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Mining Engineers' Association of India
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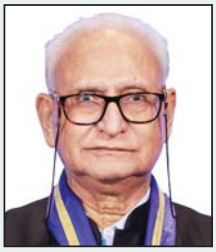

this issue contains...

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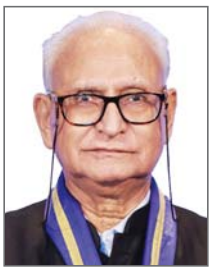
President's Message.....



Dear members..

I am writing this message with a heavy heart sharing news of the sad demise of our beloved past President Shri T.V. Chowdary at Hyderabad. Shri Chowdary was instrumental in developing MEAI to its present day form, setting up MEAI Head Office in the new premises, making suitable amendments to MEAI Bye-laws and Constitution. His untimely death is a great loss not only to MEAI but the mining industry as a whole. Let's pay our rich tributes in honour of the departed soul.

Recently, I had an opportunity to visit Bhubaneshwar in connection with the meeting of the Task Force. It was a very well attended meeting with the active presence of some large mining companies. Some very good suggestions were received. A few of them may as well be incorporated in the final report of the Task Force.

During this visit, I also had an opportunity to have an informal meeting and good exchange of ideas with the Executive Committee as well as some other senior members of Bhubaneswar Chapter. Difficulties faced by the mining sector in the Odisha region were also highlighted during discussions and some of these will soon have to be taken up with appropriate authorities. I am awaiting issue-based brief notes from the Chapter. Overall it was a very nice and productive get together organised by the Chapter.

Earlier, I attended a virtual celebration of International Women's day along with a panel discussion on "Inspiring Inclusion on Metals and Mining", very well organised by 'Women in India Mining'. It was expressed that from an era where women were not even expected to take up mining as a career choice, we have come a long way to an age of women leaders in the mining industry. Later, Shri Rajesh Chintak from Tata Steel gave a detailed presentation on how Tata Steel took initiative not only employing women work force in mining but also allowing the transgenders to operate high capacity earthmoving equipment.

We will soon be organising our third Council meeting on 13th April. Our Bailadila chapter has taken initiative to host this meeting at Bacheli. Let's hope to discuss some good points and hope the meeting will be fruitful.

With the best wishes,

S.N. Mathur
President

Mining Engineers' Association of India

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EDITOR'S DESK

Dr. P.V. Rao
Editor, MEJ

Lithium, the most talked about metal in recent times, is a key metal used in lithium-ion battery technologies. Reflecting its criticality, eight major global economies viz. Australia, Canada, China, Japan, Republic of Korea, the USA, European Union and India, included lithium in the list of their critical minerals, while cobalt and tungsten being only the other two that are common in their lists. In 2023, India recognized lithium's importance by labeling it as a 'critical' mineral along with 29 others. India defined critical minerals as those that 'are essential for economic development and national security' and whose 'lack of availability' or 'concentration of extraction or processing in a few geographical locations' may lead to the disruption of supply chains.

According to the U.S. Geological Survey, more than 90% of the world's lithium production is controlled by the top three lithium-producing countries, and nearly 60% of global lithium-processing capacity is concentrated in China. Most of the 98 Million tonnes (Mt) of lithium resources known in the world are concentrated in South America: especially in Bolivia (21 Mt - largely untapped resources), Argentina (19 Mt), and Chile (11 Mt). Acknowledged lithium Reserves are located in Chile (9.3 Mt), Australia (6.2 Mt), Argentina (2.7 Mt), and China (2 Mt). As of early 2023, over 80% of lithium production was raised from 17 mineral operations: six in Australia, two in Argentina, two in Chile, five in China. In 2023, Hard rock (59%), Brines (39%), and others (2%) accounted for the global lithium production. Lithium processing is shared globally between China (58%), Chile (29%), and Argentina (10%).

To address the prevailing problematic conditions, the Indian government has adopted a two-pronged approach by taking steps to develop its lithium capabilities: a) discover & extract national lithium resources and b) simultaneously acquire overseas lithium prospects/ cultivating partnership across supply chain. To leverage the recent discoveries of lithium deposits in India, the government has eased the mining process by allowing the auction of lithium blocks and enabling private players to mine lithium, a shift from the mostly state-run companies previously engaged in the process.

National media reported that India discovered an estimated 5.9 Mt Inferred resources of lithium in Jammu & Kashmir (the same was said to be reported in 1992 and later explored in 1999 by GSI). It may require 10 years or more from the time of establishing inferred resources to start actual mineral extraction, and claimed that if these reserves are utilized properly, India can become an exporter of lithium and the transition to a greener world can be swifter.

In the year 2023, 20 blocks of critical and strategic minerals were put for auction in Tranche-I, as Composite Licence (CL), which also included two lithium blocks viz. Salal-Haimna Block (Jammu & Kashmir) and Katghora Block (Chhattisgarh). In 2024, 18 blocks in Tranche-II (No lithium blocks) and 7 blocks in Tranche-III (till 13.3.2024) were put for auction, wherein Salal-Haimna Block from Tranche-I was relisted for auctioning.

In August 2019, a Joint Venture Company among NALCO, HCL and MECL, named Khanij Bidesh India Limited (KABIL), was formed by the Indian government to identify, acquire, develop, process and make commercial use of strategic minerals in overseas locations for supply to India. It has finalised agreements with Argentina to secure five lithium blocks and will pump in about Rs. 200 crore to explore and develop lithium mines in Argentina. India has also signed agreement with Australia for two lithium blocks.

Maybe, I am a bit scrambled with the Indian strategy. A few months ago, it was claimed that India has discovered one of the largest deposits of lithium in India (Salal block)! If India is certain of discovering such a largest deposit of lithium, then is it not rational for the government to allot this block on priority to the government mining companies to intensify its speedy exploration, development, and extraction, instead of distracting its focus, valuable time and financial resources to acquisition of lithium blocks in Argentina or Australia? Some people try to defend India's strategy by stating that it would take us substantial time to develop our lithium resources, India is opting to acquire lithium blocks in Argentina or Australia. If the lithium refining technology is not easily accessible, as we all admit, then how exactly can India acquire such a technology to extract lithium in Argentina, if not in India? How practical is it for India to scout around the world for lithium resources, when the underlying principle remains to convert lithium from its natural state of occurrence to a refined and processed state, whether the lithium natural resources occur in India or Argentina? ***Therefore, will it not be appropriate for India to focus all its research efforts in the development of indigenous lithium extraction/ refining technologies, on war footing, for the extraction of large lithium resources identified in Salal block of Jammu & Kashmir or Katghora block of Chhattisgarh!***

- Editor

NEWS FROM THE MINERAL WORLD

India to pump in about Rs 200 cr to explore, develop five lithium blocks in Argentia: Govt

India will pump in about Rs 200 crore to explore and develop five lithium mines in Argentia, the government said on Monday. Lithium is the single most important critical mineral for the energy transition; a fundamental component of lithium-ion batteries, which power electric vehicles and battery energy storage systems.

An agreement was signed between Khanij Bidesh India Ltd (KABIL), state-owned joint venture formed to scout for minerals overseas, and Catamarca Minera Y EnergÃtica Sociedad Del Estado (CAMYEN), a government-owned mining and energy corporation in the Catamarca province of Argentina to this effect. KABIL is also preparing to set up a branch office at Catamarca, Argentina. The project cost is about Rs 200 crore.

"KABIL will start exploration and development of 5 lithium brine blocks viz 1. Cortadera-I, 2. Cortadera-VII, 3. Cortadera-VIII, 4. Cateo-2022- 01810132 and 5. Cortadera-VI covering an area of about 15,703 Hectare, located in the Catamarca province of Argentina," the mines ministry said in a statement.

"With this agreement, KABIL has received exploration and exclusivity rights for five blocks to evaluate, prospect and explore and subsequent to existence, discovery of lithium mineral, exploitation right for commercial production," the ministry said. Argentina is the part of the 'lithium triangle' along with Chile and Bolivia with more than half of the world's total lithium resources and having the distinction of having second largest lithium resources, third largest lithium reserves and having the distinction of having second largest lithium resources, third largest lithium reserves and fourth largest production in the world.

"This is a historic day for both India and Argentina as we are scripting a new chapter in bilateral ties with the Agreement signing between KABIL and CAMYEN', a step which will not only play a crucial role in driving the energy transition for sustainable future, but also ensure a resilient and diversified supply chain for critical and strategic minerals essential for various industries in India," coal and mines minister Pralhad Joshi said.

India in February last year found its first lithium deposits in Jammu and Kashmir with estimated reserves of 5.9 million tonnes. The amount of lithium discovered is important for India because it actually can compete with the global average. In July, 2023 India tweaked its mining rules by allowing the entry of private miners to search for the materials. The government had earlier said KABIL has evinced interest to collaborate with Argentina-based CAMYEN for prospecting two areas for the extraction of lithium in the South American country. KABIL, a joint venture company between NALCO, HCL and MECL, was formed in 2019 for sourcing strategic minerals like lithium and cobalt from overseas locations. The JV expressed interest to partner with CAMYEN, Argentina, recently for prospecting two areas identified with the objective of establishing projects for extraction of lithium in due course of time, the mines ministry had said.

PTI / Jan 15, 2024

Looking at setting targets on offshore mineral mining: Mines secretary

"In Africa, we are exploring opportunities in Zambia, Namibia, Congo, Ghana, and Mozambique for critical minerals," the secretary said, adding that they are engaging with Australia for lithium blocks

The Centre is looking at setting targets on offshore mining which will start this year, VL Kantha Rao, secretary at the Ministry of Mines said on Friday. He said that the result of the first round of auction of critical minerals will be out in 10 days.

"We also have goals on critical minerals under which two rounds of the auction process are going on and will get the results in the next ten days," he said. At the 'Indian Mining Industry' event, organised by Federation of Indian Chambers of Commerce & Industry (FICCI), jointly with the Ministry of Mines, Rao said that Centre is also working to ensure that 100 per cent exploration of India's geological potential of the country is done in the journey towards Amrit Kaal.

"We want to ensure that the entire country's geology is explored both onshore and offshore, which currently is around 30 per cent," he said. "We also have a target to ensure that underground mining increases in the country as a percentage of overall mining."

Rao told reporters that the auction of 10 offshore mineral blocks will start after the Lok Sabha elections and that India is looking towards Africa for minerals like cobalt. "In Africa, we are looking at Zambia, Namibia, Congo, Ghana and Mozambique for critical minerals," he said, adding that they are engaging with Australia for lithium blocks. He also said that the lithium block in Jammu and Kashmir will now be auctioned again in

the third tranche as it received only two bids in the first round. He, however, did not name the bidders.

Centre launched the third tranche of the auction of critical and strategic minerals earlier this month. A total of seven critical mineral blocks have been put up for sale. So far, it has launched an auction of 38 critical and strategic minerals. Rao also said that the ministry has now started promoting and funding start-ups in the area of critical mineral-related technology development.

Raghav Aggarwal, New Delhi, BS | Mar 22 2024

➤ **Congo overtakes Peru on copper output, still behind on exports**

Mining trucks at Glencore's Katanga copper mine in the Democratic Republic of Congo. Credit: Glencore.

The Democratic Republic of the Congo overtook Peru as the world's second largest copper producer in 2023, though it still lags the South American country in exports, official data from both nations show.

Congo produced about 2.84 million tons of copper last year, the country's central bank reported. Peru's output was 2.76 million tons, the Andean country's mining and energy ministry said.

Congo has been reeling in Peru's No. 2 copper spot over recent years, with flagging mining investment in Peru linked to red tape and recent political turmoil and protests. Chile remains the distant top producer of the red meta

Peru, however, is hanging onto its lead over Congo on copper exports. Peru exported some 2.95 million tons of the metal last year, more than its annual production due to sales of stocks held over from previous years.

Rómulo Mucho, Peru's minister of energy and mines, said in early March he expected copper production to increase to 3 million tons in 2024. The ministry did not immediately respond to a request for comment.

Peru's Andes are home to major mining firms including Freeport-McMoRan, MMG, BHP, Glencore, Teck Resources, Japan's Mitsubishi, and Southern Copper of Grupo México.

Reuters | March 22, 2024

➤ **India's NMDC looking at lithium assets in Africa and Australia**

Indian iron ore miner NMDC Ltd said on Friday it is looking at lithium assets in Africa and Australia, according to a statement.

The company also said that it has so far not applied for lithium blocks on a nomination basis from the Indian government.

In June last year, *Reuters* reported that NMDC's unit Legacy Iron Ore had signed a lithium exploration pact with Australia's Hancock Prospecting Pty Ltd.

Reuters | March 22, 2024

➤ **EU to keep tabs on Norway deep sea mining efforts**

The area opened to exploration covers about 280,000 square kilometres (108,000 sq. miles), about the size of Ecuador or the state of Nevada. (*Image courtesy of Empetre | Flickr Commons.*)

The European Union will monitor Norway's progress in exploring the deep sea bed for potential mining of critical raw materials as the bloc seeks to reduce its dependence on China.

Norway is one of the first countries to formally authorize seabed mining activities in its waters after its parliament backed plans in January to prospect for minerals across 280,000 square kilometers (108,000 square miles) of its Arctic continental shelf.

"We will be attentive to the developments of deep sea mining in Norway and also around the world," Maros Sefcovic, the bloc's green deal chief, said at a press briefing. "Norway is one of the countries which is very careful when it comes to the protection of the environment."

The nation meanwhile signed a memorandum of understanding with the EU on Thursday to develop land-based raw materials and Sefcovic didn't rule out potential further collaboration in the future.

Sefcovic added that in May the EU would open a call for proposals for prospective mining projects for key raw materials from friendly countries as part of its plans to protect its supply chains during the transition to net zero by the middle of the century.

In trying to shift away from Russia for fossil fuels and China for key raw materials, the EU has boosted its reliance on Norway, which has an abundance of both.

But scientists have condemned sea bed mining and caused for a moratorium, citing a lack of data on its environmental and climate impacts. Jan Christian Vestre, Norway's trade minister, defended the move.

"We need to extract more minerals for the green and digital transition," he said. "We're also talking about our resilience and strategic autonomy. We don't want to be so dependent on countries from other parts of the world."

