"If you want smart people to come into this industry, you need to show them that you have a commitment to sustainability," said Benson, who oversees the company's intern program and runs its exploration division. "Mining needs to play an essential role in fighting climate change."

Reuters / December 10, 2021

➢ Five charts ask if mining is in a supercycle, one screams no

COP26's climate goals necessitate massive new investments in mining, but how does today's boom stack up to the aughts?

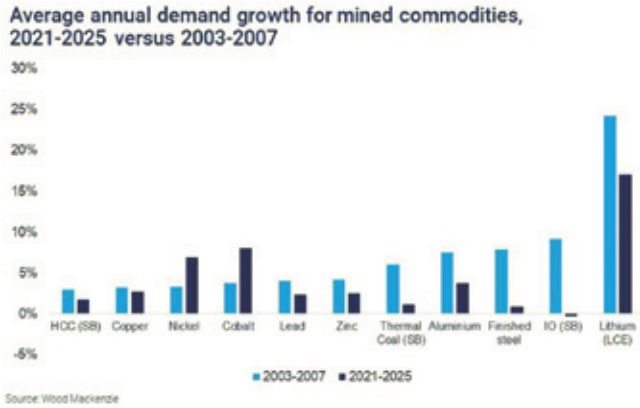
Supercycle or no? is a favourite parlour game in mining and there is no shortage of opinions and arguments on whether the industry can party like it's the aughts or if the mid-2010 hangover is just around the corner. The latest entry in the genre is by Julian Kettle, senior VP and vice chair of Woodmac's metals and mining business (read it here). Kettle's first exhibit in Supercycle demand. Are we there yet? would be rather dispiriting if you're in the bull camp. (A bull? Me?)

Bar cobalt and nickel, Woodmac's demand growth projections for this cycle are noticeably lower than during the five-year period between 2003 and 2007 when the great sucking sound from the East was getting louder and louder.

We'll get there EVentually

Even salt du jour, lithium, is going to be less boomy over the next five years than the early 2000s, when Tesla wasn't even a twinkle in Musk's eye, Nokia was the mobile phone company of the future and Volkswagen livestreaming a battery day would've seemed as silly as, you know, Volkswagen livestreaming a battery day.

As much fun as it is to talk about muskmobiles and their effect on mining, it's worth remembering that EV batteries only overtook cellphones as the number 1 use of cobalt a couple of years ago, and as Kettle points out stainless steel will remain the top nickel application through this decade.



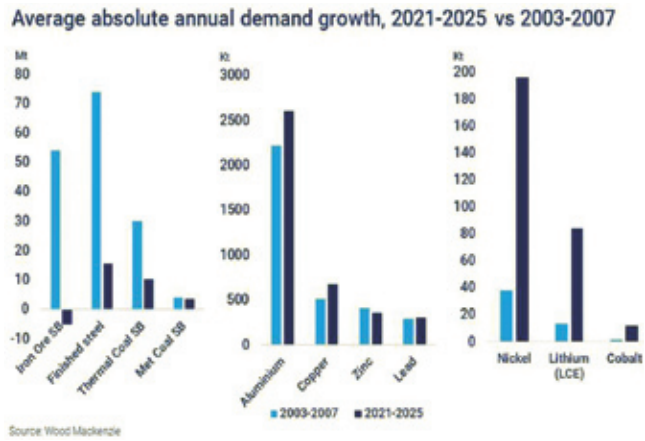
These battery metals (sorry lead-zinc, we just don't think of you in that way anymore) are also flattered in percentage terms due to the small size of their markets.

Tonne lashing

Percentage changes only get you so far – mining is an altogether different beast than 18 years ago and Woodmac's chart below shows in absolute growth terms the picture is decidedly rosier, but apart from the battery metals not exactly shooting the lights out.

And the chart on the left in exhibit two (better not look Pilbara; close your eyes Pará) should give even the most ardent supporters of the supercycle story cause for pause.

Prices were hot across metals and minerals, but iron ore was by far the most profitable commodity last time around, accounting for two-thirds of ebitda for the big five diversifieds in 2011, up from 24% in 2007.



Ore wars

Demand for nickel growing at a 200kt clip, lithium at 80kt a year and cobalt at 10kt won't exactly set hearts racing in Melbourne, London, Rio or Baar (more so in Jakarta and Kinshasa). Not when compared to more than 50 million extra seaborne tonnes per year and a benchmark price going from $13.82 in 2003 (Japan-Australia-Brazil annual benchmark) to $191.70 a tonne (62% Fe Fines CIF Tianjin) seven years later.

MINING.COM's most popular article of 2012 was headlined Forget gold, IRON ORE is the story of the decade which helps explain why hundreds of millions were allocated to study projects like Outer Harbour to the dismay of natator depressus fans everywhere. Outer Harbour wasn't the only outre project either. During the go-go days, cash from the iron cow was ploughed into all kinds of mega-projects with no railway line too long to consider constructing, ship too big to commission (warning: link contains profanity) or overburden too massive to haul away.

Animal spirits evaporated

Years of shareholder castigation have left a much chastened industry, and despite a return to mega-profits at the top tier, focus remains on dividends and capital discipline, not gearing up for growth.

Even half-brainer decisions like BHP's Jansen in Saskatchewan and Rio's Jadar in Serbia (Djokovic's double fault notwithstanding, it's lithium, duh!) appear to agonise boards. Does it really take Brazil granular at $800 and ballistic lithium prices to clear investment hurdles? Must copper go to $30,000 before animal spirits are released? Judging by this chart by Fitch Solutions, the answer – even after a healthy $12 billion upward adjustment from previous estimates – appears to be yes.

(Continued on Page 40)

MINE TAILINGS MANAGEMENT FACILITIES – A PERSPECTIVE ON PRIORITISING DISASTER RISK REDUCTION AND EXTRACTION OF ASSOCIATED METALS CRITICAL RAW MATERIALS

Dr. Sudesh Kumar Wadhawan

Abstract

The global mining industry produces billions of tonnes of mine tailings each year. This slurry of waste material is often contained in dams, which are among some of the world's largest engineered structures. These disposal sites that store the processed mine waste are collectively called the mine tailings management facilities (TMF). Several recent and catastrophic tailings dam disasters bring the complex interaction between a mine and its local operating or management context into glaring sight and concern for safety. This article highlights importance of sharing diverse knowledge about monitoring safety and management of tailings dams with some considerations for disaster risk reduction. Besides emphasis is laid on potential of recovery of associated rare and strategic and energy critical metals such as Gallium, Vanadium, Scandium, Molybdenum, Rhenium, Tellurium and Selenium and REE, etc. There is an urgent need to generate a more complete inventory on mine tailings that includes both established as well as newly constructed facilities. A case is made out for improved assessment and disclosure of "located or situated" disaster risk that ought to be prioritised for community resilience.

Keywords: *Mine-Tailings, metals recovery, disaster risk reduction*

1. Introduction

Most large-scale mines produce significantly large quantity of waste than the economic minerals. Tailings are a processed product of separating valuable minerals from uneconomic host rocks, and comprise ground-up rock, process water, and chemical reagents (Kossoff, et al. 2014). Thus, the tailings (or slurry) are the waste fine-grained materials produced after the extraction of minerals and metals from mined ore, and largely consisting of powdered rock and polluted water. These disposal sites that store the processed mine waste are collectively called the mine tailings management facilities (TMF). From the ore processing mill, the tailings are often pumped to surface storage facilities which are commonly constructed using earth dams. These range in size from that of a large-sized swimming pool to areas over 1,000 hectares. The global mining industry produces billions of tonnes of tailings each year, with an estimated 14 billion tonnes produced in 2010. TMFs are among some of the world's largest engineered structures, and a potential source of disaster risk for nearby localities (Martín Duque et al. 2015; Schoenberg, 2016). In due course of time, the sandy and muddy residue of tailings gradually drains and becomes compact and dry. The recovered water is treated to remove harmful substances that could pollute and contaminate the environment and/or jeopardise the health and safety of local communities near the facility and recycled for further use in the mining industry or discharged into the existing drainage system. However, in a process known as rehabilitation, grass and other vegetation are generally planted at and around the site to stabilise the environment. When managed improperly, tailings facilities can be both disruptive and disastrous with impacts on the environment and human health, with pollution from effluent and dust emissions being potentially toxic to humans, animals and plants. Where a tailings storage facility fails physically, the harm caused is multiplied manifolds. Flooding from tailings materials can damage the surrounding environment and may lead to loss of human life.

Several major industrial disasters such as Union Carbide in Bhopal, India, in 1984; the failure of the Chernobyl nuclear reactor in the Ukraine in 1986; the Exxon Valdez oil spill in Prince William Sound, Alaska, in 1989; and the Fukushima Daiichi nuclear accident in 2011 wrought disaster in communities and local environments In these disasters, each involved a complex set of interactions – both biotic and abiotic, between the industrial installations and the hosting natural communities (Mitchell, 1996). Therefore, similar to the natural disasters, industrial disasters involve serious disruption to the functioning of a community or a society due to hazardous events interacting with conditions of exposure and vulnerability leading to human, material, economic and/or environmental losses and impacts (UN Report, 2017). These TMF sites may include deposition of tailings in open pits, natural depressions (Fig. 1), riverine and deep-sea disposal sites, etc. In the context of increasing

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Original manuscript received: 29-6-2021; Peer reviewed and accepted: 22-11-2021

global demand for metals, declining ore grades, such as iron and bauxite, gold, copper that produce the largest amounts of tonnage of mine-waste and huge quantities of tailings, it is expected that high volume-high risk mine tailings dams will continue to be built into the future. It is noteworthy that in contrast to the water supply reservoirs, mine tailings dams are typically constructed in sequential stages over time. This mode of deferred construction contributes to the incremental expansion of project footprints, and possibly add to the potentially higher failure rate of tailings facilities (Chambers and Higman, 2011; Owen et al., 2020).

Fig. 1: *Field photograph of Aguablanca nickel and copper mine tailings storage facility in a valley depression in Spain [Photo source: Wikipedia]*

Land is integral to human habitation and livelihoods, providing food and resources, and also serves as a source of identity and cultural meaning. Objective of this article is to raise awareness and provide a window on the diverse knowledge about tailings dam with some considerations for disaster risk reduction and draw attention to unrealised potential of recovery of associated rare strategic and energy critical metals such as Gallium, Vanadium, Scandium, Molybdenum, Rhenium, Tellurium and Selenium and REE, etc. Associated critical and strategic trace metals need to be extracted with improved metallurgical techniques.

Methodology

Present contribution is prepared based on extensive literature survey, personal field observations of different mine sites and judicious integration of culled data in insightful ways. It is intended to provide a perspective on mine tailings management and need for optimum utilisation of the available mineral resources. It is emphasised and elaborated with examples of good mineral processing, waste disposal practices and raising flags on disaster risk reduction through community awareness and resilience building exercises.

2. General Considerations for Waste Disposal

The main factors which control the suitability of mine and mineral processing waste disposal sites (Howard and Remson, 1978) are enumerated below: -

1. **Geological -** both bedrock and drift lithology, and geological structure.
2. **Hydrological/ Hydrogeological -** pathways and rate of flow of rainwater passing into and through the subsurface, subsurface hydrogeological features, i.e., aquifers types, surface runoff characteristics.
3. **Topographical –** relief, slope of ground, and exposure to the elements, especially wind.
4. **Ecological –** biodiversity, effect on plant and animal habitats, endangered ecosystems.
5. **Climate** - local microclimate, rainfall, drainage patterns and flow characters and wind velocity, etc.
6. **Engineering** – structural design of the dam, embankments, physical management.
7. **Social Environment -** proximity to housing, domestic water wells, infrastructural development, noise, smell, litter, visual impact, aesthetics, etc.
8. **Economic -** distance from source of waste, mine-head and beneficiation plants, roads, access to the site, maintenance and management costs arising from the physical and locational characteristics of the site, etc.

The first three groups of factors primarily control the suitability of tip sites or the TMF, although other factors may override these in certain circumstances. Thus, a multidisciplinary approach to waste disposal site selection is desirable, to ensure that all factors affecting the suitability of sites for waste disposal are taken into consideration (Daly and Wright 1982).

Geological Controls: Factors which determine suitability of TMF sites from a geological/hydrogeological standpoint are: -

1. **Bedrock Lithology** - rock type, grainsize characteristics, texture, homogeneity, bedding characteristics, etc.
2. **Quaternary Geology** - character, thickness and homogeneity of unconsolidated cover sediments.
3. **Hydrological Properties** - of both bedrock and drift, i.e., porosity, permeability, hydraulic conductivity, attenuation potential etc.
4. **Geological Structure** - attitude of bedding, folding, faulting, jointing, lineaments and major discontinuities on all scales.
5. **Hydrogeology** - groundwater levels, distribution of aquifers and aquicludes, groundwater flow patterns, etc.
6. **Surface Runoff Patterns –** Drainage pattern, size and discharge of streams running through and around the site - controlled by the topography of the site.
7. **Geomorphology/ Topography –** Landforms, terrain relief, inclination of sloping sites, shelter from wind, visual impact of landscape.

Optimal natural waste disposal sites should have an impervious bed of rocks (shale/slate, clayey peat and cherty limestone, etc.) or a thick cover of low permeability unconsolidated or poorly consolidate deposits such as boulder clay overlying low permeability bedrock, and a thick unsaturated groundwater zone.