Bloomberg News / *March 21, 2024*

➤ India's mineral production grows nearly 6% in January

India's mineral production from mining and quarrying grew 5.9% year-on-year, a Press Information Bureau (PIB) report said on Wednesday.

The country produced over 99.8 million tonnes of coal in the period on the back of rising power demand.

India, the world's second-largest coal user, generatedrecord-high coal-fired electricity in January as rising demand for air conditioning meant that power generation firms did not make big cuts to the use of coal and other fossil fuels.

Other minerals such as iron ore, a key raw material for steel, reported a nearly 41% year-on-year growth in sales value amid growing steel demand in the country. India produced 25.2 million tonnes of iron ore in the month.

The PIB release also showed that the production of minerals such as magnesite – used to make synthetic rubber – grew over 90%, and copper concentrate – used to make refined copper – grew over 34%.

India's refined copper production is estimated at around 555,000 million tonnes per year in the coming fiscal year while domestic consumption is expected to come in at more than 750,000 metric tons.

Reuters / *March 20, 2024*

➤ Indian government rejects Hindustan Zinc's plan to split company

The Indian government, Hindustan Zinc's largest minority shareholder, has rejected the miner's proposal to split into different units as it is not convinced such a move would boost shareholder value, a government official said on Friday.

"Whatever report we have in front of us, we are not convinced by it," said VL Kantha Rao, secretary at the Ministry of Mines, which administers Hindustan Zinc.

Last September, the company said it plans to create separate entities for its zinc, lead, silver and recycling businesses to unlock potential shareholder value.

But it did not consult the government, which has a 29.54% stake in the company, on the planned move, another government official told *Reuters* on the condition of anonymity.

The official also said the government was not convinced by Hindustan Zinc's rationale for the split and that the Ministry of Mines has lodged its objection with the company.

Hindustan Zinc CEO Arun Misra told *Reuters* the company had received the ministry's communication, which will be discussed with the board along with the management's observations.

However, Misra said he believes demerging the company to create a separate silver and zinc entity will help improve its market capitalization, based on a report by a consultant.

A year back, the government had opposed Hindustan Zinc's proposal to buy two entities of Vedanta — which has a 64.9% stake in Hindustan Zinc — and forced the company to drop the plan.

Reuters / *March 22, 2024*

➤ India's Jindal takes on operations at Venezuela's largest iron ore mill

India's Jindal Steel & Power Ltd. has taken over operations at Venezuela's largest iron-ore complex, the first for a private-run firm in the South American country's heavy industry in over a decade, just months after striking a deal with the Nicolás Maduro government.

Jindal officials are carrying out inspections at iron-ore plants of CVG Ferrominera Orinoco, according to two people familiar with the process, who asked not to be named as the information isn't public. The company, which is controlled by state-owned conglomerate Corporacion Venezolana de Guayana, has five plants that produce iron-ore pellets and briquettes that serve as raw material for steelmaking.

Jindal aims to export 600,000 metric tons of the raw material per month by the end of the year, investing an initial $800,000 to upgrade existing equipment, according to one of the people. Terms of the deal aren't clear since neither the Venezuelan government nor New Delhi-based Jindal have confirmed the arrangement.

Venezuela's information ministry and Jindal didn't respond to repeated requests for comment.

Venezuela's partnership with Jindal is a departure from the government's longstanding reluctance to involve private firms into its tightly held, impoverished mining industry.

In the mid-2000s the late president Hugo Chavez reversed a privatization process started by previous governments for state-owned gold, steel and cement companies. The measure saw the exit of Luxembourg's Ternium SA, Switzerland's Holcim AG, Mexico's Cemex SAB and Canada's Crystallex International Corp. among others.

After 18 years, Maduro now seeks to reinstate foreign partnerships.

Ferrominera has an annual installed capacity of 25,000 tons of iron ore and proven reserves of 4.2 million tons. Its plants have been running below capacity after years of lack of investment and a power crisis that in 2009 forced the company to cut production to save energy.

The company's output has fallen over the years, from 15.6 million metric tons in 2001 to 5.7 million tons in 2017, according to the latest figures by the Venezuela Iron and Steel Institute.

The country's metallurgy sector has suffered setbacks due to expropriations and underinvestment to the point that it has "practically disappeared," according to a 2023 report by the Venezuela mine engineering association. Since 2000, the number of private companies in the sector has fallen from 1,200 to 70.

Bloomberg News | March 21, 2024

➤ **India looking at Africa for critical minerals, says mines secretary**

India is looking at Africa for minerals, including cobalt, and other critical minerals, Mines Secretary V L Kantha Rao said on Friday. The country is still engaging with Australia for lithium blocks, he said. Talking to reporters on the sidelines of a function here, the secretary said, "In Africa, we are looking at Zambia, Namibia, Congo, Ghana and Mozambique for critical minerals". Critical minerals, including lithium and cobalt, are crucial for technology, manufacturing and other industries. Rao further said the rules for auction of offshore minerals blocks are being readied and that 10 offshore blocks would be put on sale. The auction of offshore blocks, he said, will take place after the elections.

Rao said the result of the first round of auction of critical minerals will be out in 10 days. He further said the lithium block in Jammu and Kashmir that was put on sale in the first round will now be auctioned in the third tranche as it received only two bids. The government had this month launched the third tranche of auction of critical and strategic minerals.

A total of seven critical mineral blocks have been put up for sale in the third round. "These seven mineral blocks are auctioned under second attempt of auction as per sub-rule 10 and sub-rule 11(b) of rule 9 of Mineral (Auction) Rules 2015," the mines ministry had said in a statement. The Centre has launched auction of 38 critical and strategic minerals to date.

PTI | Mar 22, 2024

➤ **Cabinet approves royalty rates for mining of 12 critical minerals**

This completes the exercise of the rationalisation of royalty rates for all 24 critical and strategic minerals

The Union Cabinet, chaired by Prime Minister Narendra Modi, has given its nod for the amendment of the Second Schedule to the Mines and Minerals (Development and Regulation) Act, 1957, to specify the royalty rates for 12 critical and strategic minerals.

This decision includes minerals such as beryllium, cadmium, cobalt, gallium, and several others that are pivotal for the nation's strategic sectors, including defence, electronics, and renewable energy.

According to an official release from the Cabinet, "The Union Cabinet chaired by Prime Minister Narendra Modi approved the amendment of the Second Schedule to the Mines and Minerals (Development and Regulation) Act, 1957 ('MMDR Act') for specifying the rate of royalty in respect of 12 critical and strategic minerals, viz., Beryllium, Cadmium, Cobalt, Gallium, Indium, Rhenium, Selenium, Tantalum, Tellurium, Titanium, Tungsten and Vanadium."

This completes the exercise of the rationalisation of royalty rates for all 24 critical and strategic minerals. It may be noted that the government notified the royalty rate of 4 critical minerals, viz., glauconite, potash, molybdenum and platinum Group of Minerals, on March 15, 2022, and of 3 critical minerals, viz., lithium, Niobium and rare earth elements, on October 12, 2023, according to the release.

Recently, the Mines and Minerals (Development and Regulation) Amendment Act, 2023, which came into force on August 17, 2023, listed 24 critical and strategic minerals in Part D of the First Schedule of the MMDR Act. The amendment provided that the mining lease and composite licence for these 24 minerals would be auctioned by the Central Government.

The approval by the Union Cabinet for the specification of the rate of royalty will enable the Central Government

(Continued on Page 25)

ASSESSMENT OF BLAST OUTCOMES THROUGH PRE-BLAST, IN-BLAST, POST-BLAST MONITORING AND EVALUATION - A DISCUSSION

M.O. SARATHY

(Continued from Mar 2024 issue, Page Number 19)

3. TECHNICAL AUDIT THROUGH MONITORING

Chiappetta[9] says quote … The common approach of designing blasts on a trial-and-error basis is quickly coming to an end. When utilizing the full-scale blasting environment, trial and error can become cost prohibitive and leaves much to be desired in terms of true blast diagnostics …. The end user can evaluate full scale blasts in his environment, measure explosive performance, determine optimum delay intervals, profile the high walls in terms of true burdens, measure muckpile profiles and volumes and generate site characteristic blast design curves…*For many operations today, blasting is where it all begins. There is no other single unit operation within the total mining system that can affect economics more than when poor blast results are experienced* …unquote.

The three main event-based activities for a technical audit can be categorized as:

1. Pre-Blast (characterization of explosive and rock, survey of vulnerable structures).
2. In-blast (products' performance, burden response, vibration/airblast, causes of damage).
3. Post-blast (fragmentation, muckpile characteristics, ore/waste boundaries, rock damage).

These require dedicated instrumentation and expertise, which the mines may not possess and would require help from external resources. Technical evaluations are carried out both in the laboratory and in actual field conditions. Evaluation of rock properties such as density, hardness, compressive strength, tensile strength, young's modulus etc. are carried out in the laboratory before blast. Explosive's characteristics and performance can be ascertained before and during the blast. Monitoring explosive performance during blast is preferable as it is carried out in actual prevailing field conditions and measuring in-hole VOD provides valuable information on condition of the explosive and progress of detonation of explosive column. High speed videography provides a multitude of qualitative and quantitative information including 'burden response'. Fragmentation assessment, muckpile characteristics, assessing rock damage are carried out after blast. Delineating ore/waste boundaries before blast (in-situ) and after the blast (inside the muckpile) are carried out both before and after blast respectively.

The 'mine-to-mill' (also described as 'drill-to-mill' or 'pit-to-plant') concept is centered totally on monitoring and audits at all stages of operations. It holistically evaluates the inter-dependency of the various processes and cost centers with one another, beginning with drill-blast, downstream operations of loading, hauling, crushing, grinding and extraction of metal or end product. Profitability depends on how efficiently the waste rock and ore are mined and value-added final product is extracted. Optimum fragmentation is the main factor in this study.

3.1. PRE-BLAST MONITORING / EVALUATION

Activities that can be undertaken before carrying out blasts are:

- Measuring rock properties and geological mapping rock structures
- Measuring explosive properties, functional reliability and delay firing time of initiators.
- Damage in strata, if any, in the block being blasted.
- Ground water survey - to ascertain presence of water and the type of explosive to be used.

3.1.1 EVALUATING ROCK PROPERTIES

Mechanical properties such as density, grain size, hardness, compressive strength, tensile strength, Young's modulus, longitudinal wave velocity (sonic velocity) etc., can be measured in the laboratory using cores drilled out of undamaged in-situ strata. Sonic velocity is a parameter that can also be measured in the field by blasting. In this method two drillholes are drilled at a known distance apart and filled with water. One drillhole is charged with a small explosive charge primed with an instantaneous electric detonator and a sensor is suitably placed inside the other drillhole. The sensor is activated at the same time firing current is delivered to detonator. Time taken by the shock wave to reach the gauge after detonation of explosive is measured. Distance traversed and time taken by shock wave is used to derive the sonic velocity of strata in field. A schematic of measurement is given below (Lang and Favreau[17]).

3.1.2 Measure While Drilling (MWD)

With technology advancements, today's drill monitors have become more rugged, accurate, reliable, with data storage and ability to be connected with satellite communication systems. Parameters monitored during MWD include

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Table-5 BLAST MONITORING: PRE-BLAST, IN-BLAST & POST-BLAST
Details of various pre-blast, in-blast and post-blast parameters which can be studied in an Blast Optimization Programme / Technical Audit.

PRE-BLAST MONITORING AND EVALUATION	IN-BLAST MONITORING AND EVALUATION	POST BLAST MONITORING AND EVALUATION
Rock Properties (Rock characterization) ● Geophysical logging ● Measure While Drilling ● Watery drillholes ▸ Material Density ▸ Hardness ▸ Compressive Strength ▸ Tensile Strength ▸ Poisson's Ratio ▸ Bulk Modulus ▸ Young's Modulus ▸ Sonic / Compressive wave velocity Explosive Properties (Explosive characterization) ▸ Energy / Strength ● Underwater Test ● Computer Codes ● Ballistic Mortar ● Lead Block Expansion ● Plate Dent Test ▸ Product Density ▸ Velocity of Detonation (Confined/Unconfined) ▸ Detonation Pressure ▸ Detonation Temperature ▸ Weight & Bulk strength Other Developments ● Laser Profiling of bench face and front row burden ● Pre-blast survey of Structures ● Laser alignment device for Drill mast ● Borehole Video Camera ● GPS based drill placement, drilling and charging ● Blast Movement Monitor	High Speed Photography and Videography **Quantitative** ▸ 'Burden response' ▸ Burden velocity ▸ Uplifting velocity ▸ Firing times of drillholes, firing out of sequence ▸ Venting velocity **Qualitative** ▸ Energy venting due to geology / discontinuities ▸ Stemming ejection ▸ Flyrock generation ▸ Missed drillholes (misfire) ● Borehole pressure ● Explosion Temperature ● In-hole VOD ● In-hole Detonation Pressure New Developments ▸ Powerwave radar for measuring face velocity ▸ Infra-Red device for detecting initiation of explosive in drillhole ▸ In-situ strata damage ● Monitoring ▸ Noxious fumes ▸ Dust generation ▸ Ground vibrations and airblast overpressure	Quantitative ▸ Muckpile Characteristics ▸ Fragment Size Analysis ▸ Shovel and Dragline performance monitoring ▸ Crusher performance ▸ Hauling productivity ▸ Boulder count ▸ Secondary Blasting ▸ Total cost evaluation Qualitative ▸ Misfires / Missed hole detection ▸ Flyrock source, cause and range ▸ Presence of `Toe' ▸ Backbreak ▸ Overbreak / Side-tear ▸ Pit wall stability ▸ Damage to structures ● After-blast fumes ● Dust generation ● Aquifer course change ▸ Damage Assessment ● Core sample ● Borehole Video Camera ● Cross-hole Seismic ▸ Ore-Waste Delineation ● Blast Movement Monitor ▸ Green House Gases / Carbon footprint

drilled depth, penetration rate (m/s), rotary speed (RPM), pull down pressure (N), torque (Nm) and flushing pressure (kPa), bailing velocities (m/s) and drill vibrations. With MWD, the drilling and blasting engineers will have access to the nature of strata being penetrated by the drill over the entire depth such as hard-soft bands, presence of open fissures / joints, vughs etc. by which appropriate selection of explosive, selective explosive loading and placement of inert stemming decks at desired horizons can be adopted, if required. Many manufacturers provide MWD modules with their drilling machines.