The types of maps that are essential for any type of land use planning include the following: -

1. **Topographical Survey Maps** - 1" to 1 mile or modern 1:50k scale and larger scale Survey of India maps, and Google earth /satellite images - enable the topography to be assessed, the current land use to be established and the proximity of infrastructure development/ human settlements, which might be affected by the new envisaged land usage, can be determined.
2. **Geological and geomorphological Maps** - a region-wide coverage, preferably on at least a 1:50k and larger scale, are required. These allow the delineation of areas where the underlying bedrock geology is suitable or unsuitable for various types of land uses. However, even more critical to the search for waste disposal sites are accurate maps of the unconsolidated Quaternary deposits, as it is the rate of percolation of leachate through this overburden, and the ability of these deposits to attenuate the leachate by adsorption and exchange reactions which will largely determine the suitability of any given waste disposal site. Thus, the type and thickness of cover sediments are particularly important.
3. **Quaternary Geological Maps** - A detailed coverage on at least a 1:50k / larger scale is essential for regional and local planning on all scales - two main types of maps are desirable: -
   a) **Lithology Maps** - these indicate the type and distribution of unconsolidated deposits
   b) **Depth to Bedrock Maps** - give information on the thickness of the unconsolidated deposits

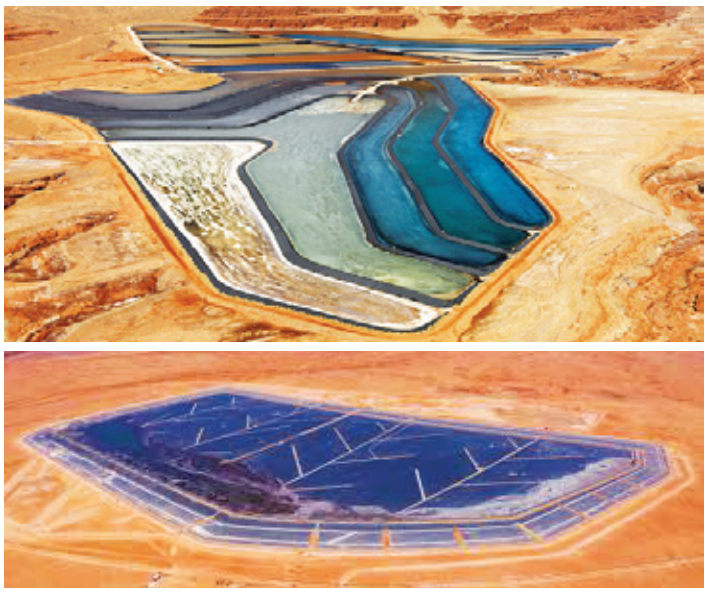

Fig. 2: Field photographs of systematically planned and regularly monitored and managed pratices of Tailings Management Facilities [Photo source: Wikipedia]

Superimposition of these two types of maps can usually enable the identification of domains where groundwater is most vulnerable due to the type and limited thickness of the overburden and potential hazard for percolating contamination. It is interesting to note that thick peat covered domains are normally least vulnerable. In the event that no sites can be identified which completely satisfy the criteria for ideal natural sites listed above, then other less than ideal sites would need to be selected, but their deficiencies must be compensated for by adaption of more stringent site management practices (Fig. 2).

3. Extraction of Associated Metals as Bye-Products

In a world of decreasing mineral resources, there really are no materials to waste. New ways to produce, manufacture and consume materials are needed in the future. Circular economy has the potential to make life sustainable for future generations and also to create business opportunities for entrepreneurs today. In order to improve materials' circulation, research and development actions are needed for valorisation and utilization of the mines waste materials and tailings. It is matter of concern that mine tailings can be highly toxic and their long-term containment is critical to the safety of surrounding communities, which may be at risk of landslides caused by residue, toxic dust and chemical leaching into the groundwater. Therefore, it is imperative that reuse and revalorization of tailings be explored to provide a source of raw materials, that also reduces their potential harmful impact on the environment and public health. The reuse and revalorization of mine tailings should, thus, be considered a priority "green alternative" to current waste treatment methods. This can be achieved through multidisciplinary research aimed to improve understanding of the geological processes behind metals' mobility, improve bioleaching efficiency and recover Rare Earth Elements (REE) and other Critical Raw Materials (CRM) from mine tailings.

Mining engineers and geoscientist are aware that Alumina industry produces red mud as waste product that is potentially a rich source of Gallium, Vanadium and strategic metal Scandium. The Bayer liquor in aluminium extraction process is the only source for Gallium, Ga metal which together with arsenic (Gallium arsenide) is an important semiconductor. Vanadium occurs both as primary and as secondary source. It is found in significant quantities in Bayer liquor. Therefore, the strategy should be planned for multi metal extraction process technology that would make India the largest producer of Ga and V as well. Scandium also occurs along with Tin - thus, an urgent need to study the Sn minerals and Sn slag for occurrence of Scandium, besides the red/ brown muds waste from the Bayer liquor, produced during manufacture of alumina from the bauxite ore.

It is remarkable that the associated minor metals produced as by-products from the base metal mines include: - Mo, Re, Te,

Se, Ge, Cd, In, Ga, V, Sc. The Molybdenum, Rhenium (nearly 75% of world's production), and Tellurium and Selenium (95% of world's production) come from copper mines and they are extracted as by-products of copper concentrators and smelting plants. Uranium is also extracted profitably from such tailings of copper mining centers at Mosabani in Singhbhum Shear Zone, India. Similarly, In, Ge, and Cd can be extracted profitably from the Zn primary circuit.

The Chrome-ore which is mined in Odisha as the source for ferro-chrome for making standard steel and other corrosion resistant high strengths steels, contains Nickel that co-occurs with chromium ore overburden. Ni needs to be extracted from such mine waste.

On Monazite beach sands - Indian Rare Earths Ltd. [IREL] is the only company extracting a few metals for its use. Other important rare earth metals such as: Samarium (Sm), Neodymium (Nd), Cerium (Ce), Lanthanum (La), Gadolinium (Gd), Dysprosium (Dy) are required to be extracted as bye-products.

As per the UNESCO-International Geoscience Programme (IGCP), the ongoing IGCP project No.682, proposed international collaborative research to enhance mineral and bio-hydrometallurgical processes that would use specific tailings deposits in Europe (Spain), Africa (South Africa) and South America (Chile) to significantly benefit all areas of human sustainable development - economy-environment-society in the following ways: -

i) improve the understanding of the geological processes controlling metals mobility in mining and industrial tailings,

ii) improve the bioleaching efficiency through the detailed understanding of the tailing mineralogy, geochemistry and microbiology, and

iii) achieve an efficient and repeatable REE and other critical minerals recovery from bio-leachates using advanced sorbent materials.

Academy of Finland with multi-disciplinary research consortium investigated the utilization of mine tailings as raw materials for ceramic industry and found that certain mine tailings are excellent raw materials for aluminium-silicate based ceramics, showing capability for high temperature solutions. Another research result was that we can produce ceramic coatings from mine tailings having comparable level electric insulation properties than reference materials produced from virgin raw materials. A revaluation of tailings on a larger scale is needed to recover valuable trace elements and create new resources for effective utilisation. Rubio and Kleinmann (2021) characterized the chemical, mineralogical, and metallurgical aspects of the Santa Barbara dam (Minas Gerais, Brazil), and performed an environmental evaluation of the alkaline water (maximum pH values of ≈ 10), at the surface of TMF containing Sb (up to 0.500 mg/L), As (up to 0.080 mg/L), and Cu (up to 20 mg/L). Therefore, the potential recovery of elements such as Sb, As, and Au was considered for tailings reprocessing boosting the circular economy. It can safely be asserted that valorisation of tailings, although challenging, can be achieved by economic recovery of the more valuable metals.

4. Vulnerability and Disaster Risk Reduction

Vulnerability is defined as set of conditions and processes resulting from physical, social, economic and environmental factors which increase the susceptibility of a community to the impacts of hazards. Whereas, hazard is a potentially damaging physical event, natural phenomenon or human activity which may cause loss of life or injury, property damage, social and economic disruption or environmental degradation. The probability of harmful consequences, or expected loss of lives, people injured, property, livelihood/ economic activity disrupted or damaged environment, resulting from interactions between natural or human induced hazards and vulnerable conditions is referred to as risks. Conventionally risk is expressed by the equation: -

Risk = Hazards x Vulnerability

However, it needs to be appreciated that risks are always created or exist within the social system, and peoples therefore, do not necessarily share the same perception of risks and their underlying causes. There are many examples where the consequences of tailings dam failures have been devastating. In the past 50 years, 63 major tailings dam failures have been reported worldwide (Liu et al. 2015). The catastrophic collapse in January 2019 of the tailings dam at the Corrego do Feijao iron ore mine in the town of Brumadinho in the Brazilian state of Minas Gerais is one of the most recent that resulted in more than 230 human deaths and large sections of agricultural land totally destroyed (Reuters, 2019). Other tailings dam failures in Brazil and elsewhere, included the aluminium sludge spill at the Ajka mine in Hungary in 2010; Philex Padcal in the Philippines in 2012, the Mount Polley mine in Canada in 2014, and the Cadia mine in Australia in 2018. There has been an increasing frequency of dam failures as reported by Uranium mining project (WISE-2012). The failures of the Mariana and Brumadinho tailings dams in Minas Gerais, Brazil, had severe environmental repercussions and caused many fatalities. Other examples include the dreadful tailings dam failure at Ajkai Timfoldgyar in Hungary in 2010; Cobriza Mine tailings failure in Peru, which happened on 10th July 2019, releasing cyanide pollution into the Rio Mantaro. Tailings dam failures are also known to inflict a huge impact in terms of loss of life, environmental effects and social damage. It is well established that the impacts can extend for tens or even hundreds of kilometres downstream – the Ok Tedi tailings failure in Papua New Guinea for example

extended for 1,000 km and disrupted the lives of 50,000 people (World Mine Tailings Failures-2020 catalogue).

Research that examined tailings dam failure had been primarily focused on the integrity of the engineered structure, and the properties of impounded materials. There has been a general lack of official national or global register of tailings dam's failure. However, multiple databases so captured, disclosed information about tailings disasters, including location, causes of failure, volumes discharged and social and environmental consequences. Findings also suggest that a range of concurrent factors are causal to most failure events, including: uncontrollable external factors (unusual weather, seismic events); technical factors (slope instability, foundation subsidence, static liquefaction of the tailings); and management or other human factors (Owen and Kemp, 2019; Owen et al. 2020). In an academic study, it is further observed that the frequency and peak in tailings dam failures occur and increase when commodities prices fall. The peak in tailings dam failures reportedly occurs about two years after the peak in commodities prices (Petley, 2009). The relationship between the peak in prices and the peak in accidents is ascribed to: -

1]. The rush to mine quickly means that design and construction standards may be low;

2]. As opportunities arise during the boom, the mining and the development of resources in increasingly difficult areas;

3]. After the boom there are pressures to cut costs as commodity prices decline;

4]. There may be a lack of independent review, presumably to avoid the time delays and costs associated with this, thus promoting compromises with quality of TMF designs and management.

In early 2016, the International Council of Mining and Metals (ICMM) led a review of tailings standards, guidelines and risk controls among its member companies. The review report concludes that while high quality guidance about the management and physical stability of tailings dams is widely available, poor implementation is the major concern. In December 2016, the ICMM released a binding Position Statement on *Preventing Catastrophic Failure of Tailings Storage Facilities* (ICMM, 2016). No requirement to publicly disclose information about tailings risks was made at this time.

Earlier, the Indian Bureau of Mines issued elaborate guidelines on Tailings Dam Design for implementation in Indian conditions and United Nations Economic Commission for Europe provided elaborate safety guidelines and good practices for tailings management facilities (IBM, 1995; UNECE, 2014). It also covers various aspects of maintenance for control of seepage, recovery and recycling of water and related environmental degradation (land, water and air) through selected case studies of ten mines, labelled 'A' to 'J'. In addition to existing site-specific TMF Operations, Surveillance and Maintenance (OMS) Manuals using the 2017 Standard as a guideline and in view of the lessons learnt from the catastrophic failures of TMFs and recent technological advancements, a thoroughly revised version of modern guidelines and global good practices for disaster risk reduction pertaining to establishing and managing TMF needs to be brought out.

Fig. 3: *Vedanta Gamsberg TMF - Gamsberg Zinc Mining and Concentrator Project located in Aggeneys, South Africa [Photo source: Wikipedia, Vedanta Report, 2019]*

Gamsberg TMF has used the largest high-density polyethylene (HDPE)-lined TMF in South Africa and will accept 3.55Mt of tailings a year. It was named the Most Outstanding Geotechnical Project of 2018 by the South African Institute of Civil Engineers. Given the sensitive environment in which Gamsberg operates, the various potential impacts of the TMF were given serious consideration. Especially important was protecting the groundwater. The TMF is fully lined with a 1.5mm HDPE liner to prevent any polluted water from reaching natural sources; and a continuous impermeable rock armour was constructed on the outside slope of the

TMF to prevent clean rain water run-off being contaminated with tailings (Fig.3). This also helps to minimise the wind dispersion of the tailings. In line with Vedanta's overall digitisation drive at Gamsberg, a number of measures were implemented including: temperature probes underneath the liner to measure if the tailings become heat-generative; and wireless vibrating wire piezometers, delivering real-time water level data. Trigger levels are built in to give warning if the phreatic surface (the level below which the ground is completely saturated with water) rises above certain limits.

However, in another incident, on 9th April 2019, a significant mine tailing failure occurred, this time at the HINDALCO bauxite mines and alumina processing works at Muri in Jharkhand, India. Another TMF failure at Jharsuguda occurred in the 2017 monsoon. An excessive amount of rainwater had accumulated within the dam, causing destabilisation, a foundation failure and ultimately a progressive and rapid failure over an area in excess of 700 metres when the dam wall slipped on the ground surface and collapsed. The same monsoon was responsible for another incident at BALCO, when a 15m section of the dam overtopped, with tailings spilling beyond the bunded area. No substantial damage was caused, and the regulator did not issue notices. In both cases the structural design was reviewed. At Jharsuguda there has been some major dam wall rebuilding. In addition, as a precaution, a large number of monitors and instruments were installed to measure hydraulic pressure and wall movement respectively. As a further precautionary measure, the TMFs across the group were maintained at the lowest possible water level with emergency contingencies put in place to deal with the possibility of unprecedented rainfall levels. The outcomes of the assessments focused on potential causes for embankment failure that could release tailings. Risks were ranked in relation to their impact on health and safety, the environment, operational economic sustainability (Vedanta Report, 2019). Besides, Vedanta fully complies with the International Council on Mining and Metals (ICMM) approach to tailings management (Fig.4).

Fig. 4: *Rampura-Agucha and Rajpura-Dariba Pb-Zn Mines Tailings Facilities (with about 50% solids) from the beneficiation plant are disposed in environmentally safe manner in tailing dam. Tailing dam stability study carried out by experts. Impervious layer on bottom & sides of the dam is provided to eliminate the possibility of any seepage. Regular groundwater monitoring and concurrent recycling of water is done for plant use. [Photo source: Sudesh K. Wadhawan]*

5. Results and Discussion

Recognizing that mining is and will always be a key component of progress, it is imperative to focus on what is being done and what can be done to improve TMF, prevent future catastrophes, and reduce the negative downstream effects of any tailings dam failures that reportedly do occur. Global resolves such as the Sendai Framework for Disaster Risk Reduction 2015–2030, have for the first time recognised the role for the private sector in DRR. For example, recent guidance to support the implementation of the Sendai Framework includes a focus on TMF and their disaster risk potential. It also highlights critical information gaps in two key areas: operator performance in managing facilities, and the proximity of downstream communities to catastrophic disaster risk. In the absence of corporate disclosure of this information, it is necessary to study and to determine proximity and elevation of TMF as a means of identifying situations where the potential for disaster risk appears to be severe.

The sheer scale of global tailings production and the high impact of tailings facility failures highlights the need to improve all aspects of tailings disposal and management. Furthermore, the compiled data here has highlighted the need to continue developing management options and technologies to both minimize tailings production and to repurpose tailings to reduce storage requirements and their associated risks. It is argued that we need a better understanding of the processes leading to tailings dam failures as well as greatly improved management and regulation of tailings facilities (Santamarina, et al. 2019).

Considering various risk perceptions and for safety of the community around the TMF, it is imperative to follow elaborate guidelines on Tailings Dam Design for implementation in Indian conditions issued by the Indian Bureau of Mines (IBM, 1995). United Nations Economic Commission for Europe provided elaborate safety guidelines and good practices for tailings management facilities (UNECE, 2014). It also covers various aspects of maintenance for control of seepage, recovery and recycling of water and related environmental degradation of land, water and air.

Besides, it should make a viable economic sense to recover associated rare metals independently or through joint efforts for optimum utilisation of indigenous mineral resources. This will encourage recycling and sustainable extraction of metals of strategic and energy critical significance such as Gallium, Vanadium, Scandium, Molybdenum, Rhenium, Tellurium and Selenium and REE, etc., and promote *Atam Nirbhar Bharat*.

6. Conclusions

Effective and safe disposal of mining wastes presents technical and environmental challenges. Each facility is unique, so a tailor-made and sound approaches are needed to ensure that the TMF is safe, environmentally sound and economical.

The primary way to decrease the risk of mine-tailings facility failure are to reduce the amount of water in the TMF, reducing the pore pressure in stored tailings through adequate drainage to prevent liquefaction processes. It is implied to accord priority to tailings storage with minimal water in the tailings, either by thickening or by filtration; and the need to continue to improve monitoring and warning systems for tailings dams and their surroundings.

The safety guidelines and good practices for tailings management facilities need to be adapted for sustainable and safe regional development and disaster risk reduction with the community involvement and enhanced resilience.

The reuse and revalorization of mine tailings should, thus, be considered a priority “green alternative” to current waste treatment methods. It is essential to recover associated minor, but critical and strategic metals, produced as bye-products from mines TMF that include: - Mo, Re, Te, Se, Ge, Cd, In, Ga, V, Sc, U, Au, etc.

In view of the lessons learnt from the catastrophic failures of TMF and recent technological advancements, a thoroughly revised version of modern guidelines and global good practices for DRR pertaining to establishing and managing TMF needs to be brought out.

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The Lignite Giant now Ignites the Nation with Clean & Green Energy...

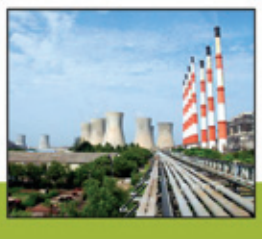
Azadi Ka Amrit Mahotsav

For more than six glorious decades, NLC India Limited has been a forerunner amongst the Public Sector Undertakings in the country in the energy sector, contributing to a lion's share in lignite production and significant share in thermal power generation. Today the company is mining 50.60 Million tonnes of lignite and coal Per Annum and generating 6061 MW of Thermal power including its subsidiaries. NLCIL has big dreams to become a 13650+ MW company by 2030. It has plans to enhance its lignite and coal mining capacity to 93.60 Million Tonnes Per Annum.

To reap the benefits of the renewable energy revolution, as a part of the National Solar Mission, Government of India has set a target to achieve 1,75,000 MW of Solar Power by 2022. NLCIL has an ambitious plan to establish 4631 MW of renewable energy projects in Tamilnadu and various states. Presently, the Company has a total renewable energy capacity of 1421 MW which includes 1370 MW of Solar Power Plants and 51 MW Wind Power Plant.

Renewable Energy Projects under operation and consideration

- NLCIL is the first CPSE to cross 1 GW capacity in solar power generation and became the member of International Solar Alliance (ISA)
- 141 MW Solar Power Projects (SPP) including Roof top solar project at Neyveli at a cost of Rs.782.24 crore.
- 1209 MW Solar Power Projects at a cost of Rs. 5343 crore at Tirunelveli, Virudhunagar, Ramanathapuram and Thoothukudi Districts of Tamilnadu. 200 KW, R&D Pilot Scale Floating SPP in Neyveli New Thermal Power Project's Raw Water Reservoir at Rs.1.16 crore.
- 20 MW SPP, integrated with 8 MWHr Battery Energy Storage System at South Andaman Island. This is the largest battery bank in India for catering the variation in solar insolation.
- A JV Company, "Coal Lignite Urja Vikas Pvt Limited" is incorporated on 10.11.2020 with Coal India Limited for establishing 3000 MW Solar Power Projects at various parts of the country.
- A 10 MW Solar Power Project in Neyveli, under Mini Smart City Scheme is on the anvil.
- 51 MW (34 x 1.5 MW) Wind Power Project at Tirunelveli District in Tamilnadu at a cost of Rs.347.14 crore.
- The company has also planned to install wind power project of 200 MW in other parts of Tamilnadu.



NLC INDIA
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NLC India Limited

'Navratna' - Government of India Enterprise

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NLC India Limited

'Navratna' - Government of India Enterprise

MESSAGE

'***The Mining Engineers' Association of India (MEAI)***' has been travelling with Indian Mining Industry for more than six decades and playing a significant role by conducting National & International Seminars, Symposia, Training programs & Workshops on Innovations and developments of latest technology to enhance skills of Mining fraternity. Moreover, MEAI is sphere-heading in dissemination of knowledge through its most acclaimed '***Mining Engineers' Monthly Journal***' to enhance technical and managerial skills of mining professionals.

I am very glad to note that MEAI in its pursuit of excellence is bringing out monthly Mining Engineers' Journal (MEJ) with more focus on Best CSR activities, Innovations in Environmental protection, and Social & Sustainable Mining activities.

Sustainability of the Mining industry stands mainly on three pillars viz. Economic, Environmental and Social aspects. Striving for sustainable development involves balancing the inevitable conflicts for achieving a dynamic balance between supply and demand of minerals for the well-being of present and future. To address many of these issues and concerns, the CSR plays a key role.

With rich and vast experience of over six decades in Opencast Mining, NLCIL has formulated its CSR Policy in line with the Companies Act- 2013 and implemented to achieve objectives in its socio-economic-environmental dimensions to become an eco-friendly sustainable mining company. NLCIL believes in '***Triple Bottom Line approach', Profit, People & Planet***, thus measuring the performance in terms of positive changes and gain improved good will of all stakeholders.

As NLCIL's 'Sustainable Development Policy' upholds Environmental sustainability is the success of the Company, NLCIL has been efficacious in adopting various measures for Land Amelioration & Afforestation viz, Physical Reclamation, Chemical Reclamation, Biological Reclamation using Bio Fertilizer. An integrated farming system, Hi-Tech farming has been developed to revive the fertility of the land. Advanced Hi-Tech cultivation is carried out through Hydroponics which is space saving and using nutrients without soil. Drip Irrigation, increasing the biomass of the soil through development of sustainable livestock rearing, Dump maintenance & Slope stabilization, Rainwater harvesting, Development of Flora and Fauna in the Reclaimed Area are also being carried out. Similarly, in Air, Water and Noise pollution control Management also NLCIL has been taking every effort to comply with the standards.

NLCIL business ethos embrace human values. We assure that while we are continuing to strive for business excellence in mining of Lignite & Coal and Power generation, our focus will be to give our society a decent today and a sustainable tomorrow.

RAKESH KUMAR
Chairman Cum Managing Director

CORPORATE SOCIAL RESPONSIBILITY

After the enactment of Companies act 2013 in February 2014, NLCIL formulated its CSR Policy in line with the Act. Subsequently NLCIL revised its CSR Policy in January 2017 and in June 2019 incorporating all the amendments of the Companies Act 2013 and DPE guidelines. NLCIL carries out CSR activities under section 135 of Company's Act choosing from Schedule VII prescribed by Ministry of Corporate Affairs, like Water Resource Augmentation, Promoting Sanitation, Preventive Healthcare, Promoting Education, Promoting Rural sports, Skill Development, Women Empowerment, Ensuring Environmental Sustainability, Opportunity Services to differently–abled, Protection of National Heritage, Social Security Measures for Senior Citizens / Underprivileged, Rural Development focusing on the socio economic development of the operating regions for achieving inclusive growth.

CSR Mission Statement

In alignment with Mission of the company, NLCIL through its CSR initiatives will continue to enhance the quality of life of the less privileged in society by providing necessary infrastructure and to be a credible and transparent organisation striving for the eradication of poverty and maintain ecological balance.

CSR Principle of NLCIL

NLCIL believes that there is no sustainable alternative to doing business other than by incorporating the principles of profit, people and planet, thus measuring the performance in terms of economic, social and environmental impact (Triple Bottom Line approach).

CSR Thrust areas and Strategic Initiatives

For purposes of focusing its CSR efforts in a continued and effective manner, the following nine thrust areas have been identified. The thrust areas identified by NLCIL are in Environmental Protection, Social Infrastructure Development, Drinking water/ Sanitation, Healthcare/ Medical facility, Community Development, Education, Skill Development / Empowerment, Disaster Management, Arts, Culture and Sport.

The activities include de-silting and deepening of Water Bodies, Water Ways to facilitate the augmentation of water resource for farm irrigation, enhanced rain water harvesting, irrigation and ground water recharging, flood control, facilitating rural development, environmental sustainability, strengthening of bunds etc. Various locations are chosen from time to time in consultation with the District Administration to execute such works for the benefit of the agrarian community in the operating region, surrounding Neyveli in Cuddalore District of Tamil Nadu State & Bikaner in Rajasthan.

Financial Year 2020-21

As per the directives of Ministry of Coal, the CSR spending for the year 2020-21 focused more on COVID-19 preventive measures for the benefit of the society at large and to support State Government and local administration in fighting against the pandemic.

NLCIL has already taken initiatives in setting-up total 28 Oxygen plants in Government hospitals across the country for a total bed strength of about 2800, Distribution of COVID-19 relief materials to surrounding villages of Neyveli, NTPL/Tuticorin, GTPP/UP, Talabira Mine/Odisha and the NLCIL's presence elsewhere, Hiring of 10 nos. of basic life support Ambulances for Cuddalore District Administration to deal with COVID-19, Financial assistance to M/s Social Economic Research Institute (SERI) towards distribution of PPE Kits to Health Workers in Cuddalore District, Financial Assistance to IIT Delhi (Chakra Innovations Startup) towards COVID-19 relief activities and Purchase of Cold Chain Equipment for COVID-19 Vaccination for Andaman & Nicobar Islands.

In line with DPE guidelines, 'Healthcare and Nutrition' was considered as annual theme for FY 2020-21 and 64.30% of CSR Fund, has been spent against the DPE guidelines of 60% towards thematic activities in the. Virudhnagar & Ramanthapuram, which were the districts chosen in Tamilnadu.

As in previous years, the CSR scheme for the year 2020-21 also covered other areas like Education, Skill Development, Rural Development, Social Infrastructure Development, Health & Sanitation , Promoting Sports, Traditional art & Culture Environmental Development,

etc for the Socio-economic Development of the society in and around Neyveli and rest of the locations.