3.1.3 SCHMIDT REBOUND NUMBER

Researchers have tried non-destructive methods to find an appropriate correlation between the rock properties and corresponding powder factor required. Schmidt Rebound Hammer Number (originally developed for testing uniaxial compressive strength UCS of concrete) has been used to assess rock properties and investigators have been able to find good correlation between Schmidt Rebound Number, UCS and powder factor required. Increasing rebound number implied increasing UCS of the material under test and requirement of higher specific charge (kg/m^3). Rebound

number varied widely in ores. Rebound number was lower in heavily jointed limestone. The number in most overburdens was similar except coarse grained and weathered sandstone. Details are given below (Choudhary[8], Sawmliana et al[29]).

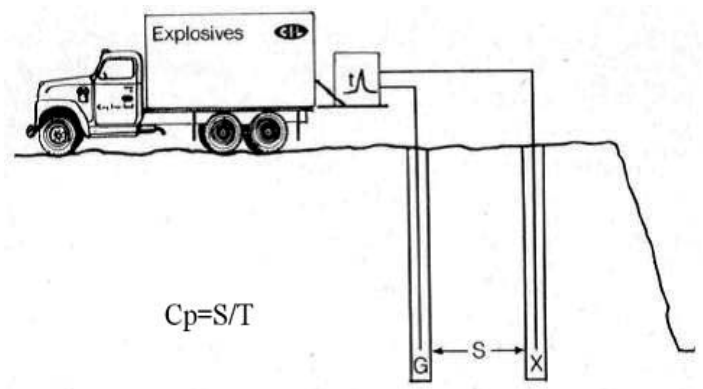

Figure-1: Measuring Sonic Velocity in the field - Cp = S/T

Cp = Sonic velocity
S = Distance between charge and gauge
T= Time recorded by Oscilloscope
O= Geophone/Gauge
X= Explosive charge

Table-6: Schmidt Rebound Number, UCS and Powder Factor

Investigator	Rock Type	Schmidt Number	UCS	PF (kg/m^3)
Chaudhary	Overburden Overburden	39-41 45-49	32-36 50-57	0.65-0.91 0.73-1.08
Sawmliana	Overburden Ore / Mineral	15-45 26-60	- -	0.28-0.65 0.25-1.05

3.1.4 GPS Based Drill Positioning, Drill Monitoring and Bulk Explosives Charging

Global Positioning System (GPS) technology has been adapted for drilling and blasting during the last few years. The system encompasses a whole gamut of operations including accurate positioning of drills, drilling the drillholes as per desired inclination and depth, monitoring the drilling using measure while drilling (MWD) and pass on the information through satellite communication to the blast designer who may be sitting several thousand kilometers away in front of his computer. The data from the drilling is analyzed and appropriate information is passed onto the bulk explosive loading pump trucks (Mobile Manufacturing Units - MMU) stationed at site. The on-board electronics accurately charges the drillholes with the desired quantity and type of explosive commensurate to strata conditions which have been recorded and analyzed during MWD (soft patches, hard bands, presence of water etc.). The positioning of drillholes by the GPS is highly accurate with very little error.

3.1.5 EVALUATING EXPLOSIVE CHARACTERISTICS

Tests for cap-sensitivity, booster-sensitivity, density and VOD can be easily carried out, while parameters such as borehole pressure, detonation pressure and detonation temperature require custom-made instrumentation and expertise. The parameters described above can be carried out at an established test facility prior to loading/blasting. Detonation temperature significantly contributes to rapidity with which gases are formed and the volume of gases generated, which subsequently alters the heave energy. Shock energy: heave energy ratio can be varied by using Emulsion-AN/AN-FO blends in various percentages.

3.1.5.1 Density

Simplest method of measuring density is to fill a measuring jar of known empty weight and volume with explosive whose density is to be measured and ascertain its final weight (g).

$$Density = \frac{Weight\ of\ jar\ with\ explosive\ (g) - Weight\ of\ empty\ jar\ (g)}{\text{Jar volume (cc)}}$$

For explosive in cartridge form, it is advisable not to cut / remove the explosive gel or emulsion from the packing to fill the measuring jar. In such cases, density of an explosive cartridge is ascertained by water displacement method, also known as immersion density method. In this method an explosive cartridge is suspended from a spring balance and weighed (W_a). A suitable container such as a drum is filled with water or any liquid whose density is known (D_l). The explosive suspended from spring balance is fully immersed into the liquid and reading on spring balance is noted (W_l). Water can be used for products whose density is higher than that of water. For products whose density is lower than 1 such as AN-FO whose density is 0.85-0.9 g/cc, then appropriate lower density liquid such as mineral oil whose density is 0.8 g/cc can be used.

$$Density\ D = \frac{W_a}{W_a - W_l}(D_l - D_a) + D_a$$

Where:

D - density of sample

D_a - density of air (=1.2 g/cc)

D_l - density of auxiliary liquid (=1 g/cc in case of water)

W_a - weight of sample in air

W_l - weight of sample in the auxiliary liquid

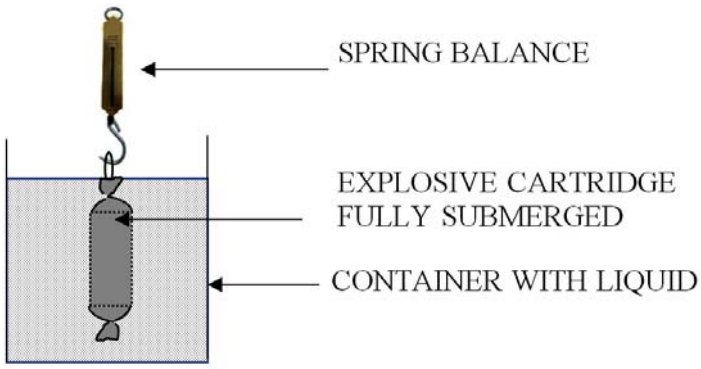

Figure-2: Method of measuring explosive cartridge density

3.1.5.2 Velocity of Detonation (VOD)

VOD of an explosive is the speed with which the detonation reaction travels through the explosive column. It is a measure of the rate at which energy is released by the explosive. High VOD explosives release energy at a faster rate compared to explosives with low VOD. This depends mainly upon formulation, charge density, charge diameter, temperature, sensitivity, and initiator strength or primer size (weight, diameter, length). For the same formulation, VOD increases with charge diameter and detonation failure occurs at its critical diameter. Normally VOD of explosives would be 8-10% higher under confinement than when measured in open (unconfined). In field studies carried out, scientists at observed in-hole VODs higher by 1.2 to 1.4 times than those measured in open (NIRM[20]). It is prudent to measure continuous VOD of explosive in-hole during the blast as it would provide actual information on the performance such as:

- Sensitivity of explosive.
- Adequacy of booster size and weight for reliable initiation of explosive column.
- Overdrive / underdrive, if any, of the explosive column near the primer.
- Whether VOD is progressing steadily (detonation stability) or there is a sudden drop in VOD or explosive is undergoing low order detonation.
- Detonation failure.
- Deterioration of explosive charged into drillholes containing static/dynamic water, acidic strata and due to extended sleeping times.
- Explosive subjected to high hydrostatic pressure at the bottom of deep drillholes by explosive's own weight, weight of stemming and/or water in watery drillholes.
- Contamination of explosive due to drill cuttings flowing into drillholes during charging.
- Explosive charge separation caused by drillhole wall collapse or due to low density explosive floating in watery drillholes.

Deterioration of explosive occurs due to long sleeping times in hostile conditions within drillholes such as contamination with water, sludge, drill cuttings. Dynamic water in strata causes faster deterioration of explosive due to leaching effect. Emulsion explosives are especially susceptible to deterioration due to crystallization of the matrix, initiated due to friction caused while flowing down the rough drillhole walls during charging. It is for this reason that emulsions are recommended to be discharged at the bottom of the drillhole using loading hose pipe instead of discharging explosive at the drillhole collar and not allow it to drop the entire depth of drillhole. While VOD values mentioned in Table-1 are indicative, actual VOD of products manufactured in India measured by researchers during their studies are given below:

Table-7: Measured VODs of Slurry and Emulsion explosives (cartridge and bulk)

Researcher	Product Type / Remarks	Diameter mm	VOD m/s
Agarwal and Mishra2	Emulsion - Underground cavern Emulsion - Mine A o/c Emulsion - Mine B o/c Emulsion - Mine C o/c	45 100 150 150	3980-4305 3701-4390 4021-4401 3541-3900
NIRM[20]	Mfgr 1 Packaged Slurry – Mine A Mfgr 2 Packaged Slurry – Mine A Mfgr 3 Packaged Slurry – Mine A Mfgr 4 Packaged Slurry – Mine A Bulk Slurry – Mine A ANFO – Mine A Packaged Slurry – Mine B ANFO – Mine B ANFO – Mine C	250 250 250 250 250 250 115 115 115	4415 4402 – 4818 4181 – 4203 3581 3933 – 4696 4200 3308 – 3957 3712 – 3917 2287 - 3708
NIRM[20]	ANFO Bulk Slurry Cartridge Booster Charge Cartridge Column Charge	In Open In Open In Open In Open	2852 – 3032 3376 – 3645 4191 3902

Pradhan[23] carried out measurements to study effect of sleeping on VOD of freshly manufactured emulsion explosive and after 3, 6, 9, 12, 15 days. He has observed drop in VOD under controlled laboratory conditions. One can imagine the deterioration that could occur due to hostile conditions in drillholes. Table-8 gives a summary of readings fresh and after 15 days.

Table-8: Drop in VOD of explosives on storage

Set No.	Fresh m/s	After 15 days m/s	% Drop	Remarks
1	4130	3780	8.5	83 mm cartridge, in open
2	4170	3810	8.7	”
3	3960	3810	3.8	”
4	4130	3810	7.75	”
5	4200	3840	7.1	”
6	4920	4359	11.5	In 152 mm drillhole

3.1.5.2.1 VOD Measuring Methods

VOD can be measured under different conditions, such as (a) unconfined viz in open (b) partly confined in pipes of various materials / wall thickness viz steel, copper etc. (c) fully confined as in a stemmed borehole. However, for measurement of VOD inside a stemmed drillhole, continuous recording during detonation is most preferable as measurements can be carried over long lengths of explosive column. The classic D'Autriche method of measuring VOD is a non-electric method and utilizes detonating cord of known VOD to measure VOD of the explosive under test. VOD is measured between two discrete points in an explosive column and is suitable for surface measurements only. VOD is also measured between two discrete points in an explosive column using ionization probes and 'start-stop' digital timer. The probes are simple to assemble and consists of two strands of thin insulated mono-core wires twisted and embedded in the explosives at a known distance apart. The detonation shorts the first probe which starts the timer and timer stops when the second probe gets shorted.

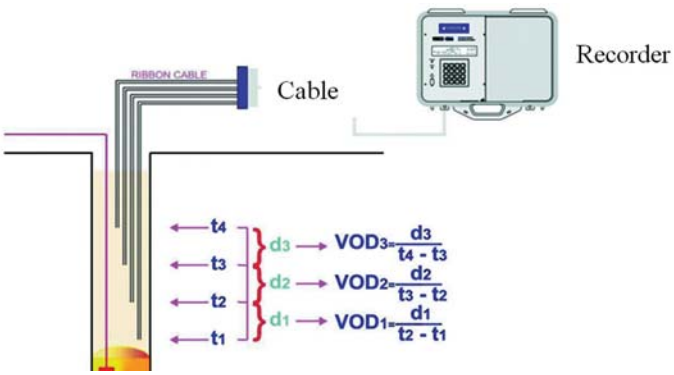

Figure-3: Concept of measuring VOD between discrete points along explosive column

The time interval is recorded in micro or milliseconds. Similar concept is possible with fiber optics-based timer which senses the light when detonation passes through. The above methods can be used for measuring VOD on surface, either in the open or in partly confined in pipes. Continuous in-hole VOD measurement is carried out using electrical methods and fiber optics. Various techniques developed for measuring VOD are described (Chiappetta and Vandenburg[11])

3.1.5.2.1.1 Spike technique

This technique uses shorting of wires placed in the detonating explosive column. For measuring in-hole, modified ionization targets are used. Multiple targets at pre-determined intervals can also be used. Upon shorting of the probe or target, capacitors in a circuit board get discharged and spikes are recorded in an oscilloscope. VOD is determined from the distance between spikes and actual distance between targets. Similar concept is adapted for use with fiber optic systems also. The fiber picks up the light from detonation to send signals to the timer unit.

3.1.5.2.1.2 Resistance wire method: This method uses two insulated twisted wires of known resistance per metre, a constant current generator and an oscilloscope. This is placed along the explosive column inside the drillhole. As detonation progresses, the cable gets shorted by ionization and as the length gets reduced, so does the resistance. The rate of change of resistance results in voltage drop which is proportional to shortening length of twisted wire (consumed during detonation) recorded by the oscilloscope and data used to deduce the VOD.

3.1.5.2.1.3 SLIFER (acronym for Shorted Location Indication by Frequency of Electrical Resonance):

This method uses a shorted co-axial cable placed along the explosive column and an oscillator. Frequency of the cable is governed by its length. As the cable length gets shorter by the progressing detonation, frequency of oscillation increases. Rate of change of length of cable is determined by monitoring frequency as a function of time with the help of in-built electronics.

3.1.5.2.1.4 Time Domain Reflectometry (TDR) - CORRTEX VODR-1 system

System uses technique similar to radar, wherein a pulse of radio waves is sent out and a reflected pulse (echo) is returned. The system uses a co-axial cable and principle used is electric pulse getting reflected from the cable end, even if the cable is not shorted at the end. Reflection occurs wherever circular shape of cable is changed by the detonation and system works very reliably even when cable is not consumed as required in SLIFER or resistance wire method.