- ❖ NLCIL under CSR is implementing the following numerous social welfare and community development activities in the surrounding villages at Neyveli and in Cuddalore District which can be publicized as part of the Media Plan:
- ❖ The company is installing 28 nos. of Oxygen Plants and 450 nos. of oxygen concentrators at various Government Hospitals in Tamilnadu and Other states as part of COVID'19 preventive and management measures.
- ❖ The Company has rejuvenated more than 30 lakes in the surrounding villages at Neyveli in Cuddalore District and in Tamil Nadu. The impacts of project are appreciable rise in the ground water table in the surrounding regions, increased livelihood of villagers leading to reduced migration from villages to cities, improved accessibility and availability of water for irrigation, improved livestock number in this region and Improved pisciculture and aquaculture in the surrounding villages.
- ❖ The company is developing and strengthening social infrastructure in the surrounding villages of Neyveli and in Cuddalore District since its inception. Under the CSR programme, NLCIL has been constructed new classrooms at various Government schools and colleges, constructed required facilities at Government hospitals, constructed toilets in the villages and schools, developed water supply systems with gravity tanks, constructed public libraries and constructed skill development centre for women empowerment etc.
- ❖ The interventions of above mentioned CSR activities can be showcased through various platforms of PR to augment the brand image of NLCIL.

CT Scan facilities at NLC India General Hospital

Oxygen Plants set up in Neyveli, Bikaner & Thoothukudi

Donation of Ambulances to Cuddalore District Administration

Imparting skills to Project Affected Persons

TECHNICALITIES OF BLAST INITIATION SYSTEMS RELEVANT TO BENCH BLASTING - A DISCUSSION

M.O. SARATHY

Abstract

Blast initiation systems play a significant role in the final outcome of a blast. From humble beginnings of using gunpowder in Safety Fuse, today the industry has witnessed a renaissance with the development of super-accurate, field programmable, remotely fired, wireless Electronic Delay Detonator (EDD). Each initiation system has its own advantages and disadvantages and the developments over a period of time have succeeded in overcoming the inadequacies experienced with the earlier products. Millisecond electric delay detonators, detonating relays, non-electric detonators based on low energy detonating cord (LEDC) or shock tube all used pyrotechnic delay elements having limitations such as timing overlap, scatter and shift in timing with age. Development of electronic detonators has overcome these lacunae.

1. Introduction

Success of a blast is the result of appropriate selection of drillhole diameter, drillhole pattern, blast design and geometry, initiation system and sequence, accuracy of delay firing time, satisfactory performance of explosive used. The role of the blast initiation systems is often seen just as a means of initiating the explosive in the drillhole, but their contribution to the final outcome of a blast including fragmentation, muckpile looseness, control of fly rock, ground vibration and air blast is significant. From using electric delay detonator with long lead wires in deep drillholes, blasting operations today have turned a full circle with mines presently using electronic detonators with long lead wires, the only difference being the pyrotechnic delay element being replaced by a miniaturized electronic circuit, small enough to be fitted into a detonator shell and ability to programme the delay firing time in increments of 1 millisecond.

2. Indian Scenario - brief history

During late fifties and early sixties, there were only two companies in India engaged in the supply of commercial explosives and blasting accessories. They were Imperial Chemical Industries (ICI) which later became Indian Explosives Ltd (IEL) in Kolkata and Indian Detonators Ltd (IDL) at Hyderabad. IEL was formed in 1953 as a joint venture with the Government of India and started manufacture of explosives at their factory in 1958 in Gomia, Bihar (presently in Jharkhand). IDL was formed in 1961 and factory set up in Hyderabad, Andhra Pradesh (presently in Telangana). Both companies started business by importing finished products such as plain detonators, electric detonators, safety fuse and detonating fuse from their overseas associates, subsequently started assembling in India using imported components and later established their own manufacturing facilities. Chemical Division, Indo Burma Petroleum (IBP) entered explosive business in 1976 and commercial production was started from their factory in Korba, Madhya Pradesh (presently in Chhattisgarh) in 1977. Today in India, around 47 companies are licensed to manufacture various categories of products, of which some manufacturers offer a wide range of explosives and accessories required for blasting operations. Hindustan Copper Ltd and Hindustan Zinc Ltd used to import Anodet, a LEDC based non-electric detonator manufactured by Canadian Industries Ltd, Canada for use in Ring Blasting and Large Hole Stoping operations below ground. Table-1 briefly describes the main features of various types of blast initiation systems.

Table-1: COMPARISON OF VARIOUS TYPES OF INITIATION SYSTES

PRODUCT	ADVANTAGES	INADEQUACIES
Safety Fuse + Plain Detonator	• Non-electric system. Immune to stray currents. • Used to set-off blast in hilly terrain prone for lightning.	• Not suitable for in-hole use in multiple hole blasts, including deep hole blasts.

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Original manuscript received: 24-10-2021; Peer reviewed and accepted: 19-12-2021

Electric Detonators	• Integrity can be checked prior to use - continuity, resistance. • Blast size limited by exploder capacity.	• Susceptible for accidental initiation due to extraneous electricity sources such as static, radio frequency (RF), earth leak currents, lightning.
Detonating Cord	• Rugged and reliable. • High brisance. • High tensile strength. • Initiate explosives which are cap-sensitive. • Connections and hook-up easy. • Infinite number of drillholes can be blasted in conjunction with detonating relays. • Multi path surface initiation reduces misfire risk.	• Only visual checking possible. • Initiation of explosive in drillhole starts from top. • Ejects stemming. • Causes desensitization of booster-sensitive explosive in drillhole. • Prone to misfire due to ground movement cut-off of downline. • Surface causes severe air blast noise.
Shock tube Detonators	• Non-electric system. Immune to stray currents. • Infinite number of drillholes can be blasted in conjunction with surface trunkline delays. • Does not eject stemming. • Does not desensitize booster-sensitive explosive in drillhole. • Does not create air blast when used on surface. True bottom hole initiation	• Only visual checking possible. • Low tensile strength of shock tube. • Susceptible for oil ingress in sleeping drillholes. • Shock tube on surface affected by U-V rays over time. • Damage to shock tube by shrapnel from surface unit. • Assigning in-hole and surface delays for controlled blasting require understanding.
Detaline System (Low Energy Detonating Cord: (0.5 g/m PETN)	• Same as above. • Two-path surface initiation reduces misfire risk. • Reduced surface noise	• Only visual checking possible. • Low gram cord can desensitize booster-sensitive explosive in small diameter drillhole
Electronic Detonators	• Very accurate firing time: (0.01 – 0.005%). • Programmable in increments of 1 millisecond. • Delay window 1-30,000 ms. • Less prone to premature initiation due to extraneous electricity sources.	• Requires higher levels of skill for planning blasts, assigning delays in drillholes during programing of detonators, hook-up and operating exploder. • Unintended firing during logging, aborting reported.

3. Blasting with Electric Detonators (Instantaneous and Delay)

Electric detonators are used for blasting in both above and below ground. In organized civil sector, both instantaneous and delays are used in tunneling, excavation of trench, canal, road cutting and ground levelling. Unorganized sector uses instantaneous electric detonators for well digging and manual quarries. In opencast mines, instantaneous electric detonators are used for setting off a blast and for secondary blasting. Electric delay detonators with pyrotechnic delay element are used in tunneling, stoping operations in underground metal mines, for initiating detonating cord downlines at the collar and for delaying trunklines in multi-row blasts. Permitted category instantaneous and delay detonators are used in underground coalmines. While electric delay detonators with long lead wires were in use for deep hole blasting overseas, probably in India too this was the practice prior to introduction of detonating cord in the late sixties for bench blasting. Electric detonators have an inherent safety concern since they are susceptible for accidental-unplanned initiation due to earth leakage currents, static electricity, R-F energy from radio transmitters, walkie-

talkies, mobile phones, while working under HT lines and lightning activity. Manufacturers offer moderately insensitive, medium insensitive and highly insensitive electric detonators assembled with specially designed fuse heads.

4. Blasting with Detonating Cord

PETN Detonating cord is a non-electric initiation system, inferring that it is immune to extraneous electricity sources such as stray currents, static, RF energies (except lightning).

The author's blasting journey began in 1974, when detonating cord was already in use for blasting in Indian opencast mines as downlines and surface trunklines. Delay across burden (rows) was provided with electric delay detonators or detonating relays. Downline at the collar was set-off using electric millisecond delay detonators (delays 1-10) and during early eighties, Sequential Blasting Machine (SBM) was used in place of exploders in many limestone mines attached to cement plants. Use of SBMs got phased out due to its limitations in terms of blast size (only 1-10 millisecond delay numbers available then), high consumption of copper wire for connecting the circuits leading to the SBM. Detonating cord downlines hooked onto s and delayed using detonating relays became the standard practice in Indian mines.

4.1. Disadvantages of using detonating cord as downlines and trunklines

Detonating cord contains a core of secondary explosive Penta Erythritol Tetra Nitrate (PETN), which has high velocity of detonation (VOD) in the range of 6500-7000 m/s and generates lot of brisance (shock) and gas. When used as downline in the drillhole, detonating cord causes stemming ejection and desentizes column charge.

4.1.1 Stemming ejection: Since the cord is initiated at the collar and detonation travels from top downwards, stemming gets disturbed and ejection takes place. This results in detonation products in the drillhole to escape causing borehole pressure to drop significantly, leading to poor blast results.

4.1.2 Desensitization of booster-sensitive explosive in drillhole: The brisance and gas generated within the drillhole by the cord causes a shock wave which compresses the booster-sensitive charge (ANFO, Slurry) and de-sensitizes (dead-pressing) it. The effect is more pronounced (i) in smaller diameter drillholes and gets reduced as diameter increases (ii) with increases in core load (g/m PETN). Energy loss was found to be as high as 45% in 2" drillholes with 1 g/m cord and 50% in 4" drillholes diameter with 10 g/m cord. In drillholes of 10"-12", the loss of energy gets significantly reduced and found to be 5% with 1g/m and 10% with 10g/m cord (Drury and Westmaas, 1978). ANFO got hard around the cord.

4.1.3. Detonation in drillhole travels across burden

Ideally, detonation of explosive charge in a drillhole should travel along its column. The high brisance results in side-initiation of cap-sensitive explosives and sensitive portions of booster-sensitive products and results in detonation across the drillhole diameter. Class-2 explosives require a charge length of 4-6 times drillhole diameter to reach its steady state VOD. With side initiation, detonation travels across the drillhole diameter and the explosive fails to reach its steady state velocity and thus reduction in full energy release by the explosive.

4.1.4. High airblast noise

Pigtails of detonating cord downlines at the collar and trunklines laid on surface for hook-up cause severe air blast overpressure due to high brisance. 200 m of 10 g/m cord laid on surface is equal to 2 kg of PETN firing in the open (equivalent to 8 numbers of 250 g cast boosters).

4.1.5. Downline cut-offs

Cut-off of downlines are known to occur due to (i) ground movement caused by the blasting of a drillhole, while adjoining unfired drillholes in the vicinity are scheduled to fire on a later delay connected to the downline at the collar. This occurs in highly stratified strata and when large delay is provided between drillholes in a row or across burden (ii) explosion products at high pressure jetting through in-situ cracks / open joints to cause cut-off.

5. Blasting with Non-Electric Shock Tube Detonators

Dr. Per Anders Persson of Nitro Nobel AB, Sweden invented-developed the shock tube during the sixties and world's first shock tube based non-electric detonator NONEL® was launched in the year 1969. This is one of the most significant invention which revolutionized the blasting operations world over. NONEL offered several significant advantages over the earlier products such as electric detonators and detonating cord. Briefly, they are:

- Being non-electric, they are immune to extraneous electricity sources such as stray currents, static electricity, RF energies emanating from walkie-talkies, mobiles (except lightning).
- The detonation wave that passes through the annular space within the tube is non-disruptive viz tube remains intact (unlike detonating cord which detonates and gets totally consumed).
- Offers an option to set-off the explosive at any desired horizon in drillhole, including bottom hole initiation (even electric detonators have this advantage).
- Shock tube being non-disruptive, does not eject stemming from drillhole.
- Shock tube being non-disruptive, does not de-sensitize the booster-sensitive explosive in the drillhole. Allows

detonation to travel along the column and not across the diameter.

- Since shock tube is non-disruptive, airblast noise levels are significantly low.
- Theoretically, unlimited number of drillholes can be blasted using a combination of in-hole and surface (trunkline delay) units, and yet controlling maximum charge per delay.

IDL Industries Ltd, Hyderabad demonstrated the advantages of bottom hole initiation in bench blasting in the late seventies by carrying out blasts in few limestone mines with Nonel imported by them. Use of non-electric detonators for bench blasting in India got established in eighties.

5.1. Protection against shrapnel causing damage to shock tube, resulting in misfire

'Shrapnel' can be defined as small pieces of projectiles emanating from an explosion. All surface delay units are housed in a plastic bunch block connector with manufacturers having their own design and raw material for the connector. Upon initiation of the surface delay unit, pieces of plastic housing as well as metal pieces from the detonator shell get generated and eject over some distance with great force. The shrapnel can cause damage to the outgoing shock tube resulting in a misfire and hence precautions have to be taken to prevent damage to shock tube. Manufacturers currently design low charge-low strength detonators and bunch connectors manufactured using special polymers that are tough, so that very less shrapnel get generated. It is suggested to cover the bunch connector with a heap of drill cuttings to arrest shrapnel.