3.1.6 DETONATION PRESSURE AND DETONATION TEMPERATURE

Detonation pressure is the pressure within a detonating column of explosive, behind the reaction front (interphase) of reacting and unreacted zones. Detonation pressure is a function of VOD and density of the explosive and implies that explosives with higher VOD and density would generate higher detonation pressure. Among commercial explosives, AN-FO has the lowest detonation pressure while cast primers have the highest (Table-1). Mencacci and Chavez[19] carried out field trials and found similar trends as per rudimentary principles explained above. They observed in decreasing order, detonations pressures as given in Table-9. They used carbon resistor gauges for measurement. Principle is, when the carbon resistor gets compressed, its conductivity increases in proportion to magnitude of pressure. The driving circuit provides constant voltage irrespective of load. The signal is recorded on an oscilloscope and using a pre-calibrated curve, the detonation pressure kbar is computed.

Table-9: Measured in-hole detonation pressures for various commercial explosives

Product	Hole Diameter mm	VOD m/s	Detonation Pressure K.bar
Dynamite (50 mm)	76 (water filled)	6500	120
Emulsion 70: ANFO 30	165	5500	110
Emulsion (50 mm)	76 (water filled)	5000	100
Emulsion 30: ANFO 70	165	4500	84
ANFO	110	3800	83
ANFO	84	3800	74

Cavanough and Onederra[7] measured in-hole continuous VOD, detonation pressure and detonation temperature of an Emulsion-ANFO 50:50 blend at a density of 1.2 g/cc. in two 270 mm diameter drillholes. Carbon resistor gauge was used to measure detonation pressure inside drillholes and recorded 2.1 and 2.8 GPa pressure. They also designed sensor to measure detonation temperature using photo-transistor and temperature of 2700 and 3300 Kelvin (2427, 3027°C). Corresponding in-hole VODs recorded were 5000 m/s and 5100 m/s. Measuring detonation temperature in-hole during detonation requires very rugged sensors that have to withstand high pressures and temperature, record and transmit the signals in a very short time before getting destroyed.

3.1.7 MEASURING BOREHOLE PRESSURE

Borehole pressure is the pressure generated on the walls of the drillhole after detonation of explosive and is considered to be approximately half that of detonation pressure.

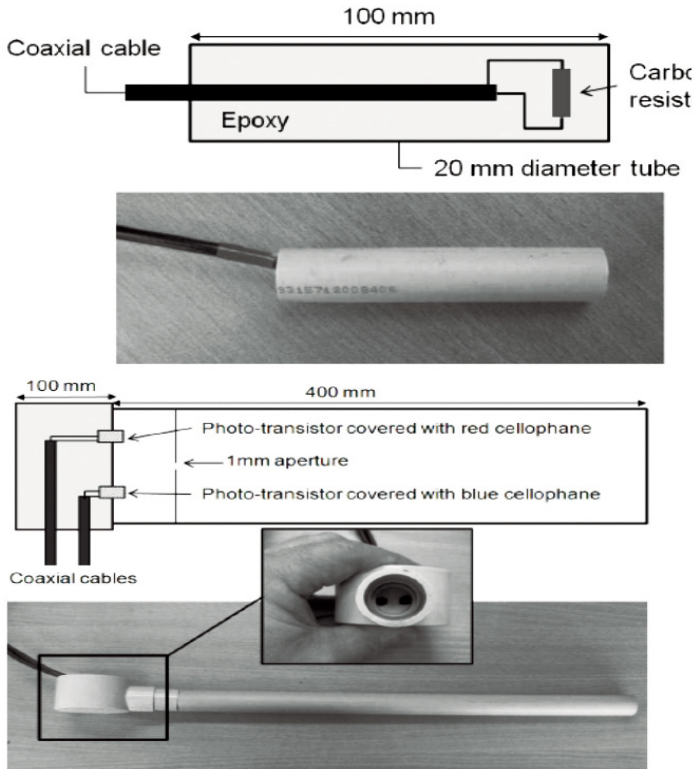

Figure-4: Sensors for measuring detonation pressure/temperature (Cavanough & Onederra7)

3.1.8 GAS VOLUME

Gas volume liberated by different explosives is normally measured in laboratory using specially fabricated metal tanks or chambers excavated in rock. It is highly impractical to measure gas volume in the field during a blast. Commercial explosives are known to generate 800 - 900 liters of gas per kg of explosive, usually derived from thermo-chemical calculations. The chambers mentioned above are usually used for assessing volume of noxious fumes (Carbon Monoxide, Nitrous Oxides etc.) generated by explosives during detonation.

3.1.9 WATER PROOFNESS

It is well known that AN-FO has no water-proofness at all because AN is highly hygroscopic and dissolves in water. Heavy ANFO (20:80 or 30:70 Emulsion-ANFO blend) have varying degrees of resistance to moisture and are charged after de-watering the drillholes. Slurry and emulsion products have good water resistance, with the latter having an edge over the former. It has to be understood that these are various chemicals blended to form a finished product and have a limited shelf life under storage or different conditions of use. Explosives charged in dry drillholes remain stable for longer periods, while products charged in watery drillholes decay faster. Packaged explosives last longer compared to bulk explosives. Deterioration is faster in strata containing dynamic water or acidic mine water due to leaching effect.

3.1.10 STRENGTH / ENERGY

After invention of dynamite by Alfred Nobel in 1867, Nitroglycerin (NG) based explosives were popular for almost 100 years. Strength comparisons were made considering strength of Blasting Gelatine (BG) as 100 and that of other products indicated as a percentage of BG such as 60%, 80% or 90%. The explosive properties of fertilizer grade Ammonium Nitrate (AN), was accidentally discovered in 1947 when a ship berthed in the harbor of Texas city, USA carrying fertilizer (oxidizer) packed in bitumen lined paper bags (fuel) in its hold (partial confinement), caught fire and exploded causing large scale damage and casualties. With this knowledge, scientists mixed AN with various types of fuels such as carbon black, used engine oil, shredded rubber for use in blasting work. Finally, a well oxygen balanced mixture of AN with Fuel Oil (Diesel oil) was developed and AN-FO is a popular explosive today. Drawbacks of AN-FO such as poor moisture resistance, low density, low VOD led to the development of AN-water based slurry/watergel and emulsion explosives. With the phasing out of dynamites in many countries and use of AN-based products gaining wide acceptance, all comparisons are now made considering weight strength and bulk strength of AN-FO as 100.

While describing explosive strength (energy), two parameters are used namely weight strength and bulk strength. Weight strength is indicated as calories/gram or kilo calories per kg and bulk strength as calories per cc or kilo calories per litre. As per published literature AN-FO made with prilled AN has weight strength of 913 k.cal / kg and density of 0.85 g/cc has. Hence, its bulk strength is 913 x 0.85 = 776 k.cal/litre. Slurry or emulsion explosive formulated to generate the same weight energy of ANFO and having a density of 1.18 g/cc will have bulk strength equal to 913 x 1.18 = 1077 k.cal/liter viz 39% higher bulk strength compared to AN-FO with added advantage of higher VOD, water-proofness and low fumes. This property is used while designing blasts with expanded patterns or for blasting tough, massive formations.

Over the years, many methods for assessing / measuring explosives energy have been developed which involve explosive quantities as small as 10 g to larger samples weighing kilograms. Methods developed are qualitative and quantitative in nature. Qualitative methods include plate dent test, double pipe test, cylinder expansion and cylinder compression tests. Quantitative tests include trauzl lead block, ballistic mortar and underwater (pond) test. Trauzl Lead Block and Ballistic Mortar were developed mainly for evaluating the strength of secondary explosives, Tri Nitro Toluene (TNT), Nitroglycerine (NG) and explosives sensitized with NG such as Gelatine and dynamites, which detonate reliably even in small quantity and mass. Manufacturers in India adapted both the methods for evaluating strength of slurry and emulsion explosives and it is often debated that these types of products do not detonate efficiently in such small mass and diameter and hence not suitable. In the field, comparative strength test is carried out using crater blasting technique. Energy (or strength) of an explosive is also computed using sophisticated thermo-chemical equations which assign values for each ingredient used in the explosive composition (Sarathy and Vidyasagar[28]).

3.1.10.1 Underwater Test (Pond Test)

This is a rather complex method requiring expertise on detonation physics and instrumentation. The principles are briefly enumerated. Underwater test is considered as a reliable method for assessing relative strengths of explosives against a standard. It is considered to nearly simulate the conditions similar to which the explosive performs in rock. However, in this method water is the medium, which has a much lower acoustic impedance and mechanical strength than rock. Unlike other quantitative tests described, the charge quantity chosen can be large and of diameter as used in actual blasts. If the pond size and water depth is sufficiently large, charge as high as 100 kg is used at depths of 20 m. A known quantity of explosive is detonated underwater in a pond of adequate size and at a pre-determined depth (depth of burial). Firing the charge under water provides good confinement (as offered by the rock mass and stemming) and the charge is fully coupled to the medium viz water (as a fully coupled charge in a drill hole). The dimensions of the pond (extent and depth), depth of water in pond and the depth of burial of charge are critical. Same explosive tested in two different underwater environments may reveal different values and cannot be compared. Hence for comparison, it is imperative that the various products are tested with a standard charge quantity under identical conditions viz in the same sized pond, water level and depth of burial of charge.

This test method uses tourmaline piezoelectric gauges and oscilloscope which measures (i) shock wave energy and (ii) bubble pulse energy. Shock energy is a direct measurement after detonation and from the pressure profile, the impulse density and shock wave energy are measured. Detonation products form a big expanding bubble commensurate to heat of formation of the gases. This energy is the work carried out by the gases against the hydrostatic pressure of the surrounding water in expanding the bubble to its first maximum size. The hydrostatic pressure of the water in the pond causes the bubble to collapse and sends out a shock impulse which is recorded by an oscilloscope. Bubble period is the time interval between detonation (first shock recorded) and the impulse generated at first bubble implosion. Subsequently, the bubble gets compressed again by the surrounding pressure and expands again and these oscillations continue till the bubble bursts out of the water surface. Only the first oscillation is considered in underwater measurements (Bjarnholt and Holmberg[4], ISEE[15]).

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3.1.10.2 Thermo-Chemical Calculations

This is an advanced technique of computing explosive energy, wherein the heat of explosion of the explosive formulation is calculated by assigning values to the individual ingredients used. The technique uses the 'equations of state' and computer programmes developed specially for the purpose. The sophistication of the programme, the equations used and values assigned by the developer of the programme to individual ingredients in the composition are the possible limitations of this technique. Energy calculated for the same formulation using two different computer programmes may yield different values. 'TIGER' software is popular and widely used by researchers and scientists for computing explosive energy

3.1.10.3 Cratering Tests – Livingston Crater Theory

Though not a technique for measuring explosive energy, crater tests is one of the earliest field tests method used to compare strength of explosives and hence included in this section. Crater theory was first put forth by C.W. Livingston and was used to compare the performance of different explosives in the same strata for final selection and use. 'Cratering' is a term used for describing the inverted conical cavity of broken rock caused by a spherical explosive charge placed in a vertical drill hole without having any free face in front or side. The only free face present is at the top viz the drilling surface. Spherical charge is defined as a charge having its length: diameter ratio equal to 6. Drill holes of varying depths are charged with the same quantity of explosive under test. Charge type and charge quantity/ length being the same, parameters assessed for correlation are drill hole depth, volume of crater formed, fragmentation obtained and length of unblasted drill hole (bootleg / socket) remaining after detonation. As the 'depth of burial' of the charge is increased progressively, the crater volume increases and reaches a maximum volume, described as 'optimum depth of burial' beyond which the crater volume progressively reduces. As the depth of burial is further increased, no crater is formed and only spalling is observed on the surface around the drill hole collar. This is defined as 'critical depth'. For a given type of rock, the optimum depth of burial is established for various explosives under evaluation and data used for fixing the burden distance. Livingston based his tests on charge quantity suggested the optimum depth value as burden distance to start with. Another way is to calculate the specific charge (kg/m^3) or powder factor (m3/kg) at optimum depth of burial and use it to arrive at burden, spacing using empirical relationships.

3.1.11 ASSESSING ROCK DAMAGE – CORE DRILLING / BOREHOLE CAMERA

Monitoring damage to rock behind the blast is essential from final pit wall slope stability point of view. Measurements are carried out behind the last row using transducers or pressure monitors. Before blast, cores are drilled out at specific pre-determined intervals behind the last row and analyzed. After the blast, rock cores are again drilled in the same array and cores analyzed for damage, if any. Borehole camera is also used before and after blast.

3.2. IN-BLAST MONIORING / EVALUATION

3.2.1 IN-HOLE VOD, DETONATION PRESSURE, BOREHOLE PRESSURE AND DETONATION TEMPERATURE MEASUREMENT

The techniques of measurements have been discussed in sections 3.1.5.2.1, 3.1.6,.3.1.7. While measurements / characteristics of explosives can be carried out prior to blasts under controlled test conditions, monitoring during the blast would provide a true picture of actual performance such as run-up velocities near primer, drop in VOD, due to charge separation, deterioration of explosive due to mixing with drill cuttings, water, explosive in a state of static and dynamic de-sensitization etc. which have a direct impact on blast outcomes.

3.2.2 HIGH-SPEED PHOTOGRAPHY / VIDEOGRAPHY AND BURDEN RESPONSE

High speed cameras are widely being used now-a-days as a diagnostic tool for optimization. Blasts are observed and results assessed both qualitatively and quantitatively. Blasts are picturized at speeds ranging from 400 to 1000 pictures per second (frames per second FPS). The resolution at 400 FPS would be 1 image every 2.5 milliseconds while with 1000 FPS, it would be one image every millisecond. Blasts are picturized at high speed and analyzed frame by frame using motion analyzers or similar equipment. Chiappetta[10] has listed 18 parameters which can be monitored using high speed photography, and some are listed below.