5.2. Protection against in-hole cut-offs

Initially, the in-hole delay units were supplied with delay of 475, 500 ms (200, 225 ms were introduced later), while surface delays supplied in India are 17, 25, 34, 42 (17+25), 50, 67 (50+17 or 25+42), 109 (42+67) and 176 (67+109) ms. Few overseas manufacturers offer 9 ms also. After in-hole shock tube is set-off at the surface (considered as start-zero time), the detonation travels within the tube at 2000-2200 m/s and sets off the detonator after 475 or 500 ms. The surface delay units as per assigned delay get initiated sequentially and travel outward / away from the first drillhole along spacing and across rows (burden). Ground movement from blasting of first drillhole occurs after 475 ms and by that time, several surface units have got initiated, moved ahead and set-off the in-hole units (Figure-1). The initiation of the surface delays would be several rows ahead (11 rows ahead with 42 ms, 7 rows with 67 ms and 4 rows with 109 ms) before any ground movement starts and hence misfire is less likely to occur, due to ground movement cut-off (unlike detonating cord). It is prudent to use longer delay in-hole. Figure-1 explains the concept pictorially.

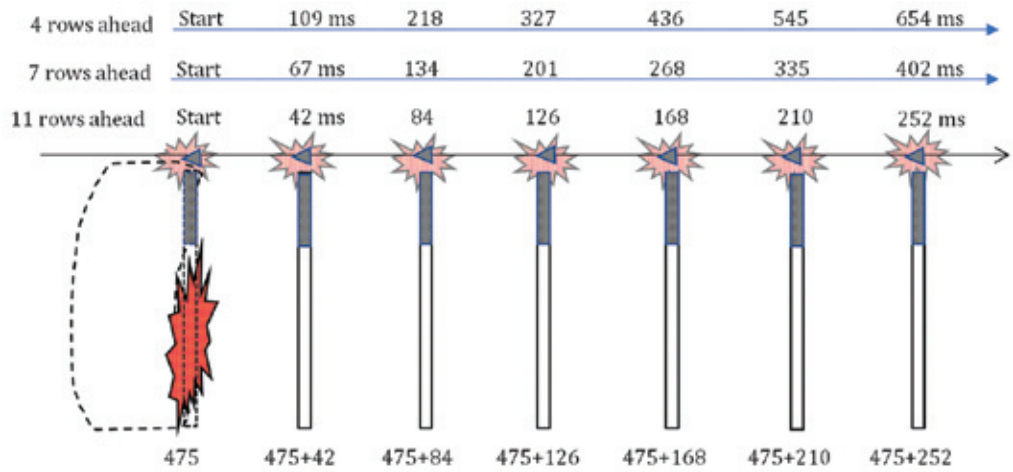

Figure 1-In-hole detonator fires after 475 ms, while surface delay initiation is much ahead preventing misfire due to ground movement cut-off

5.3. Shock tube configuration / connection

As much as practicable, the surface connector must be placed in such a manner that the in-hole tube is perpendicular (at 90°) to the drillhole. Acute angles should be avoided. The number of shock tubes that should be connected and method of hook-up should be as per manufacturers' suggestions and followed strictly. The number of tubes in a bunch connector is normally between 6-8. Detonating cord and shock tube MUST NEVER be placed inside the same bunch connector. The high brisance of detonating cord can cause damage to both outgoing tube as well as the bunch connector leading to a misfire.

5.4. Why lower delay at bottom and higher delay on top in an explosive column

Manufacturers provide delay timings 200/225 or 475/500 ms. Normally when single column is loaded, 200 or 475 ms with longer shock tube length are placed at the bottom and 225 or 500 ms with shorter tube length (for cost reduction) placed at the top. The higher delay placed at the top is an insurance

or back-up in the event of misfire of bottom delay. The delay timings from a batch of detonators follow a bell-shaped distribution curve viz 50% of the timings recorded would be higher (to the right side) and 50% would be lower (to the left side) of the nominal mean delay time. If both bottom and top delay units have the same delay viz 200 ms or 475 ms, then statistically, in 50% of the drillholes, the top unit will get initiated earlier and true bottom hole initiation would NOT be achieved. Figure-2 illustrates various options.

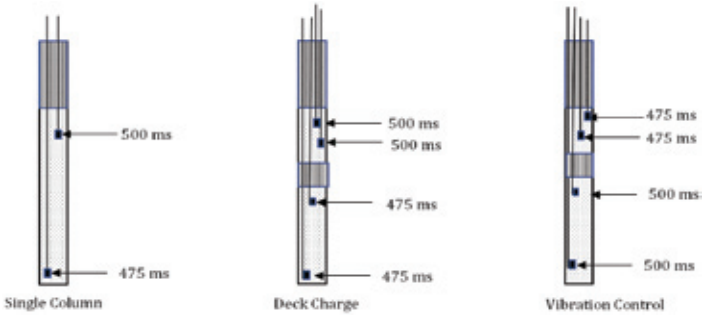

Figure 2 - Suggestions of using in-hole delay detonators

5.5. Initiating a blast surface hook-up with Safety Fuse + Plain Detonator

Some opencast mines situated in hilly terrain are prone for lightning and thunderstorms. Hence, for initiating a blast, use of electric detonators is avoided and plain detonator crimped onto a long length of safety fuse is used. After the safety fuse is lit, the blaster vacates the site in a vehicle (jeep/van). This is an unsafe practice as the vehicle can stall exposing all those present in vehicle to high risk. Sometimes, defective or deteriorated safety fuse might burn at a faster rate and blast can take place earlier than perceived. It is prudent to use a product, which can set-off the blast staying inside a blast shelter placed at a safe distance. Overseas mines use a non-electric detonator called 'starter' - an instantaneous surface unit crimped to a shock tube of 300/500 m length supplied on a spool. Indian users desirous of using a similar product can approach local manufacturers and request them for supplies. *Mines need to invest for safety*.

5.6. Surface hook-up suggestions to minimize extent of misfires

Handling a misfire in deep hole blasting is a cumbersome and a risky operation. Unfortunately misfire of products do occur due to quality issues at the manufacturers' end and also wrong method adopted by the user during hook-up. Figure-3 shows two configurations of surface hook-up. In the top sketch, misfire of surface delay has occurred in the drillhole #3 in second row resulting in drillholes 3, 4, 5, 6 remaining unfired, while all other drillholes have initiated. Drillholes in row #3 behind the four misfired drillholes would result in poor fragmentation, restricted frontal movement, tight muckpile and hard digging conditions. The situation would have been more serious if misfire had occurred in row #1, as drillholes behind the misfires in rows #2 and 3 would have got affected severely.

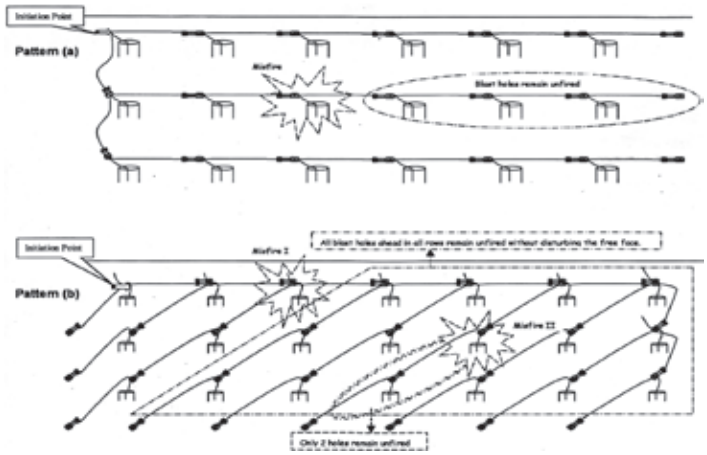

Figure 3 - Suggestions for hook-up of surface delay

The hook-up shown in the bottom sketch is more user-friendly in terms of handling a misfire. A misfire occurring in places shown in sketch would not affect the blast as severely (as the situation described earlier) and it would be possible to salvage by reconnecting fresh surface delay and attempt to re-fire the misfired blast.

5.7. Multi-deck blasting on different delays for ground vibration control in bench blasting

Using combinations of surface delays, it is possible to design blasts where charges are separated by 8-9 ms for ground vibration control (17-9 = 8, 25-17 = 8, 34-25 = 9, 42-34 = 8, 50-42 = 8) Statutory authorities while according permission for blasting in the vicinity of habitat or structure, often prescribe a very low maximum charge per delay of 25 - 50 kg for deep hole blasting using 250 mm diameter drillholes. The mines indent for 4 or 6 delays with 25 ms intervals viz 200, 225, 250, 275, 300, 325 ms or 400, 425, 450, 475, 500, 525 ms for use in multi-deck charging. In such situations, the firing times have to be extremely accurate to ensure statutory compliance. Products of different manufacturers should not be used in the same blast due to vagaries of timings, age of product and shelf life. It is prudent that user should inform manufacturer-supplier need of their timing requirements so that manufacturer can process the various delays for multi deck charging. *The 8 ms separation is not effective in deep drillholes*.

A word of caution: Pyrotechnic based delay elements have an inherent drawback as they exhibit overlap (where a higher delay fires before a lower delay or vice versa), have scatter (+/-) in delay firing times due to vagaries in composition, particle size, bulk density and processing conditions. The nominal firing time is also known to shift with age viz pyrotechnic delay composition becomes sluggish.

Manufacturers endeavor to ensure accurate firing times through superior technology and strict quality assurance measures adopted during production.

6. Electronic Detonators

The concept-idea of an application specific electronic circuit (ASIC), small enough to be placed inside a detonator shell and capable of being programmed to energize and discharge energy after a precise time delay is the most significant development after the shock tube. At the 1983 annual conference of International Society of Explosives Engineers (ISEE), a concept of electronic detonator was presented (Worsey and Tyler, 1983). Product development ideas had already begun in South Africa, Australia around that time. Trial blasts in mines using electronic detonators probably began during the late eighties overseas. Today in India Orica, GOCL, Solar and C-Det are supplying electronic detonators.

Electronic detonators look very similar to electric delay detonators, with a metal shell and twin lead wires passing through a plug crimped to the shell. In electric detonators, the leads are directly fixed to a fuse head making it vulnerable to extraneous electricity sources. The fuse head initiates the explosive train consisting of pyrotechnic delay element, priming charge ASA and base charge PETN. Whereas in electronic detonators, the pyrotechnic delay element is replaced by the digital circuit placed between the fuse head and lead wires. The digital circuit enables certain protection against extraneous electricity sources. Like electric and non-electric detonators, electronic detonators too enable initiation of explosive at any desired horizon in the drillhole (point initiation) and overcome all the lacunae of pyrotechnic delays such as overlap and timing scatter (+/-) which increases with delay time. Timing accuracy is high, firing times can be programmed in increments of 1 ms and programming window is 1-30,000 ms (30 seconds). Initial electronic detonators had factory programmed delay timings mimicking pyrotechnic delay detonator timings. This was followed by the miniaturized circuit being assigned a number at the factory and delay time keyed in on the exploder prior to blast. For example, if the user chose 38 ms, then numbers 1, 2, 3, 4 would fire at 1x38=38, 2x38=76, 3x38=114, 4x38=152 ms and so on. GOCL in India used this concept initially and later introduced the fully field programmable version. Among the many inputs that result in good fragmentation, loose diggable muckpiles, reduced ground vibrations and flyrock generation, accuracy of firing times of delay initiators used in the blast are known to play a significant role. Electronic detonators fulfill this requirement and the blast designer is ensured of firing times as per design. Accuracy of firing times is $\pm$1 ms for lower nominal times and Orica claims accuracy improvement from 0.01 to 0.005%. Significant advantages in final results with the use of electronic detonators has been reported in a number of papers by various authors. Superior fragmentation, reduction in average fragment size, improved digging, productivity increase, 'conditioning' of fragments leading to more efficient comminution and reduced ground vibrations for same maximum charge per delay and/or scope to increase maximum charge per delay (due to accuracy of delays) have been enumerated.

Orica, the world's leading manufacturer of commercial explosives and blast initiation systems manufactured their 100 millionth electronic detonator on May 01, 2019. The largest blast recorded till date (12/2019) with electronic detonators is at Caval Ridge mine, Bowen Basin of BHP Mitsubishi Alliance where 4.7 million cu.m of OB was blasted using 2194 MT of bulk explosives charged in 3899 drillholes using 8144 nos. of Dyno Nobel's DigiShot detonators. Remotely fired wireless electronic detonators have also been introduced by Orica, Dyno, AECI.

7. Important Tips / Suggestions for Users

- GO THROUGH MANUFACTURERS' TECHNICAL DATA SHEET or INSTRUCTION MANUAL THOROUGHLY and FOLLOW INSTRUCTIONS EXPEDITIOUSLY.
- Explosive materials and blast initiation systems must be handled with utmost care. Never subject them to misuse, abuse or unintended energy defined as FISH – Friction, Impact, Static (electricity), Heat.
- Cap-sensitive explosives are those that can be set-off using a standard No.6 strength detonator. Booster-sensitive explosives are less sensitive and for initiation, require another package of explosive, which is cap-sensitive.
- Purpose of blast initiating device is to set-off the explosive charge in the drillhole in a desired manner and sequence.
- Detonators of different manufacturers should not be used in same blast / circuit.
- While using electric detonators, check resistance of individual detonators, continuity of circuit using AUTHORIZED ohm-meters. NEVER use electrician's multimeter or megger for checking resistance / continuity of detonator circuits.
- Ensure proper connection of leadwires so as to avoid 'contact resistance'. If the factory supplied detonators' leadwire ends are oxidized-rusted, then cut-off about 5 cm and freshly skin the insulation and connect.
- In bench blasting, explosive needs to be initiated at the bottom of the drillhole (bottom hole initiation) and detonation should travel along the column, not across diameter of drillhole. Initiation should occur at floor level and not at the sub-grade.
- Users should ascertain with the manufacturers, compatibility of products being used, before carrying out blasts.
- Ensure proper knots/connections while using detonating cord trunklines, downlines. and while connecting detonating relay. Follow manufacturers' instructions.

- PETN/TNT cast boosters get initiated reliably by a No.8 strength detonator or detonating cord having core load of 10 g/m. For use with lower grammage cords, cast boosters have to be specially designed. Users should consult manufacturers for compatibility of use.
- Ensure method of connecting shock tubes into surface bunch connectors is correct as per manufacturers' data sheet. While hooking up, NEVER PLACE DETONATING CORD and SHOCK TUBE IN SAME BUNCH CONNECTOR as high brisance of cord can cause cut-off of shock tube.
- Never connect shock tube to detonating cord using tape or knot. Always use the plastic connector provided by the manufacturer on the tube. If user wishes to use shock tube detonator in-hole along with detonating cord trunkline, user should ask manufacturer to supply shock tube detonators with factory assembled plastic connector.
- Never connect shock tubes with knot or side splice. One shock tube will not initiate another. Open ends of shock tube placed within a sleeve will propagate. Contact manufacturer.
- Do not subject shock tube to sudden jerks while lowering a heavy primer cartridge during charging or run track of heavy machinery over shock tube or cause entanglement with equipment, moving vehicles, causing it to snap. Shock tubes are known to undergo initiation due to snapping and this phenomenon is known as 'snap-slap-shoot'. There are several incidents described in various presentations. Initiation of detonating cord due to stretching and snapping has also been reported
- If there is a requirement to cut detonating cord or shock tube, use a sharp knife in a single smooth operation. NEVER attempt to cut both products using scissor, cutting plier, serrated edge such as a hack-saw blade or impacting between two hard surfaces. The free end of the shock tube is usually sealed at factory using ultrasonic sealing. It can be cut, if required just prior to blast - for example for inserting it into a shock tube starter for setting off the blast.
- While using shock tubes, avoid (i) formation of kinks (ii) avoid acute reverse bend of tube.
- Unlike electric detonators which can be fired using any type of exploder (or AC mains), electronic detonators require 'dedicated' logger/programmer and blasting machine unique to the manufacturer. To prevent unauthorized use, exploders are provided with a physical key or dedicated digital key or protected with a password made available to the blaster. Hardware and electronic detonators of different manufacturers SHOULD NOT/CANNOT BE INTERCHANGED.
- Suspend charging operations and vacate blast area during severe thunderstorms and lightning activity. An approaching thunderstorm's distance from blast area can be assessed by observing the time taken for the sound to reach the ears after seeing the lightning flash. Speed of sound in air is 343 m/s (1125 ft/s) at 20°C. Speed increases marginally with temperature (hotter) and reduces when atmosphere is cold.
- ***Golden rule is to stop all charging operations and vacate blast area when there is thunderstorm and lightning activity in blast area***. Shift all uncharged items to a safe location. Exposed pig tails of detonating cord, shock tubes, leadwires of electronic detonators should be buried inside the drillhole and covered with drill cuttings - stemming.

8. Conclusions – Looking Ahead

Safety is paramount during blasting operations. Explosives and initiation systems should never be subjected to 'FISH' during storage, transport and handling. In the event of an approaching thunderstorm and lightning activity, suspend charging operations, vacate the blast area and resume only after the storm has passed. Exposed detonating cord, shock tubes, leadwires of electronic detonators should be buried inside the drillhole and covered with stemming. All surface hook-up must be removed. Blast initiation systems play a significant role in the success of blasting operations, beyond just setting off the explosive in the drillholes. They contribute significantly in terms of fragmentation, muckpile looseness, diggability, productivity, and control of environmental issues such as fly rock, ground vibrations, airblast overpressure and total costs. Each product has specific advantages and disadvantages. Accuracy of pyrotechnic delay firing time had been a matter of concern for a long time and has been overcome with electronic delay detonators. From humble beginnings of Safety Fuse in 1831 (still being used today!), the industry has witnessed the use of wireless electronic detonators, the signals for initiation passing through hundreds of metres of solid rock to set-off a blast below ground. Use of electronic detonators in India is mostly confined for ground vibration control. Mines should now start using electronic detonators regularly as a tool for blast optimization on the concepts of 'mine-to-mill', through extensive monitoring and evaluation of individual operations.

(Reference[2,3] have been used extensively while preparing the paper - Author)

9. References

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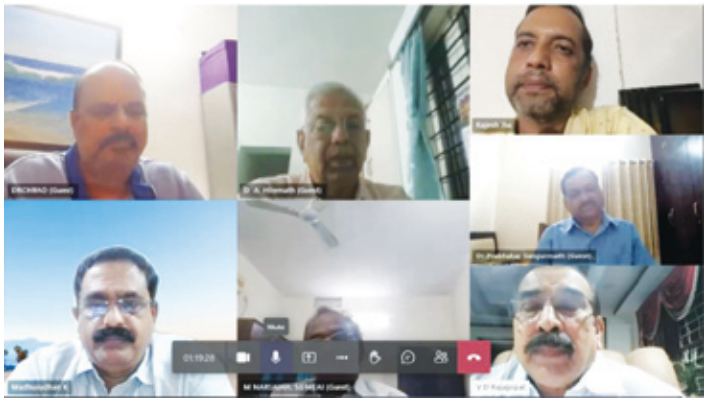
MEAI NEWS

MEAI HEADQUARTERS

Minor Minerals Committee first meeting



The first meeting of MEAI - Sub Committee on Minor Minerals was convened online by the President MEAI - Sri. K. Madhusudhana. Chairman of the sub-Committee Dr. V.D. Rajagopal, esteemed members Dr. D.A Hiremath, Dr. Prabhakar Sangurmath, Shri. Rajesh Kale and Dr. CH. Rao have participated and discussed a road map for the sub-committee and provided valuable inputs. Secretary General MEAI Sri. Narsaiah coordinated the meeting.

National webinar on statutory amendments@2021

A National webinar on Statutory amendments carried out in 2021 was conducted on line on 8.12.2021. The Chief Guest Shri. Mantu Biswas, Former CCOM, Shri. Akshaydeep Mathur and Shri. A. R. Vijay Singh presented papers on recent amendments on Mining Laws. The presentations were applauded by the participants.

AHMEDABAD CHAPTER

Executive Committee Meeting of the Chapter

A Meeting of Executive Committee of the Ahmedabad Chapter was held on 4.12.2021 at 7.30 pm at Hotel Novotel with Shri. Roopwant Singh, IAS Managing Director of GMDC & Commissioner of Geology & Mining, Government of Gujarat, as special invitee. All office-bearers and the members of the Chapter attended the meeting. All ex-officio members, Vice President-I Shri. S.N. Mathur, Council members Shri. A.K. Garg and Shri. P.N. Rao, and Shri. A.L Thakor, Past Chairman were also present.

At the outset Shri. H K Joshi Chapter's Chairman welcomed the Special Invitee Shri Roopwant Singh and all the Committee members and their families. In his welcome address he presented the highlights of the Ahmedabad Chapter along with the focus on the future activities to be carried out, with special emphasis on the technical event proposed to be organized along with 2nd Council meeting in the month of January 2022. Shri. S. N. Mathur suggested some activities that may be organized at Chapter and its Local Centers levels during Silver Jubilee Year. He also figured out some possible subjects for the Seminar/ Technical meet on 21st January 2022 along with 2nd Council meeting. Special Invitee Sh. Roopwant Singh, IAS congratulated the Chapter for the activities being carried out. He also shared his wide experience & his association with the mining Industry. Meeting ended with Vote of thanks, proposed by Shri. A.K. Makadia followed by family Dinner.

Welcome Address by Shri. H.K. Joshi

Shri. Roopwant Singh, IAS addressing the Meeting

Shri. A.K. Makadia greeting Shri. S.N Mathur

BHUBANESWAR CHAPTER

Hybrid Technical Session held on 3rd Dec'21

The Bhubaneswar Chapter organized a Hybrid Technical Session on 3rd December 2021 at Chrome Valley Club, Sukinda Chromite Mine of Tata Steel Mining Limited in both the virtual & physical mode. Newly elected office bearers of the Chapter, Shri. Pankaj Kumar Satija (Chairman), Shri. Shambhu Nath Jha (Secretary) and other senior members of the Chapter had graced the occasion. The session was attended by the members of the Chapter through virtual mode while the mining fraternity of Sukinda Valley have attended the session physically.

Welcome address by Shri. Shambhu Nath Jha

The session started with auspicious lamp-lighting by the dignitaries followed by welcome address of Shri. Shambhu Nath Jha (Secretary) in which he welcomed all the participants that attended the event and also thanked former Chairman Mr. M C Thomas and Secretary Mr. Dipak Behera of the Capter for their efforts in keeping the Chapter active and vibrant even during COVID-19 pandemic period. He also thanked various speakers for bringing their technical expertise to the event.

Speaking on the occasion, Shri Pankaj Kumar Satija had stressed up on the importance of this type of technical sessions for the benefit at individual and industry level by learning and sharing newer things by interacting in group. He also assured that this type of events will take place regularly. He also appreciated MEAI for its approach in providing opportunity to professionals in their career growth through frequent technical sessions and seminars to remain updated on current issues and concerns of the industry and different approaches to manage these.

Shri Pankaj Kumar Satija (Chairman) addressing the session

Presentation by Mr. Mrinal Pai, M/s Skylark Drones

Three technical presentations on the following topics were presented by officials from M/s Skylark Drones, M/s eTrans Solutions and M/s Sandvik Mining & Rock Technology.

Topic 1: Drones in Mining-Increasing Safety and Efficiency Presenter- Mr. Mrinal Pai, CTO & Cofounder, Skylark Drones.

These days drones are used to conduct faster surveys, monitor extraction volumes in day-to-day mining activities. He emphasized on how his firm is working on advance technologies in drone survey to end material pilferage, cut down on labour costs as in conventional survey and to improve operational efficiency.

Presentation by Mr. Sanjeev Kumar, M/s eTrans Solutions

Topic 2: Safety/Theft Control/Performance Enhancement through technology

Presenter-Mr. Sanjeev Kumar, Business Development Manager, eTrans Solutions Private Limited

He presented on how his company is working on digitization of mining operation by reducing man machine interface. He also talked about emerging solutions in the field of mining for reducing operational and maintenance cost.

Presentation by Mr. Sumeet Kumar, M/s SANDVIK

Topic 3: Automine Surface Drilling for Boom Drills by M/s Sandvik Mining & Rock Solutions.

Presenter: Mr. Sumeet Kumar, Manager, Sandvik Mining and Rock Technology

He has briefed about their latest product Leopard DI650i, fully automated drill machine which can be operated remotely. He also explained about the benefits associated with this type of drill like improved efficiency and reliability, lower maintenance costs, improved safety, one operator multiple machines operation etc.

The event ended with the vote of thanks proposed by Shri Naveen Shrivastava, AGM-Mining, Tata Steel Mining Limited.

Jabalpur Chapter

Indian Mining Day Celebrations

Indian Mining day was celebrated by Sagmania Limestone Mines, Satna Cement works, Satna, Madhya Pradesh on 1st Nov 2021. Various activities were organised at mines in which there was active participation by all executives, workers and other associates. The programme commenced with Mining Day Pledge, welcome note and speeches about the importance of Indian Mining day celebration. A Presentation about recent Mining circulars was presented as part of knowledge sharing initiative. Spot quiz competition for workers, Plantation activities, Videos on Mines safety were shown to workers etc. were the highlights of the programme. Prizes were distributed to winners and participants. Everyone participated with great enthusiasm.

RAJASTHAN CHAPTER- UDAIPUR

Visit to Piplantri Village: Marble Mine Waste Dumps Turned into Oasis by *Padma Shri* Sh Shyam Sunder Paliwal

A joint visit was organized by the Rajasthan Chapter-Udaipur and RSMM Ltd. Udaipur on 19th November, 2021 to Piplantri Village to witness the work done by Shri Shyam Sunder Paliwal in the field of protection of environment,

forestry development, welfare of girl child (Beti Bachao, Beti Padhao), water conservation, organic farming etc. for which President of India, Honorable Shri Ramnath Kovind awarded him the **fourth highest civilian** award '*Padma Shri*'.

Some Facts about Shri Shyam Sunder Paliwal

Shri Shyam Sunder Paliwal is a well-known social activist from Piplantri, Rajasthan. After witnessing his village turning into a barren land due to extensive mining, he decided to plant trees in the area so that no one faces the situation of drought in future. Sadly, when his elder daughter, Kiran, was only 18 years old, she passed away due to dehydration. The much-grieved father planted a Kadam tree (Burflower tree) symbolizing a sublime love in the remembrance of his daughter, and from here he started the noble initiative of turning his village into a green haven.

When he became the Sarpanch of his village, his first goal was to encourage and motivate people to stop killing the girl child, and the second goal was to plant more trees in the area. He told that an innovation has been done by starting '*Kiran Nidhi Yojna*', according to which 111 trees are planted whenever a girl child is born. It is followed by a fixed deposit of Rs. 31,000 in which Rs. 10,000 was contributed by the family members of the girl child and rest by the panchayat members and other villagers. The amount was handed over to the girl or her family after she gets matured.