'Burden Response' is an exceedingly useful parameter that is studied using high speed videography. Different types of rocks, ore, minerals and overburden respond differently when blasted using different types of explosives. 'Burden response' is a term used to define / describe the way in which the burden in front of a drillhole reacts after detonation of explosive in drillhole. After detonation which is considered as zero time, changes can be observed in the bench face after a certain lapse of time (time to initial movement). Change observed is the onset of frontal movement from the bench face after initiation, the minimum time before movement begins and this is denoted as T_{min}. Figure-5 gives details of observations made which are self-explanatory. T_{min} depends on: (a) Rock / ore type - hard / soft, fine grained / coarse grained, high density / low density (b) Explosive type - ANFO, Heavy ANFO, Watergel-Slurry or Emulsion (c) Burden distance and drillhole diameter - larger drillholes / higher burden (d) Sonic/longitudinal wave velocity. The minimum response time can be decreased by reducing

the burden distance, by using higher energy explosive or a combination of both. Burden response analysis is a very useful tool for selecting inter-hole and inter-row delay timing in bench blasts (Chiappetta[10], Onederra and Esen[21]).

Table 10: Assessments possible through high speed photography / videography

Qualitative	Quantitative
a) Drillholes firing out of sequence – related to delay timing accuracy. b) Energy (gas) venting due to geology - through joints, mud seams, bedding planes. c) Blown out shots due to excess burden, ineffective stemming, watery drillholes. d) Front row burden break-out due to less burden – wrong placement or deviation of drillhole. e) Drillholes generating brownish-yellow fumes, an indicator of nitrous oxides. f) Misfires, if any. g) In-flight collisions of fragmented rock during heave improving fragmentation.	a) Firing times of drillholes / initiators. b) Burden response. c) Frontal burden movement velocity (face) - very useful during cast blasting. d) Uplifting velocity from collar zone -cratering effects and source of flyrock. e) Venting velocity (gas energy) through stemming ejection - airblast overpressure.. f) Burden movement trajectory during overburden casting.

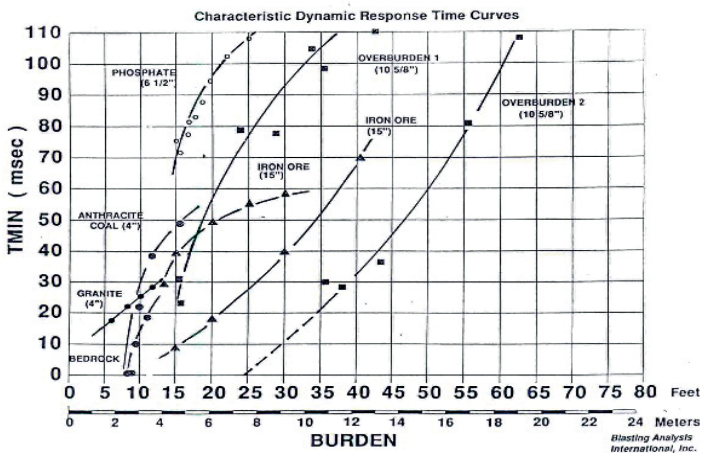

Figure 5 - Burden Response Times in various materials, explosives and drillhole diameters Chiappetta[10]

3.2.3 INFRA-RED DEVICE FOR MONITORING DRILLHOLE FIRING TIMES and BURDEN MOVEMENT

Infra-red sensing device has been tested for ascertaining firing times of individual drillholes and between rows. Since blast progresses from front to back, the firing of drillholes at the back invariably get obscured by the stemming ejection, blast gases and dust generated by the drillholes firing in front. Infra-red sensor operates at a wave length approximately 10 times longer than the visible wavelengths. Longer the wave length, more efficient is the penetration through stemming ejection, escaping gases and dust. Ingra-red device picks up the bright flash from detonating cord trunk lines or an upline taken from the explosive column and bundled on a stake embedded on the surface near the drillhole collar. Infra-red sensor gives an electric signal output and not a visual one (Blair and Little[5]).

3.2.4 ROCK MASS DAMAGE – BLAST VIBRATIONS and GAS PENETRATION

Instrumented monitoring is carried out during blast. Parameters monitored behind blast include vibration and air pressure in dedicated drillholes drilled for the purpose and sealed suitably, using accelerometers and borehole air pressure gauges. Where drillholes can retain water, appropriate sensors are used as water is fully coupled, incompressible and is a good transferrer of shock energy. Commonly used gauges are carbon resistors, manganin gauges, piezo-electric type sensors, transducers and hydrophones. Air pressure, particle velocities are monitored (Brent and Smith[6], Ouchterlony et al[22]).

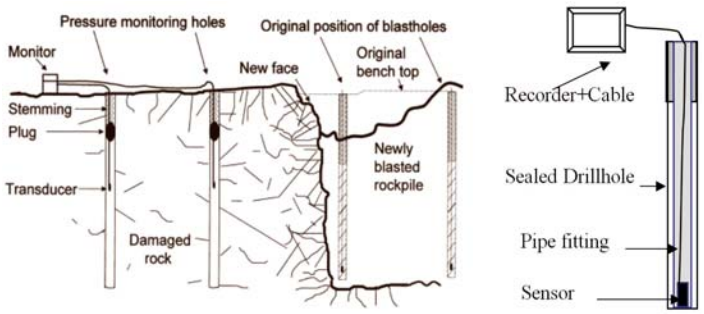

Figure 6 – Schematic of monitoring borehole pressure or vibration behind blast (Brent and Smith[6] and Ouchterlony et al[22])

3.3. POST-BLAST MONITORING / EVALUATION

A number of post-blast parameters are measurable / quantifiable

3.3.1 POST-BLAST FRAGMENTATION ANALYSIS

Fragmentation measurement is usually depicted as a size distribution curve with percentage passing of fragments vis-à-vis fragment size. Quantifying fragmentation is a means of determining blast performance vis-à-vis excavator bucket and crusher opening (grizzly) size.

3.3.1.1 Optimum Fragmentation - Definition

Chiappetta[9] lists the various perceptions / suggestions of field personnel with regard to definition of 'optimum blast fragmentation'. They are:

- Smallest size fragment a blast will produce.
- Blast that produces no oversize – no need for secondary drilling and blasting.
- Fragmentation that provides highest production rates.
- Crushing costs are least viz minimum.
- Small pieces which can be handled by mining equipment in use.

3.3.1.2 Fragmentation assessment methods: Visual 'eye-ball assessment' is the easiest and least expensive method. With advancements in technology, image processing, computer graphics and software, evaluation of fragmentation has become very scientific and accurate and removes the subjectivity of the former. Various methods adopted for fragmentation assessment is described by Chiappetta[9]:

- Qualitative visual analysis – Eye-ball assessment of fragmentation is based on long experience of the blaster who has been carrying out blasts regularly at site. This method is subjective and perceptions / assessment may vary between individuals. According to Cunningham[12] the eye is not a good judge of mean size, especially for muckpiles with low uniformity.
- Sieving / Screening – Entire blasted muck is sieved for fragmentation assessment. This is practical for small scale tests, but not for large production blasts, though attempted.
- Boulder count and quantum of secondary blasting / breakage carried out – Number of boulders generated and their sizes, for unit volume of excavation is monitored as well as quantum of secondary blasting carried out (pop shooting / plaster shooting) or mechanical breakage using stationary hydraulic breakers installed at crushers or as attachment on shovels.
- Bridging delays at crusher – Oversize from ROM causes bridging of chutes and build-up on grizzly at the crusher. Rock breakers are deployed to break the large fragments to suit the input size of crusher. Monitoring this is a means of fragmentation evaluation.
- Productivity with work and time studies – The load-haul cycle time is mapped. Hard digging conditions due to poor fragmentation and tight muck piles result in slow loading, poor bucket fill factor, time taken for segregating boulders in muckpile, more number of loading cycles to load a dumper causing idling and longer turn-around time of trucks are monitored accurately.
- Photography and photogrammetry – This is an accurate and scientific method to assess fragmentation. Photographs of the loaded muck are taken on the haul truck, on the conveyor belt and of the muckpile at specific intervals as the excavator loading progresses into the muckpile. Computer software analyzes the fragment sizes. WipFrag, Split Desktop, Shovel Metrics, Fraglyst4.0 (CIMFR), PowerSieve & FRAGTrack (ICI/ Orica) are few references.

3.4 MONITORING MUCKPILE CHARACTERISTICS

Along with fragmentation, characteristics of blasted muckpile is an important parameter linked to efficient loading. They include (a) Muckpile profile commensurate to loading machine in use (b) Muckpile looseness (c) Swell percentage and void ratio (d) Uniformity index (e) Angle of repose (f) Moisture content in muckpile

3.5 MONITORING AND ASSESSMENT OF ROCK DAMAGE DUE TO BLASTING

While gas pressures and particle velocities are measured behind the last row during in-blast, post-blast damage assessment is carried out by:

- Drilling cores at pre-determined locations both before and after blast and examining the cores for new cracks, damage.
- Visual examination of a dedicated array of empty drillholes behind a blast using borehole video camera, before and after a blast. Brent and Smith[6] observed many large horizontal open cracks and several large vertical cracks along the drillhole walls after blast, while no visible discontinuities or structures were observed before blast.
- Extensometers for ascertaining large shifting / movement of rock mass.
- High frequency cross borehole seismic logging for determining crack density.
- Permeability of rock mass.

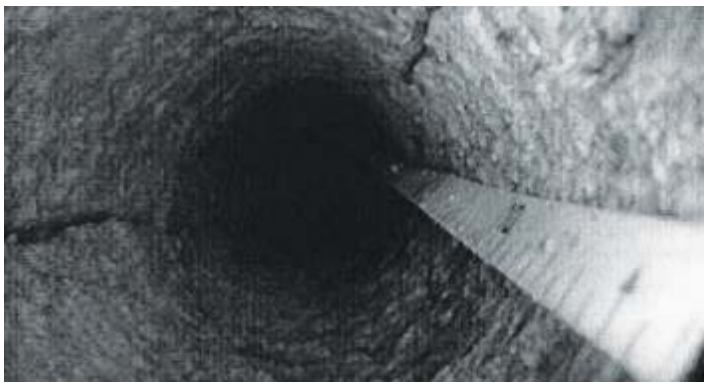

Figure-7 Image inside monitoring drillhole showing cracks (Brent and Smith[6])

3.6 Monitoring Ore-Waste Rock Delineation After Blast – Use of Blast Movement Monitors (BMM)

In ore mining blasting, de-lineating ore-waste rock boundaries before blast (in-situ) and after blast (within muckpile) helps in 'selective excavation' by loading machines. Inaccurate post-blast delineation can lead to valuable ore erroneously going to the dumps and waste material miscategorized as ore is sent for processing. Mixing of waste rock with ore (contamination of ore) can affect comminution costs through increased volume of grinding for extraction of same quantity

of metal. Earlier methods for measuring blast movement and to reduce loss and dilution of ore used physical objects (markers) such as wooden stake, coloured PVC pipe, chain, rope, coloured sand filled in bags. The markers are placed at different depths in drillholes specially drilled for the purpose or embedded in the stemming of drillholes charged with explosive. These markers though of low cost and easy to adopt, have limitations such as poor recovery, poor visibility if they get buried inside the muckpile after the blast, becoming visible only during excavation. Another major drawback is their inability to measure movement below the surface of muckpile viz sub-surface movement (Rogers and Kanchibotla[25]). These limitations led to the development of directional transmitters (electronic sensors) patented by the Julius Kruttschnitt Mineral Research Centre (JKMRC), University of Queensland, Australia called Blast Movement Monitors (BMM). The BMMS are radio frequency identified (RFID) tags-based transmitters housed in strong shock resistant material moulded in the form of a sphere (Figure-8). In the block being blasted, a set of dedicated drillholes are drilled which are not charged (empty) and a BMM dropped into each one of them. The system consists of:

- RFID Transmitter.
- 'Activator' which switches on each transmitter and programs them as required.
- A special 'Detector' to locate each BMM in-situ.
- Dedicated software which calculates the movement of each BMM in 3-dimensions.

The BMMs after activation are dropped into the dedicated empty drillholes and then surveyed. After blast, their resting positions are located using the detector which processes the data using the dedicated software and information is stored for posterity. It takes 1-2 hours to process the entire data and to identify the in-situ ore-waste rock boundaries. The information is passed on to the excavator operator and for appropriate deployment of excavators. BMMs are recovered after blast from the muckpile and can be re-used (Thornton[33])

Figure-8: Blast Movement Monitor (Downloaded from the internet)

4. WAY FORWARD

Mines are mainly geared for production related activities and invariably do not invest in infrastructure, instrumentation and dedicated expertise for blast-related advanced monitoring. Mines at best may own for regular use, simple instruments such as vibrograph, laser bench profiler and may not possess instrumentation for in-hole VOD measurement and high-speed video camera capable of speeds between 500-1000 frames per second (FPS). Hence, for a total blast optimization study, mines may have to seek help of research agencies such as National Institute of Rock Mechanics-NIRM, Central Institute of Mining and Fuel Research-CIMFR or academic institutions, who have the knowledge and expertise to carry out such advanced studies.

Mines should start looking at optimization through more structured monitoring and identify areas needing improvement. They should monitor on a regular basis parameters and processes within their capabilities and take external help for a one-time total audit and implement the findings and suggestions diligently. *This would also help suppliers of explosives and blast initiation systems to become aware of any shortcomings with their products and have an open mind for improvement.* Mines should wean out of the powder factor concept which is so deeply entrenched in the business, endeavor to carry out better blasts and use scientific methods of analysis for optimum results.

Measurement of rock characteristics of samples from different parts of the mine can be carried out as a one-time activity and data used appropriately. Burden response studies will reveal a wealth of information for the explosive-rock combination studied such as optimum burden, appropriate inter-hole and inter-row delay interval, causes of cratering, stemming ejection, venting of energy, back-break if any. Post-blast muckpile characteristics and fragmentation study helps in identifying if the downstream requirements are being met or not. From safety considerations, monitoring damage behind blast should be carried out when blasting final pit walls. In ore mining, delineating ore-waste rock boundaries inside the muckpile helps selective mining and prevents valuable ore reaching the dumps and unnecessary wasteful comminution if waste rock reaches the crusher.