During visit sh Paliwal told that saplings are not planted here for photographing the area, but the responsibility of their complete safety is also taken

On the Raksha Bandhan day, Rakhi is tied by sister first to plants like brother and then to brother.

After the initiative of Piplantri village, encouraged from here, now this work is being done in other gram panchayats and people are being made more and more aware of the environment.

After his proactive initiatives, the sex-ratio in the village has increased, and more than 3,50,000 trees have been planted, so far. Villagers have also planted aloe-vera and rose plants, which are used to make various medicinal products of daily use, and later, sold in the market. It has helped in generating employment in the village.

Visiting officers/ members saw the plantation work and found a great bio-diversity in the area where different types of plants are shelter homes to many birds and animals. Development of nursery and water ponds adds to the natural value of plantation.

He has also started '*Swajaldhara Yojana*' to conserve and preserve water, and around 1,800 check dams that have been constructed on the pasture lands over the mountains in the last 11 years to recharge the groundwater level.

Now this village among the Aravalli ranges has become an "adarsh gaon' (ideal village), which has survived Rajasthan's severe drought and water scarcity. There are countless puddles in the ranges, which is an unlikely sight in Rajasthan," says Shri Paliwal, which turned the barren Rajsamand into an oasis. This has resulted in providing a positive impact on the water table in the area. The Piplantri model has now been emulated by 157 panchayats in Rajasthan, Maharashtra, Bihar and other states

The effective utilisation of government schemes has played a big role. "All the check dams and trenches have been constructed by villagers working under different programmes, such as the MNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) and the Integrated Watershed Management Programme.

He was also awarded the 'Nirmal Gram Award' (2007) by the then President of India, Dr A. P. J. Abdul Kalam. In 2019, Shyam Sunder Paliwal and TV actress, Sakshi Tanwar, appeared in the 'Karmaveer' episode (7 November 2019) of Kaun Banega Crorepati 11. He was appointed as Eminent Guest Speaker by Ministry of Rural Development Government of Rajasthan. He was key speaker at the Launch Program of '*Sansad Adarsh Gram Yojna*'.

Addressing the visitors, Shri Shyam Sunder Paliwal said that it is responsibility of each individual to start new era for protection of environment, tie-up with nature and create resources for employment in the village so that migration from rural to urban can be stopped. He further told that how plantation is done on overburden to create greenery on dumps. Today, Piplantri village has earned a unique identity in the international arena as summarized below.

- Piplantri Model -Village is now recognized as the model for many villages all over India and globally.
- The Deputy Minister of Namibia appreciated the Piplantri work and shown interest to implement Piplantri Model in Namibia.
- The story of Piplantri village is taught in the schools of Rajasthan (Rajasthan Board of Secondary Education) and in Denmark.
- Various TV Channels (MTV) and media personnel have also prepared documentaries on the development made at Piplantri Village and on the significant work accomplished in the area of Girl Child welfare by Shri Paliwal. An Argentine movie, "Sisters of the Trees" highlights accomplishments of Shri Paliwal and intimately portrays the life of the women of Piplantri, the positive changes and the challenges they face

Observation of officers/ members:- They witnessed the great work done at grass root level at Piplantri by way of beautiful plantation over dumps/barren and charagah/ pasture lands which are inspirable for all nature loving people and to boost our efforts to create aesthetical beauty around us. Piplantri is a role model where systematic plantation converted wasteland into quality forest in which variety of plants. This forestry area serves many purposes like shelter to animals, soil conservation and augmentation of ground water level. Tremendous efforts have been made towards water conservation. Mine owners must visit and adopt ways and means to implement in their areas for developing eco-friendly mining.

The members enjoyed the delicious country food served in the man-made forest amidst the drizzling drops of rain which made the event more natural and fascinating.

On this occasion Shri TR Agarwal, Financial Advisor, Shri Mukesh Chaturvedi, Group General Manager, RSMM Ltd. along with Sh MS Paliwal, Secretary, MEAI, Udaipur Chapter appreciated and honored Padma Shri Sh Shyam Sunder Paliwal by presenting a memento and shawl. Shria Shyam Sunder Paliwal, in turn, '*Padharo Mahare Desh'* also presented memento to Mining Engineers' Association of India and Rajasthan State Mines and Mineral Ltd.

OBITUARY

Shri. C.K. Joshi

Shri C K Joshi (LM .no. 255) has expired on 12.12.2021. He was a thorough gentleman and a true geologist cum mining engineer. MEAI Ahmedabad Chapter has lost a valuable member.

The Members of MEAI deeply condole the sad demise of Shri. C K Joshi and pray for his soul rest in peace.

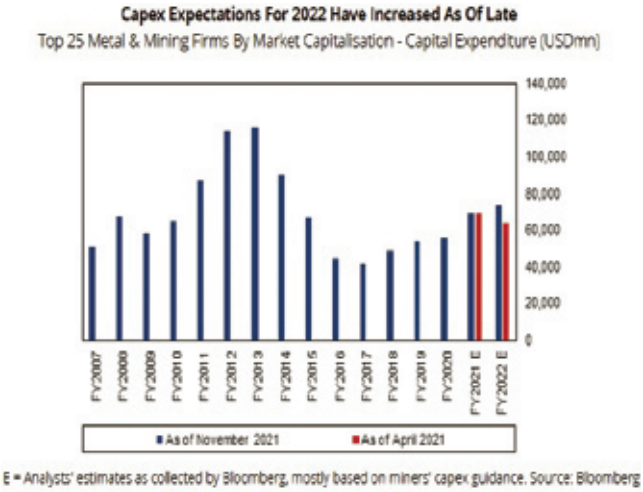
OBITUARY

Shri. Mathur Sobhagya Mal

Shri S.M. Mathur (LM no. 1510) has expired on 14.12.2021. He is a Life Member of Rajasthan chapter-Udaipur.

The members of MEAI express their heartfelt condolences to the bereaved family of Shri. Mathur Sobhagya Mal.

(Continued from Page 14)

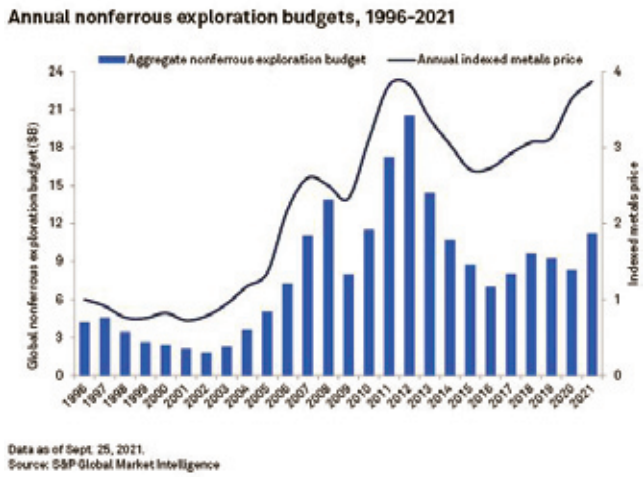


At the peak in 2013, the top 25 largest mining companies had outlays of $117 billion; the second year in triple digits. Next year it may rise beyond $70 billion.

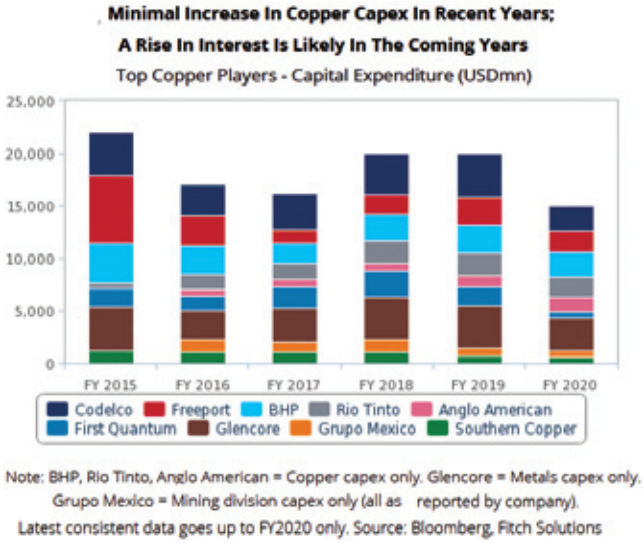
All the fields are brown and the sky is grey

During the Beijing boom, exploration budgets (non-ferrous, but really who drills for iron?) were considerably larger than they are today despite metal prices at similar levels. Greenfield exploration was a thing – as late as 2013 half of the top ten largest copper expansion projects were greenfield. Early-stage exploration budgets in 2020 fell to their lowest on a percentage basis, and after a slight uptick this year still accounts for only 26% of budgets.

Neither did boards shrink from frontier markets. Now they are finding that what were considered South American safe bets are degrading faster than ore overages in the Andes. Trial balloons about entering Africa are found to be made of lead and advancing a project in US jurisdictions remains a life sentence.



Copper capex chill



If iron ore was doing the heavy lifting in the 2000s and early 2010s, it will be up to copper to supersize this

cycle. But copper's top tier hasn't exactly gone capex crazy and when there is spending it's mostly to keep production steady or fulfill environmental pledges – another day, another desalination plant.

Only a fraction of the 28,000 mining trucks in operation globally are zero emissions. Lithium-ion batteries aren't getting cheaper anymore and even with sweet tax incentives like Canada's, just to convert what you already have will take away dollars from expansion plans.

Pricing to scare

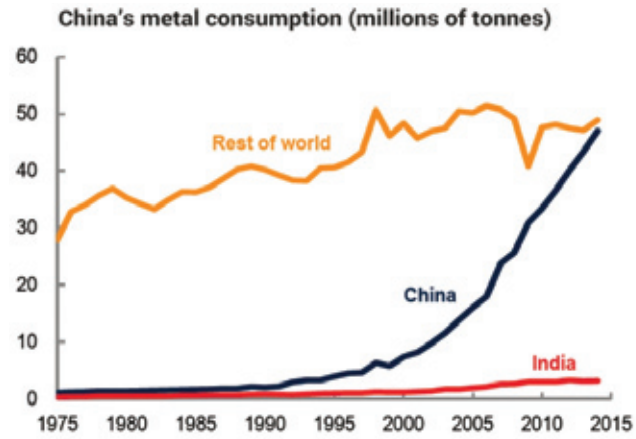
In a recent report headlined Copper: Pricing to scarcity, Goldman Sachs calls copper the most mispriced commodity. Scarcity is a pretty strong word to use in any report about commodities. The investment bank has recapitulated its bullish forecast for copper to average $11,875 a tonne (just below $5.40 per pound) next year and step gains to $15,000 ($6.80) in 2025. But Goldman is a lonely voice.

A monthly poll conducted by FocusEconomics released Thursday shows wide disparities in forecast prices by the investment banks, brokers, economists and governments collected December 1 – 6. Among investment banks, the lowest forecast among the more than 30 participants for the average price next year is by BMO Capital Markets, which predicts copper to retreat to the $7,875 ($3.60) level (and $6,625 in 2023, ouch!). RBC and Société Générale are also firmly in bear territory with forecasts around $8,250 in 2022 while TD Securities, Capital Economics and Citigroup barely see copper scaling $9,000 next year. The consensus forecast for 2022 is an average of just over $8,900, sliding to $8,480 in 2023. All blame a slowing China, particularly its property sector, for the bearishness.

We'll always have Qingdao

The final chart is six years old and from the World Bank Commodity Outlook for 2016 (unfortunately not available for public viewing anymore) which rather belatedly forecasted a severe downturn in Chinese commodity consumption.

China's economic growth rate may have slowed to 30-year lows, but in absolute terms, the country's economy will add the equivalent of Turkey's GDP this year, two South Africas' worth of economic activity, three Philippines, four New Zealands, and no less than five nominal Hungarys. If you're talking tonnes of metal rather than trends that should be unalloyed good news. But looking at this chart, 2021 to 2035 cannot but fall short of 2000 to 2014.



Source: World Bureau of Metal Statistics.
Note: Last observation is 2014. The six metals are included: aluminum, copper, lead, nickel, tin and zinc.

Frik Els | December 9, 2021

IMIC TRAINING PROGRAM BY NACRI IN APRIL 2022

Dear friends,

Please look out for the detailed announcement on the IMIC PDP training program in the MEJ February 2022 issue. This is a mandatory training program to be attended by those mineral industry professionals who wish to register as Competent Person under the Indian Mineral Industry Code (IMIC) for reporting Exploration Results, Mineral Resources and Mineral Reserves in India. The NACRI-IMIC CPs have already been recognised by the SME, USA and the NACRI is now in the process of attaining reciprocity with other CRIRSCO member countries to enable our RCPs to act as CPs in their jurisdiction.

For more details, please contact:

The Secretary General,
MEAI at meai1957@gmail.com or 040-66339625
[OR]

NACRI Co-Chair,
Dr PV Rao at drpvrao@gmail.com

NOMINATIONS FOR MEAI AWARDS 2022

The Mining Engineers' Association of India presents awards sponsored by the Industry/individuals during Annual General Meeting in June -July every year. Nominations for the following Awards are invited in the prescribed form, so as to reach the Secretary General by **15th of March 2022**. Nomination can be made by one member for one award only.

1. **MEAI - Sitaram Rungta Memorial Award** for the best paper on Mining related issues during the year 2021.
2. **MEAI NMDC Award** for significant contribution to Iron Ore Industry during the year 2021.
3. **MEAI Simminds Award** for significant contribution to limestone industry during the year 2021.
4. **MEAI Smt. Bala Tandon Memorial Award** in recognition of contribution to Mining Industry for improving ecology, environment and a forestation during the year 2021.
5. **MEAI Abheraj Baldota Memorial Gold Medal Award** (Mining Engineer of the year 2021) in recognition of significant contribution to Mining Industry by a Mining Engineer with 20 years of experience in the Industry.
6. **MEAI Abheraj Baldota Memorial Gold Medal Award** (Young Mining Engineer of the years 2021) in recognition of significant service to Mining Industry by an Young Mining Engineer who has not completed 35 years of age as on 2020.
7. **MEAI-SRG Informational Technology Award** for the year 2021, In recognition of significant contribution to Mining Industry adopting Information Technology during the year 2021.
8. **MEAI-Smt. Gullapalli Saraladevi Memorial Award** (Lifetime Achievement by a Mining Engineer) during the year 2021.
9. **MEAI Master Tanay Chadha Memorial Geologist Award** for the year 2021 in recognition of significant contribution by a geologist in the field of Mineral Exploration, quality control and production, mine planning etc. during the year.
10. **MEAI- Smt Veena Roonwal Memorial Award** for the year 2021 to a Mining Engineer/Geologist/a qualified person involved with Mining Industry with 10 years experience for presenting a paper during the year in a seminar/ symposium workshop organized by MEAI on "Water Management in and around a working mine" or "Implementation of New/Latest Technology in Mining and allied subjects.
11. **MEAI- Smt Kiran Devi Singhal Memorial Award** for the year 2021 only to a person (MEAI Member/Non member- need not necessarily be from mining discipline) for his/her contribution in the field of "Development and Conversation of Minerals and Environment" in and around Metalliferous mines (excluding Coal and oil) during the year 2021.
12. **MEAI Award to a best paper in Mining Journal** Published in the Mining Engineers' Journal in the year 2021.
13. **MEAI-SCCL Coal Award** for the year 2021 to a Mining Engineer, a Geologist, a Mechanical Engineer and a Foreman/Over man for meritorious contribution to the Coal Industry.

For detailed guide lines please visit website **www.meai.org**
or memorandum of association and rules and regulations (as on 01.03.2018)

Applications and Guide Lines

Application must be supported by at least two council members and must reach MEAI NHQ in Prescribed Format at Hyderabad before **15th March 2022**.

Applications are to be sent along with enclosed soft copies in (PDF format) with subject MEAI Awards 2022 to email - **meai1957@gmail.com**.

MEAI PROFESSIONAL DEVELOPMENT PROGRAMME (MPDP)

The Mining Engineers' Association of India (MEAI), as a part of Technical Competence Building Mission in the country with focus on Training in Mining, Geology, Exploration, New mineral laws, DMF, NMET, Blast Design, Safety management, Mine Environment etc. wishes to develop the requisite knowledge and competence of all professionals working in Mining, Geology, Exploration and Mineral based industries.

In this direction, MEAI wishes to organize its first series of Professional Development Programmes online.

The key objective of the MPDP is to enhance technical competence through imparting knowledge of various techniques and know-how of Mining Engineering, Mineral Exploration, Mine Safety Management etc. for Mining Professionals working in various organizations. The content of the training programme will encompass emerging issues of Mining Engineering and Geological Exploration. Resource persons will be drawn from various organizations who are renowned and have excelled in their own areas of expertise to train the participating Mining Engineers & Geologists in the field.

MPDP will comprise of theoretical lectures backed with practical case studies, group tasks and discussions.

Course Duration (Online mode)

- Six (6) days with two days in a week (Fri & Sat)
- Four (4) Sessions per day
- 90 minutes per session
- Important Dates: 4th March 2022 (Fri), 5th March 2022 (Sat)
  11th March 2022 (Fri), 12th March 2022 (Sat)
  18th March 2022 (Fri), 19th March 2022 (Sat)

Chairman

MEAI Training, Development & Program Committee
(vidyarthikud@hotmail.com; meai1957@gmail.com) Mobile: +91-8105250113

The credits obtained from the MPDP will be eligible for the mandatory 40-hour credits required by the RCPs to renew their RCP status under IMIC, by the MEAI-NACRI CP Registration Committee.

MEJ RIDDLES

Dear Readers of MEJ,

In order to increase the readership of MEJ, which has been felt essential in the interest of our ardent members, the mineral industry professionals as well as the mining sector, the Editorial Board of MEJ has decided to hold a monthly QUIZ. The monthly QUIZ will designed and printed in MEJ based on the content published in the previous month's MEJ. The MEJ readers will be given five objective questions with multiple choices to choose and expect them to respond with their correct answer by email to the Editor at **editor.mej.meai@gmail.com** by 20th of the current month. If more than three members responded with the correct answers, then the three winners will be decided by draw. Each winner will be issued a certificate of merit and a nominal cash prize of Rs 500.

Request the members to take part in the maiden QUIZ in large numbers and benefit from the enhanced knowledge by reading the Journal from end to end.

December 2021

1. Who delivered Technical Talk on Recent Development in Environment Clearance on Indian Mining Day?

(a) Prof. B.B. Dhar, New Delhi
(b) Dr. K. Srinivas, HOD, Mining Engg. Dept. Hyderabad
(c) Prof. Gurdeep Singh IIT(ISM) Dhanbad
(d) Prof. D.M. Surana, Jodhpur

2. Who Appealed for helping the Mining Industry and Mentor the students?

(a) Sri Akhlilesh Joshi, Director HZL Board
(b) Sri A.K. Kothari, Past President MEAI
(c) Sri P.C. Purohit, Past Chairman, Jodhpur Chapter
(d) Dr. T.N. Venugopal, Past Chairman, Banglore Chapter

3. Which groups of rocks are endowed with some of the best Zinc mineral resources in India?

(a) Bhilwara super group
(b) Udaipur super group
(c) Jaipur Super group
(d) Alwar Super group

4. Name of the Hindustan Zinc flagship project to mobilize rural women into Self - Help groups?

(a) Mitra
(b) Sakhi
(c) Raksha
(d) Mehandi

5. Who was the Chief Guest at IMD Celebrations held at MEAI HQ?

(a) K. Madhusudhana
(b) BRV Sushil Kumar
(c) Sharat Kumar Palleria
(d) Bidyut Chakraborty

WINNERS OF RIDDLES PUBLISHED IN THE MEJ DECEMBER 2021 ISSUE

Mr Sunil Goyal
Senior Manager (Mining), Diamond Mining Project, NMDC Ltd.

Mr Arun Kothari
Director (Retd.), Dept. of Mines & Geology, Govt. of Rajasthan

Dr. D. S. Rao
Chief Scientist, Head, HRD, CSIR-IMMT, Bhubaneswar- 751013

To receive the cash prize of Rs 500, the winners are requested to please contact the

Secretary General, MEAI
by email at **meai1957@gmail.com** or Mob. 9177045204.

CONFERENCES, SEMINARS, WORKSHOPS ETC.

INDIA

2-4 Mar 2022: **International Mineral Development Conference and Exhibition (Mbd-2022)**. Nagpur, India. For details contact: Website: http://www.mineralinfo.net; E-mail: mineralinfoindia@gmail.com; mbd.info2021@gmail.com; Cell No./ WhatsApp +91 9823015772

ABROAD

21-22 Jan 2022: **International Conference on Economic Geology, Mineralogy and Mining ICEGMM** in Amsterdam, Netherlands. Website URL: https://waset.org/economic-geology-mineralogy-and-mining-conference-in-january-2022-in-amsterdam; Contact URL: https://waset.org

31 Jan - 2 Feb 2022: **International Mining and Resources Conference (IMARC) 2022**. Conract: Phone: +61 3 9008 5946; Email: info@imarcmelbourne.com; Website: https://imarcglobal.com/

11-12 Feb 2022: **International Conference on Geology and Mining ICGM** in Kuala Lumpur, Malaysia; Website URL: https://waset.org/geology-and-mining-conference-in-february-2022-in-kuala-lumpur; Contact URL: https://waset.org

15 -18 Feb 2022: **International Mining, Equipment, Minerals and Metals Exhibition (IME 2022)**. Contact: The Mining, Geological & Metallurgical Institute of India (MGMI), GN-38/4, Sector-V, Salt Lake, Kolkata – 700091, West Bengal, India. Tel: +91-33-23573482 / 3987 / 6518; Fax: +91-33-23573482; Email: office@mgmiindia.in. Web: www.mgmiindia.in

4-5 Mar 2022: **International Conference on Mining Geology and Resource Estimation ICMGRE**. Conducted by World Academy of Science, Engineering and Technology. Rome, Italy

4-5 Mar 2022: **International Conference on Mining Intelligence ICMI**. Rio de Janeiro, Brazil. Organised by World Academy of Science, Engineering and Technology. Contact URL: https://waset.org

22-23 Mar 2022: **International Mining Geology Conference 2022**. Brisbane, Australia and Online. Contact: Ph. 1800 657 985 or +61 3 9658 6100

25-26 Mar 2022: **International Conference on Mining Geology and Ore Treatment ICMGOT** in Madrid, Spain. Website URL: https://waset.org/mining-geology-and-ore-treatment-conference-in-march-2022-in-madrid; Contact URL: https://waset.org

1-2 Apr 2022: **International Conference on Sustainable Water Management (ICSWM)**. Cebu City, Philippines. Website URL: http://conferencefora.org/Conference/30610/ICSWM/

15-16 Apr 2022: **International Conference on Mining Geology and Rock Excavation ICMGRE** in Cape Town, South Africa. Website URL: https://waset.org/mining-geology-and-rock-excavation-conference-in-april-2022-in-cape-town; Contact URL: https://waset.org

19-20 Apr 2022: **International Conference on Exploration and Mining Geology ICEMG**. Paris, France. Website URL: https://waset.org/exploration-and-mining-geology-conference-in-april-2022-in-paris

22-23 Apr 2022: **International Conference on Mining and Mineral Technologies ICMMT**. Tokyo, Japan. Website URL:https://waset.org/mining-and-mineral-technologies-conference-in-april-2022-in-tokyo; Contact URL: https://waset.org

3-4 May 2022: **International Conference on Mining Technologies and Sustainable Systems ICMTSS**. Rome, Italy. Website URL: https://waset.org/mining-technologies-and-sustainable-systems-conference-in-may-2022-in-rome; Contact URL: https://waset.org

20-21 May 2022: **International Conference on Recent Advances in Mining Technologies ICRAMT**. Berlin, Germany. Website URL: https://waset.org/recent-advances-in-mining-technologies-conference-in-may-2022-in-berlin; Contact URL: https://waset.org

24-25 May 2022: **International Conference on Mining and Mineral Processing ICMMP**. Montreal, Canada. Contact URL: https://waset.org. Website URL: https://waset.org/mining-and-mineral-processing-conference-in-may-2022-in-montreal

3-4 Jun 2022: **International Conference on Trends in Web Mining**, Information and Knowledge Extraction ICTWMIKE. Rome, Italy. Contact URL: https://waset.org. Website URL: https://waset.org/trends-in-web-mining-information-and-knowledge-extraction-conference-in-june-2022-in-rome

29-30 Jun 2022: **Mining World Congress**. London, United Kingdom. Website URL: https://miningconferences.org/; Program URL: https://miningconferences.org/agenda/; Contact URL: https://miningconferences.org/contact-us/; Contact E-mail: info@miningconferences.org

18-20 Jul 2022: **International Conference on Design Methods in Underground Mining ICDMUM**. Dubai, United Arab Emirates. Website URL: https://waset.org/design-methods-in-underground-mining-conference-in-july-2022-in-dubai; Contact URL: https://waset.org

19-20 Jul 2022: **International Conference on Land Reclamation in Mining Areas ICLRMA**. Copenhagen, Denmark. Website URL: https://waset.org/land-reclamation-in-mining-areas-conference-in-july-2022-in-copenhagen; Contact URL: https://waset.org

Printed and Published by M. Narsaiah, Secretary General, Mining Engineers' Association of India,
on behalf of Mining Engineers' Association of India and printed at Deepu Printers, Raghava Ratna Towers, Chirag Ali Lane, Nampally, Hyderabad - 500 001.
and published at F-608 & 609, 'A' Block, VI Floor, Raghavaratna Towers, Chirag Ali Lane, Abids, Hyderabad - 500 001. **Editor: Dr. P.V. Rao**

TATA STEEL

#WeAlsoMakeTomorrow

TATA

#SteelFact

Globally, extensive

afforestation

programmes are converting mines into habitats for local wildlife

Source: World Steel Association

*Currently, an area of 563 hectares is covered via afforestation in our mining locations.

*Data as on October 2021

PLANTING DOUBLE THE TREES FOR A BETTER TOMORROW

BOTANICAL PARK, NOAMUNDI

We are ensuring that the natural ecosystem in our mining locations is preserved. We have progressively implemented Biodiversity Management Plans at all our raw material locations in order to ensure no net loss in biodiversity.
Sure, we make steel.
But #WeAlsoMakeTomorrow.

www.wealsomaketomorrow.com | | www.tatasteel.com

Date of Publication: 26-12-2021
Date of Posting: 29 / 30 of every month

Regd. with RNI R.No. 71519/1999; No. of Pages: 44+Cover 4
Postal Regd. No. H-HD-GPO/024/2021 - 2023