4.1. Role and responsibilities of users carrying out blasting

Scott[30] summarizes the role and responsibility of users of explosives thus:

Quote…Consumers and manufacturers have quite different roles in the explosives industry. It is unhealthy for the explosives expertise to reside only with the manufacturers. It is natural that they will have a leading position in terms of the chemistry and manufacturing techniques *but explosives users must take greater responsibility for the application of*

explosives in their blasting operations. They have the task of fragmenting rock according to the needs of their mining or construction operations and only they can properly judge whether they are achieving their objectives or not. Mine operators have tended to regard blasting as a minor, but necessary step in their production process and have previously been satisfied to rely on the explosive suppliers for the provision of the technology and advice. This should continue, but from a position of greater technical equality than in the past. Independent professionals have an important and responsible role to play in supporting both groups…Unquote

5. CONCLUSIONS

In an era of increasing costs, optimization is the need of the hour. With special reference to blasting operations, optimization gains significance considering the broad delineation of operations of drilling, blasting, loading, hauling, comminution (crushing-grinding) and extraction of finished product. The mine-to-mill initiative holistically monitors the inter-dependency of each operation with the other. A complete technical audit on the performance of explosives and blast initiation systems on the blast outcomes during the three phases of activities of pre-blast, in-blast and post-blast gains significance. Rock characteristics can be obtained by sending samples to any accredited laboratory. Mines can measure explosive's density and VOD at their respective sites, but require external expertise for evaluating other parameters. Mines can monitor ground vibrations and study blasts qualitatively using video cameras but for quantification (face velocity, firing times of drillholes, burden response etc.) require dedicated support of motion analyzers and related expertise. Monitoring in-hole shock pressure, gas pressure, detonation pressure, detonation temperature, fragment size analysis, post blast damage to in-situ rock mass, delineation of ore-waste rock boundaries inside muckpile all require specialized instrumentation and knowledge which the mines mostly do not possess and would require external help. This paper attempts to review the various monitoring techniques available for assessing performance of explosives systems and blast outcomes in large open pit mines and quarries. Advances made in instrumentation and ability to monitor events that occur in milli/micro/nano second time intervals is transforming blasting which was hitherto considered as an 'art' into a full-fledged 'science' and users are encouraged to utilize them for identifying optimum parameters and make their operations profitable.

6. ACKNOWLEDGEMENT

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7. REFERENCES

1. AEISG – Code of practice: Prevention and Management of blast generated NOX gases in surface blasting, Edition 2, 2011
2. Agarwal. H and Mishra. A.K - A study on the influence of density and viscosity of emulsion explosive on its detonation velocity. AMSE Journal January 2018.
3. Bhandari. S - Personal communication.
4. Bjarnholt. G and Holmberg. R - Explosive expansion works in underwater detonations. Sixth Symposium (International) on Detonation, California, USA, 1976.
5. Blair. D.P and Little. T.N - Assessment of open pit blast performance using infra-red airblast and video techniques. Proceedings, Fragblast, Vienna 1993
6. Brent. G.F and Smith. G.E - The detection of blast damage by borehole pressure measurement. Journal of South African Institute of Mining and Metallurgy, Jan/Feb 2000.
7. Cavanough. G and Onederra. I - Development of detonation pressure and temperature gauges.
8. Chaudhry. B.S and Sonu. K - Assessment of powder factor in surface bench blasting using Schmidt rebound number of rock mass. IJRET Volume 2 Issue 12, December 2013.
9. Chiappetta. R.F and Borg. D.G - Increasing productivity through field control and high-speed photography. FRAGBLAST, Lulea, Sweden, 1983.
10. Chiappetta. R.F - Generating site specific blast designs using state-of-the-art blast monitoring instrumentation and PC based analytical techniques. Proceedings ISEE 1991.
11. Chiappetta. R.F and Vandenberg. B - Portable, multi-channel and continuous velocity of detonation records. 7th High Tech Seminar, Blasting Analysis International Inc. 1997.
12. Cunningham. C.V.B - Fragmentation estimations and the Kuz-Ram model - Four years on. Proceedings Fragblast, Colorado, USA 1987.
13. Floyd. J.L - The development and implementation of efficient wall control blast designs. Proceedings, ISEE. 1998.
14. Hagan. T.N and Morris. P - The mechanisms, measurement and control of blast-induced fracturing in pitwalls in weak rock. Proceedings, International Symposium on Weak Rock, Tokyo, Japan 1981.
15. ISEE Blasters' Handbook. 17th edition.
16. Kanchibotla. S.S - Seshat Consultants, Australia. Personal communication, September 2020.
17. Lang. L.C and Favreau. R.F - A modern approach to open pit blast design and analysis. C.I.M Bulletin, June 1972.
18. McKenzie. C - Methods of assessment and monitoring of the effects of gas pressures on stability of rock cuts due to blasting in the near field. Report submitted to Hong Kong Govt.
19. Mencacci. S and Chavez. R - The measurement and analysis of detonation pressure in blasting. Proceedings of EFEE Conference, Brighton 2005.
20. NIRM - Evaluation of explosives performance through in-the-hole detonation velocity measurement. Report S&T Project, Ministry of coal 2001.
21. Onederra. I and Esen. S - Selection of inter-hole and inter-row timing for surface blasting - an approach based on burden relief analysis.
22. Ouchterlony. F, Nie. S, Nyberg. U and Deng. J - Monitoring of large open cut rounds by VOD, PPV and gas pressure measurements. Proceeding Fragblast, Canada. 1996,
23. Pradhan. M - Sleep time: its consequences on performance of bulk explosives. Journal of scientific and industrial research, February 2010.

24. Ramulu. M, Sangode. A.G and Sinha. A - Blast Optimization with In-Situ Rock Mass Characterization by Seismic Profiling at an Opencast Coal Mine in India. Coal Operator's Conference, University of Wollongong, 2012.
25. Rogers and Kanchibotla - Proceedings Fragblast, New Delhi,2012.
26. Salmi. E.F and Sellers. E.J - A review of the methods to incorporate the geological and geotechnical characteristics of rock masses in blastability assessments for selective blast design. Engineering Geology, 281 (2021) 105970.
27. Sarathy. M.O - Toxic after-blast fumes (with emphasis on surface blasting). Mining Engineers' Journal, February 2019.
28. Sarathy. M.O and Vidyasagar. N - Bench Blast Design using Explosive and Rock Properties - A Discussion. Mining Engineers' Journal, March 2017
29. Sawmliana. C, Roy. P.P and Singh. R.K - Assessment of explosive charge factors in surface blasting using rebound hardness values of rocks. Proceedings, Fragblast, New Delhi. 2012
30. Scott. A - Explosives performance - who needs to know? Third International Symposium on Rock Fragmentation by Blasting (Fragblast), Brisbane, Australia, 1990.
31. Shoshun Chang & Chen Gang (2002) - Characteristics of Shock Waves in Rock Mass Surrounding Blast Holes. Fragblast 7, Beijing, China
32. Singh. S.P - Prediction and determination of explosive induced damage. Proceedings, Fragblast, Vienna, 1993.
33. Thornton. D.M - Application of electronic monitors to understand blast movement dynamics and improve blast designs. Proceedings, Fragblast, Spain. 2009.
34. Zhengdong Leng, et al (2014) - A new theory of rock-explosive matching based on reasonable control of crushed zone. Engineering, Vol. 12, No.6, December 2014.

(Continued from Page 12)

to auction blocks for these 12 minerals for the first time in the country, it added. The royalty rate on minerals is an important financial consideration for the bidders in the auction of blocks.

Further, the method for calculating the average sale price (ASP) of these minerals has also been prepared by the Ministry of Mines, which will enable the determination of bid parameters.

As per the release, the Second Schedule of the MMDR Act provides royalty rates for various minerals. Item No. 55 of the Second Schedule provides that the royalty rate for minerals whose royalty rate is not specifically provided therein shall be 12 per cent of the average sale price (ASP).

Thus, if the royalty rate for these is not specifically provided, then their default royalty rate would be 12 per cent of ASP, which is considerably high as compared to other critical and strategic minerals.

Also, this royalty rate of 12 per cent is not comparable with other mineral-producing countries. Critical minerals have become essential for economic development and national security in the country. Critical minerals such as Cadmium, Cobalt, Gallium, Indium, selenium and Vanadium have been used in batteries, semiconductors, solar panels, etc.

These minerals have gained significance given India's commitment to the energy transition and achieving net-zero emissions by 2070. Minerals like beryllium, titanium, tungsten, tantalum, etc. have been used in new technologies, electronics and defence equipment.

Encouraging indigenous mining would lead to a reduction in imports and the setting up of related industries and infrastructure projects. The proposal is also expected to increase the generation of employment in the mining sector. The Geological Survey of India (GSI) and Mineral Exploration & Consultancy Ltd. (MECL) have recently handed over the exploration report of 13 blocks containing one or more critical minerals like cobalt, titanium, gallium, vanadium and tungsten. Further, these agencies are conducting exploration for these critical and strategic minerals in the country.

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TO BOOST PRIVATE INVESTMENT IN MINING SECTOR, INDUSTRY AWAITS SHIFT TO INVESTOR FRIENDLY MINERAL REPORTING CODE

Mines ministry asked to consider adoption of JORC model in place of UNFC.

In a bid to spur private investment in India's mining sector, representatives of Vedanta Group pushed the Mines Ministry to shift to an investor friendly resource classification code during a meeting on October 18, 2023. The representatives asked the ministry to consider the adoption of Joint Ore Reserve Committee (JORC) classification, developed by mining experts in Australia, as opposed to the currently used United Nations Framework Classification (UNFC), which does not mandate disclosures pertaining to the economic viability of mining exploration projects.

According to experts, India's current resource classification rules based on the UNFC have made the prospect of mineral exploration unattractive to private companies as it fails to provide any degree of economic certainty, which in turn has hindered the flow of private investment in the sector. Between FY19 and FY23, the mining industry recorded foreign direct investment (FDI) in equity valuing $1.1 billion, just .4 per cent of gross equity inflows worth $259 billion.

A resource classification code is necessary to assess resources and reserves in a mineral block, to prepare geological reports to facilitate its auction for both exploration and mining, and for a mining company to evaluate its assets.

In the meeting, the mines ministry secretary proposed a joint working group involving Geological Survey of India (GSI) and Indian Bureau of Mines (IBM) to study the issue, as per the meeting minutes obtained by The Indian Express through the RTI. Experts point out that India's mining industry has already developed and recommended the Indian Mineral Industry Code (IMIC) in 2019, which is based on the same template as the JORC classification, however the ministry is yet to formulate rules in line with the IMIC despite informal assurances.

The mines ministry, GSI, and IBM did not respond to emails asking for comments.

"Unlike other sectors, the mining sector deals with natural processes, the knowledge of which remains incomplete prior to the commencement of mineral extraction. It is critical for the Indian mineral sector to communicate effectively and transparently with the investment community using internationally accepted terminology and definitions, which are essential to earn their trust. This internationally accepted terminology is incorporated in the IMIC," said Peter Stoker, deputy chairman of Australia's JORC and principal geologist at the Brisbane office of AMC Consultants.

While the UNFC framework allows for the reporting of resources in general, which include undiscovered and uneconomic resources, the IMIC and the JORC classification, both aligned with the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) template, also require the reporting of reserves, which are economically viable deposits with high geological confidence confirmed through studies at least to a pre-feasibility level. In other words, reserves indicate the likelihood of profitably mining a mineral block at the time of reporting. "You cannot report resources in the CRIRSCO system unless you establish that there is a reasonable prospect for eventual economic extraction," explained Dr P V Rao, co-chair of the National Committee for Reporting Mineral Resources and Reserves in India (NACRI), which developed and maintains the IMIC code.

In determining the economic viability of mining projects, the CRIRSCO template considers ten modifying factors including legal, infrastructural, processing, metallurgical, marketing, environmental, and governmental factors. Globally, CRIRSCO consists of 15 members including the

USA, Australia, Brazil, Canada, Chile, South Africa, and the European Union. Membership to CRIRSCO requires countries to produce reporting codes that comply with the CRIRSCO template. India was admitted to CRIRSCO in 2019 following the recognition of the IMIC as a CRIRSCO-compliant code.

"The CRIRSCO framework's primary function is to ensure that investors and their advisors have comprehensive information that is relevant to make financial and technical decisions. This data is crucial for forming reliable opinions on the results and estimates being reported, thereby promoting informed decision-making in the mining sector," according to Vikram Mehta, partner at EY India's metals and mining division.

In addition to the mineral reporting template, CRIRSCO also provides a governance system to ensure competent and ethical reporting by industry professionals.

On the other hand, the UNFC framework, which is more comprehensive and diverse, has a wider application in policymaking. "UNFC is a useful tool for national governments to see beyond the horizons of an investor's point of view and allow formulating informed policy decisions, country-specific strategic decisions, and maintenance of a national inventory," said Shameek Chattopadhyay, managing director and principal consultant at SRK Mining Services.

"Under UNFC, all resources including mineral occurrences and mineral zones that have reconnaissance level or very low level of confidence in terms of estimation of quantity and quality are also reported, albeit under separate categories," explained Pankaj Sinha, managing director at UK-based DMT Consulting Limited.

Importantly, while the CRIRSCO framework can be mapped onto the UNFC framework, given that the latter has a much broader scope, the reverse is not possible as CRIRSCO is far more specific in scope.

In 2015, the mines ministry notified the Minerals (Evidence of Mineral Contents) (MEMC) Rules, for which they used the CRIRSCO definitions for resources and reserves, while the framework for classification of resources was borrowed from the 1997 UNFC framework. "At the time, we told them that you cannot mix oranges and apples to say that they are one. The two are not compatible in that manner," Rao explained.

Then, in 2021, the ministry amended the MEMC Rules and removed the definitions stated in the 2015 version. "The amended rules totally ignored the CRIRSCO definitions and the UNFC framework. At present, India is also not following the UNFC framework in toto, which was updated in 2019," Rao added. MEMC Rules are used for the purpose of preparing geological reports for the auction of mineral blocks. Mining companies have to rely on such reports for the valuation of mineral blocks and to determine whether or not they should participate in a given auction.

According to Stoker, a shift to the IMIC will allow the Indian mineral sector to communicate effectively and transparently with the investment community. "It is another step towards realising the immense potential for private investments in exploration and mining in India, which has largely not been successful under the current UNFC mineral reporting system as the prescribed terminology and definitions are not acceptable to the global investment community," he said.

"If the IMIC was also adopted for internal or non-public reporting, then the information available in tenders and for joint ventures and takeovers, would comply with the requirements of international banks which require reporting in accordance with one of the major codes for due diligence studies," Stoker added.

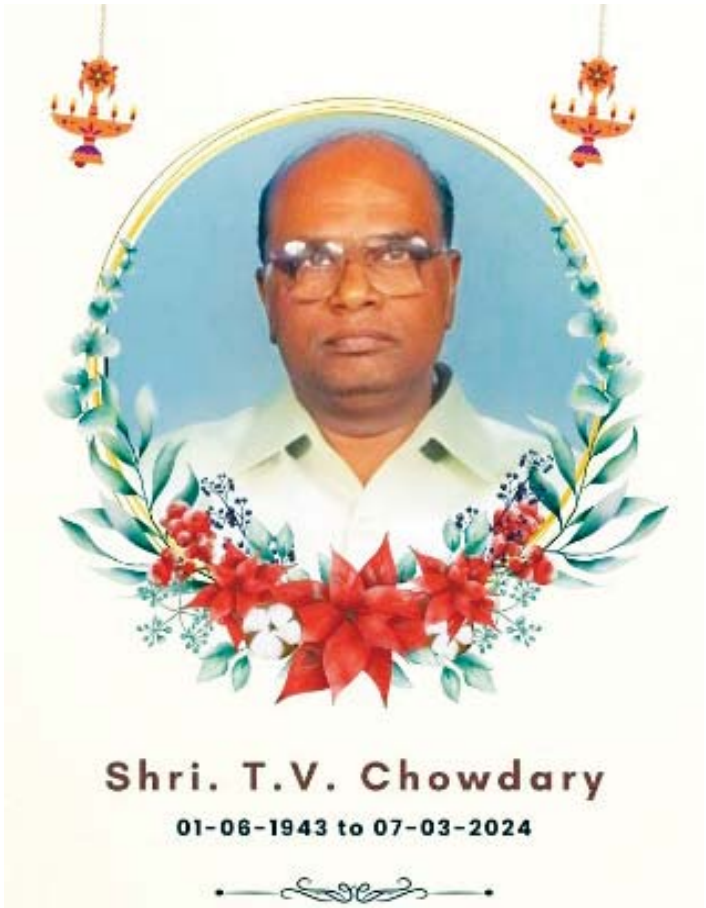
According to Chattopadhyay, adapting India's mining rules to the IMIC code will attract private investment to the sector by providing greater clarity on the economic feasibility of exploration projects. "The IMIC will help the Indian mining industry with access to capital for mining and exploration companies for undertaking scientific exploration, project development, and mine expansion programmes by allowing potential investors to take informed decisions to invest in a particular project, through appropriate transparency, materiality, and competency," he said. Moreover, the IMIC also sets minimum public reporting standards for listed mining companies, which can further streamline the process of raising funds from the equity market.

Aggam Walia, The Indian Express,
New Delhi | March 7, 2024

MEAI NEWS

MEAI HEADQUARTERS

OBITUARY



Shri. T V Chowdary was born on 01-06-1943 at Maddalacheruvu Village in Kalyandurg Mandal, Anantapur Dist. of erstwhile, Andhra Pradesh. His schooling and college was done in Anantapur Dist. He joined Osmania University in the Mining Engineering Branch and passed out in 1964.

He did his MBA in the year 1984 from Osmania University. He completed a Bachelor degree in law in the year October 2001. He became a Bar Council member in 2002.

Shri. T V Chowdary started his career in the Bengal Coal Company of Andrew Yule for 4 years in 1969 and then joined the Govt. of A.P as Asst. Director of Mines in the Department of Mines and Geology. He rose to the position of Director and held the post for many years. He streamlined the processing of applications for Mineral Concessions which paved way for phenomenal growth of mining industry in erstwhile Andhra Pradesh in turn maximizing mineral revenue to the State, making Andhra Pradesh as number one in the Country. He formulated a New Granite Mining Policy which transformed the Industry from exporting raw blocks to creating value addition by the establishment of cutting and polishing units in the State. This policy was adopted by the Govt. of India for the entire country bringing in Granite Conservation and Development Rules 1999. He founded DMRTUF Development of Mineral Resources and Technology Upgradation Fund first of its kind in the Country to take up research and development and technology upgradation in the mineral industry. Simultaneously he headed public sector undertakings such as APMDC, NEDCAP, APSRTC and APTEX. He retired from Government service in 2001.

He was Chairman Hyderabad Chapter from 1992-1994. He was President MEAI for 2 terms from 1997 to 2001. During his tenure as President, MEAI headquarters was shifted to Hyderabad. He started publication of MEJ and started new Chapters raising the membership to over 5000. He was also a Member of many professional organizations, such as IEI, and SME.

He was more than just a president, he was a visionary, a mentor, and a friend to many. His dedication and passion for our cause were evident in every decision he made and every action he took. Under his guidance, our association flourished and achieved remarkable milestones.

He continued active association with MEAI in the capacity as Chairman of the Bye-laws amendment Committee twice in 2010 & 2017, and continued as Chairman of the MEAI New Office Building Renovation Committee.

After retirement, Shri. T V Chowdary became Director of Trimex Group of Companies and was instrumental in setting up an integrated mining and mineral separation project involving right from exploration, mine planning, obtaining all clearances/approvals/ sourcing of technology and in setting up a world class project at Srikakulam in A.P. The project is the first of its kind to process 5 minerals under one umbrella and leaping to create value addition to be a fully integrated Titanium producer to be the largest player in Titanium Feedstock Industry in Asia. Shri. T V Chowdary was also an Independent Director in M/S Pokarna Ltd and M/S Divyasakti Granites Ltd.

Shri. T V Chowdary was awarded “Rastriya Gaurav Award in 1993” by all India Achievers Conference, New Delhi for his contribution for the Development of Non-conventional Sources of Energy in Andhra Pradesh.

Shri. T V Chowdary was recipient of “Sitaram Rungta Award” in the year 1992 and also been awarded “Life time Achievement Award” for his contribution to the field of

Mineral Administration & Innovation in Mining in the year 2014 by MEAI.

Beyond his professional achievements, Shri. T V Chowdary will be remembered for his kindness, his compassion, and his unwavering commitment to serving others. He touched the lives of countless individuals, offering support, guidance, and encouragement whenever it was needed most.

As we mourn his loss, let us also remember the legacy he left behind. Shri. T V Chowdary may no longer be with us in person, but his spirit will continue to inspire us as we carry forward his work. Let us honor his memory by rededicating ourselves to the principles and values that he held so dear.

We extend our deepest condolences to Shri. T V Chowdary family. The family members please know now that you are not alone in your grief, and that our thoughts and prayers are with you during this difficult time.

Shri. T V Chowdary's thoughts will endure for generations to come. His impact on our Association and the lives of those he touched will never be forgotten.

M. Narsaiah
Secretary General, MEAI
On behalf of the Association Members

Condolence meeting held on 11th March 2024 at MEAI Headquarters

Shri T V Chowdary, former President of MEAI passed away on 07-03-2024 at AIG Hospital, Hyderabad. On the next day Shri. V S Rao, Past President, Dr. P V Rao, Shri. M. Narsaiah, Shri. B Surender Mohan and Shri. L Krishna visited the residence of Shri. T V Chowdary to pay their floral tribute and convey condolences to his family members on behalf of MEAI.

Shri. T V Chowdary
Past President, MEAI
01-06-1943 to 07-03-2024

On 11-03-2024, MEAI Hyderabad Chapter and Headquarters organized a condolence meeting at MEAI Headquarters to pay homage to late Shri T V Chowdary. Initially, Shri. V S Rao spoke about his memories with Shri. T V Chowdary. Later, Shri. Md Fasihuddin, Shri. V D Rajagopal, Dr. P V Rao, Shri. B R V Susheel Kumar, Shri. B S P Raju, Shri. B. Surender Mohan and Shri. L Krishna also narrated about their long association with Shri. T V Chowdary, and spoke about his contributions to the Indian mining industry.

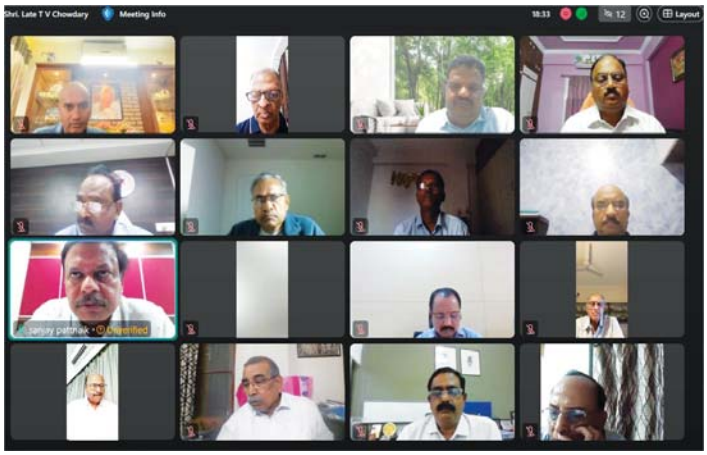
Secretary General paying respects to Late Shri. T V Chowdary

Members observing two-minute silence in memory of Late Shri. T V Chowdary

Members sharing their experiences with Late Shri. T V Chowdary

Members paying tribute to Late Shri. T V Chowdary

On 19-03-2024, an online condolence meeting was organized for the members of MEAI to pay their tributes to Shri Late T V Chowdary. Vice President – II Shri. Dhananjaya Reddy, Shri. Sanjay Kumar Patnaik, Shri. K Madhusudhana, Shri. V S Rao, Shri. T Victor and Shri. V D Rajagopal, Shri. Anil Mathur, Shri. R H Rao, Dr PV Rao, Shri. Lakshminarayana G, Shri. K J Amarnath, Dr Yamuna Singh and Shri. S K Vashisth shared their experiences and praised his valuable contribution to the Association and mining fraternity.



MEAI members expressing their condolences to the family of Late Shri. T V Chowdary

Sons of Late Shri. T V Chowdary viz. Shri. T Vamsi and Shri. T Sridhar thanking the MEAI members present in the condolence meeting

Glimpses of Shri. T V Chowdary

Shri. T V Chowdary participated in the CRIRSCO Training Program and NACRI meeting held at Hyderabad. Shri. T V Chowdary, Shri. P R Tripathy, Shri. K. Madhusudhana in the picture.

National Seminar held on Road Map towards Sustainable Mining at Hospet on 21st & 22nd September 2018. Shri. T V Chowdary, Shri. T Victor, Shri. A K Kothari, Shri. T Venugopal and Shri. K Madhusudhana in the picture.

National Seminar held on Road Map towards Sustainable Mining at Hospet. Shri. T V Chowdary flanked by Shri. Deepak Vidyarthi and Shri. V D Mali.

5th Council Meeting (2017-2019) and Extraordinary General Meeting held on 21-09-2018 at Hospet. Shri. T V Chowdary with Shri. T Victor, Shri. Meda Venkataiah and Shri. A R Vijay Singh

In the 5th Council Meeting (2017-2019) held at Hospet, Shri. T V Chowdary with Shri. B Sahoo

Shri. T V Chowdary seated with the Council Members in the 5th Council Meeting (2017-2019)

BELLARY HOSPET CHAPTER

Report on Two-day National Seminar held at VSKU POST GRADUATE CENTRE NANDIHALLI SANDUR on 23-24 Feb 2024

The B-H Chapter in association with Department of Mineral Processing, VSKU PG Centre Nandihalli-Sandur organised a 2-day national Seminar on "Advancements in Geology, Mining and Mineral Processing" (AGMMP 2024) on 23-24 February 2024 at the Institute's Auditorium, Vijayanagara Srikrishnadevaraya University post graduate Centre Nandihalli-Sandur.

Geology, Mining, and Mineral Processing are integral components of the global economy, contributing significantly to various industries such as construction, manufacturing, and energy production. In an era marked by rapid technological advancements and growing global demand for natural resources, it is imperative to bring together experts, professionals, and enthusiasts in the fields of Geology, Mining, and Mineral Processing. The two-day conference was aimed at providing a platform for knowledge exchange, collaboration, and discussions that will contribute to the sustainable development and efficient utilization of geological resources. The challenges and opportunities in the fields of Geology, Mining, and Mineral Processing have never been more critical. With the increasing demand for minerals, metals, and energy resources, there is a pressing need for innovative technologies, sustainable practices, and interdisciplinary collaboration. This National Seminar addressed these needs by fostering a conducive environment for networking, learning, and exploring cutting-edge advancements in the mentioned fields. To stay abreast with the latest developments and innovations in these fields, a two-days national seminar was organized by the BH Chapter in association with Department of Mineral Processing, VSKU PG Centre Nandihalli-Sandur, bringing together experts, researchers, industry professionals, and policymakers to exchange knowledge, share experiences, and explore emerging trends.

Lighting the lamp by the dignitaries before commencing the program

Dr. P. Sharath Kumar, Chairman, Department of Mineral Processing, VSKUPG Centre Nandihalli-Sandur explained the background of the seminar in his preamble while Dr Basavaraj Hatti rendered the welcome address. The seminar was inaugurated by Prof Ananth L Zandekar, Vice Chancellor (Incharge), and Vijayanagar Srikrishnadeveraya University Ballari. The dais was orchestrated with eminent personalities in the fields of geology, mining and mineral processing. Sri K. Madhusudhana, past president MEAI, Sri. Dhananjay Reddy, COO, ERM Groups and, Sri S.N.

Rudresh, Registrar, Vijayanagara Srikrishnadeveraya University ballari, Sri MD Saleem, Director, SMIORE and Sri S.H.M. Mallikarjuna, Chairman BH Chapter along with Sri P.V Rao, Secretary BH Chapter. In the Inaugural address the inaugurator shed light on the international opportunities available for young research scholars and PG students of geology and Mineral Processing.

On the first day, the seminar focused on advancements in geology and exploration techniques aimed at discovering new mineral deposits and optimizing resource utilization. Keynote Speaker Sri D.L. Sralaya, Director, Fe Power Tech and Solutions Bangalore has delivered the talk on future of Pellet Industries: a view on resources and their challenges. Speakers discussed the use of low grade effectively for production of quality agglomerates.

Sri S.H.M. Mallikarjuna honouring the speaker Sri D.L. Saralaya (Right)

Dr Sanjeev latchireddy has presented on the challenges in the fine grinding of low grade ores and grinding economics. The speaker also shed light on cost benefits of optimum grinding.

Dr Sanjeeev Latchireddi making his technical presentation

Dr T Santhosh, Shangai Mile Stone, China explained about the hydrogen reduction of BHQ iron ores and the plant layouts.

Mr Vishwajeeth Gosh (left) presenting a memento to Dr T Santhosh (right)

Sri Channa mallikarjuna Patil, has presented on the artificial intelligence, Machine Learning and Data Analytics in Mineral Exploration. Experts elaborated on the integration of machine learning algorithms and data analytics techniques in geological data interpretation, facilitating predictive modeling and targeted exploration efforts.

Sri K. Ramani(right) presenting a memento to Sri Channa mallikarjuna Patil (left)

Some corporate presentations were also made to show the technological advancements. The corporate presentation from kimberlite chemicals Pvt ltd. and M/s Delkor Pvt Ltd. have presented the recent changes in the technology and showcased their products and attracted accolades from the participants.

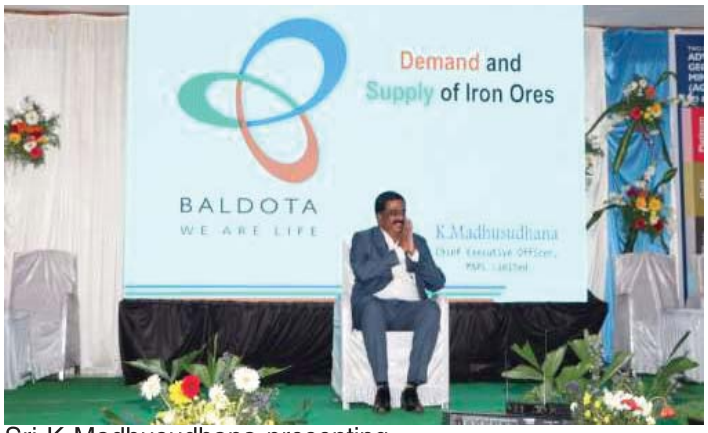
Mining and Mineral Processing

The second day of the seminar delved into innovations in mining practices and mineral processing technologies aimed at enhancing productivity, sustainability, and environmental stewardship.

Sustainable Mining Practices: Discussions centered on sustainable mining practices, including adoption of renewable energy sources, waste minimization strategies, and implementation of environmentally conscious mining technologies.

Advanced Mineral Processing Techniques: Experts highlighted advancements in mineral processing technologies such as sensor-based sorting, froth flotation enhancements,

and hydrometallurgical processes, enabling higher recovery rates and lower energy consumption.



Sri K Madhusudhana presenting

The two-day national seminar provided a platform for stakeholders in geology, mining, and mineral processing to exchange insights, showcase innovations, and address challenges facing the industry. By leveraging cutting–edge technologies and embracing sustainable practices, the sector is poised to meet the growing demands for minerals while minimizing environmental impacts and maximizing socio-economic benefits.

The National Seminar on Advancements in Geology, Mining, and Mineral Processing served as a valuable platform for knowledge exchange, networking, and collaboration among stakeholders in the minerals industry. The discussions and insights shared during the seminar are expected to contribute to the development of sustainable and responsible practices in geology, mining, and mineral processing, thereby supporting the growth and prosperity of the industry.

Photos on Valedictory function and felicitation to sponsors are given below.

RAJASTHAN CHAPTER-UDAIPUR

Report on 5-day workshop on Resource Estimation and Mine Planning in Open Cast Mining

A five-day workshop on Resource Estimation and Mine Planning was organized by the Rajasthan Chapter-Udaipur in collaboration with the College of Technology and Engineering (CTAE) from February 19, 2024, to February 23, 2024. Subject experts from M/S Data Mine imparted exhaustive training and aimed to enhance the skills of our members free of charge.

Overview

The workshop was designed to offer practical insights into resource estimation and mine planning utilizing the Data Mine software to our members. It attracted an overwhelming response with about 93 enthusiastic participants in attendance, surpassing our initial expectations. The event provided a valuable platform for participants to enhance their knowledge and expertise in this critical aspect of the mining industry.

Key Objectives

1. To provide hands-on training on resource estimation and mine planning using Data Mine software free of charge.

2. To enhance the skill and knowledge of participants in the mining sector.
3. To offer a platform for networking and knowledge exchange among industry professionals.

Workshop Sessions

The workshop consisted of interactive sessions, practical demonstrations, and hands-on exercises covering various aspects of resource estimation and mine planning. Participants were given the opportunity to work with the Data Mine software under the guidance of experienced experts.

The sessions were structured to cater to both beginners and experienced professionals, ensuring comprehensive learning for all attendees.

Valedictory Function

The workshop was concluded with a valedictory function held on February 23, 2024, at the Mining Department, CTAE, Udaipur. The event was graced by the esteemed presence of the Vice Chancellor of MPUAT as the chief guest. The valedictory function provided an opportunity to acknowledge the participants' dedication and commitment throughout the workshop.

(L to R) Sh Asif M Ansari, Secretary, MEAI-Udaipur, Sh MS Paliwal, Chairman, MEAI-Udaipur, Sh Ajit Kumar Karnatak, VC-MPUAT, Dr PK Singh, Dean, CTAE-Udaipur, Dr Anupam Bhatnagar, Head, Mining Engg. Deptt., CTAE & Sh Sanjay Choudhary, Technical Service Manager, Datamine International Ltd.

Glimpses of Valedictory Function

Feedback and Response

The workshop was organized free of charge and received an overwhelmingly positive response from all participants. Many attendees expressed keen interest in the content and appreciated the opportunity to enhance their skills in resource estimation and mine planning. The interactive nature of the sessions and the practical approach were particularly well-received.

Conclusion

The Resource Estimation and Mine Planning workshop organized by MEAI Udaipur Chapter in association with CTAE and subject expert M/S Data Mine was a great resource for the workshop. It not only provided valuable insights and practical knowledge to participants but also fostered collaboration and networking within the mining industry. MEAI reaffirms its commitment to promoting growth and innovation in the mining sector through such educational initiatives.

EXHIBITION OF MINERALS AND ORES ON FEBRUARY 17, 2024

Vis-a-vis Counselling on Mining and Earth Sciences Education at Sri Vahini Institute of Science and Technology

On the occasion of the 2nd Balostavam event organized by Janachaitnya Vedika, Tiruvuru, on February 17, 2024, at Sri Vahini Engineering College, Tiruvuru, NTR Dist. A.P., nearly 50 government-aided and corporate school students competed in 24 academic and 8 cultural events. Sri. Koneru Venkateswara Rao, former Secretary-General, MEAI organized the exhibition to educate the participants about the mineral wealth of our nation.

The exhibition was inaugurated by Dr. R. Nagendra Babu, principal of Sri Vahini Engineering College along with Smt. K. Madhavi, Revenue Divisional Officer, among others. Approximately 250 individuals, including students, teachers, and guests, visited the exhibition. Many students expressed their joy upon seeing the colorful minerals and ores. Particularly, students of 9th and 10th classes keenly noted the physical and chemical properties and their uses. All visitors showed particular interest in minerals such as Mica, Asbestos, Barite, Iron ore, Galena, Chromite, Pyrite, Graphite, ornamental Garnet, various colored Limestone, Quartz, Dolomite, Magnesite, Vermiculite, Stalactites, Quartz vug (though it has no economic interest), and Quartz crystal(transparent).

The college principal requested that the exhibition be set up every year at their college for the benefit of civil engineering students and those from other adjacent colleges.

Inauguration of exhibition. Mr KV Rao on extreme right.

All visitors were provided explanations about the occurrences, composition, and uses of minerals and ores. Some female visitors were particularly delighted after watching the garnet piece against sunlight and brought more girls to view the pleasing reddish Colour. Some visitors went through our seminar publications, Mining Engineering Journal (MEJ) copies, and other mining literature. The exhibition concluded at 4:00 pm.

Sri KV Rao, Former Secretary General, MEAI

Patial view of Exhibition centre

Mr KV Rao explaining to visitors

Students mesomrised with the samples

MEAI COMMITTEES APPROVED FOR THE TERM 2023-25

Govt. Policies Review & Recommendation and Minor Mineral Committee	
Dr VD Rajagopal	Chairman
Shri BRV Susheel Kumar	Member
Shri Saurbah Priydarshi	Member
Shri CM Dwivedi	Member
Shri Pankaj Kumar Satija	Member
Shri TN Venugopal	Member
Dr CH Rao	Member
Shri M Narsaiah	Secretary

International Affairs Committee	
Shri T Victor	Chairman
Dr Abani R Samal	Member
Dr PV Rao	Member
Shri Lalit Mohan Soni	Member
Shri MC Thomas	Member
Prof Bhabesh C Sarkar	Member
Shri B Sahoo	Secretary

Resource Mobilisation Committee	
Shri K Madhusudhana	Chairman
Shri DB Sundara Ramam	Member
Shri Dhananjaya G Reddy	Member
Shri Laxman Singh Shekhawat	Member
Shri Swagat Ray	Member
Shri Pankaj Kumar Satija	Member
Shri Vinay Kumar	Member
Shri Anil Mathur	Member
Shri Sitaram Kemmannu	Member
Shri M Narsaiah	Secretary

Training & Development Committee	
Shri Deepak Vidyarthi	Chairman
Shri SC Suthar	Member
Dr M Iftikhar Ahmed	Member
Prof Bhabesh C Sarkar	Member
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Shri B Sahoo	Secretary

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Shri HK Joshi	Member
Shri MS Paliwal	Member
Shri SHM Mallikarjun	Member
Shri SN Jha	Member
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Dr BS Choudhary	Member
Shri B Sahoo	Secretary

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Dr PV Rao	Chief Editor
Shri K Madhusudhana	Member
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Dr VN Vasudev	Member
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Shri AK Garg	Member
Dr PV Rao	Member
Dr PC Purohit	Member
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Election Committee	
Shri Dhananjaya G Reddy	Chairman
Dr DA Hiremath	Member
Shri AK Jain	Member
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Shri M Narsaiah	Secretary

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Prof Bhabesh C Sarkar	Member
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Shri B Surender Mohan	Member
Shri MS Venkataramayya	Member
Prof Sushil Bhandari	Member
Prof Bhabesh C Sarkar	Member
Shri B Sahoo	Secretary

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Shri Deepak Gupta	Member
Shri PN Sharma	Member
Shri Atul Kumar Bhatnagar	Member
Shri M Narsaiah	Secretary

Environment Committee	
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Dr CH Rao	Member
Shri KS Yadav	Member
Dr A Srikant	Member
Ms Gunjan Pande	Member
Shri K Venkata Ramana	Member
Shri B Sahoo	Secretary

(Continued from Page 25)

➤ **Coal Production And Dispatch From Captive And Commercial Mines Goes Up By 27% And 29% Respectively**

There is month on month (m-o-m) and year-on-year (yoy) increase in coal production and dispatch from captive and commercial. The total coal production and dispatch from captive and commercial coal mines during the period from 1st April to 29th February 2024 was 126.80 Mt and 128.88 Mt, marking an impressive increase of 27.06% and 29.14% respectively, as compared to the same period of the FY 22-23, reflecting heightened efficiency and a strong logistics network.

As of 29th February 2024, the total number of producing mines stood at 54, with 35 allocated to the Power sector, 11 allocated to the Non-Regulated Sector, and 8 allocated for Sale of Coal. 91 mines have been successfully auctioned under Commercial Coal Auctions, out of which 7 mines have already commenced coal production.

The total coal production and dispatch in the month of February 2024 was 14.85 Mt and 12.95 Mt, with an increase of 37% and 33% respectively, as compared to 10.85 Mt and 9.72 Mt respectively in the same month of FY 2022-23. The average daily coal production and dispatch rate was 5.12 Lt and 4.46 Lt per day respectively, showing consistent performance.

The Ministry of Coal attributes this success to the strategic implementation of policy reforms, and the relentless dedication of the mine allottees. The Ministry of Coal is focused on sustaining this growth trajectory and the aim is to further streamline operations and bolster the infrastructure to meet the rising energy demands of the nation.

BS / Mar 04 2024

➤ **Human rights court orders Peru to pay damages to mining town**

The Inter-American Court of Human Rights on Friday ordered Peru to pay damages to residents of an Andean town for violations of their right to a healthy environment from years of air, water and soil pollution from a nearby mine. The court ruled the state failed to comply with its duty to regulate and supervise La Oroya Metallurgical Complex, which was active for nearly a century before debts and environmental regulations forced it to close in 2009.

The court said it corroborated that exposure to lead, cadmium, arsenic and sulfur dioxide posed a significant risk to at least 80 local residents, who did not receive adequate medical attention from the government when they became ill. The court decided they should receive at least $30,000 each in damages, with the most vulnerable receiving $50,000.

A further $65,000 each should be paid to the legal beneficiaries of two victims who died from diseases caused by the pollution. Officials from Peru's government and its mining ministry did not immediately respond to Reuters' request for comment. La Oroya partially resumed operations in 2023, managed by Metalurgica Business Peru SAC, a firm that counts former workers among its shareholders and promised to comply with environmental standards. Peru is the world's second largest copper producer and mining makes up 60% of its total exports. The court ordered the government to assess the current state of contamination in La Oroya and provide cash and free medical aid to the victims.

Reuters / March 22, 2024

5th IN-PERSON PROFESSIONAL TRAINING PROGRAM ON IMIC ON 6-10, MAY 2024

Venue: MEAI HQs, Raghavaratna Towers, Abids, Hyderabad 500 001

Mining Engineers' Association of India (MEAI), the trusted voice of the Indian Resources sector, is the leading Professional Organisation (PO) recognised by the National Committee for Reporting Mineral Resources and Reserves in India (NACRI) and the Committee for Mineral Reserves International Reporting Standards (CRIRSCO). MEAI accepts the obligation of offering Professional Development Programs to its members, registering Competent Persons (CP) and supervising their ethical conduct. NACRI is the National Reporting Organisation (NRO) of India recognised by CRIRSCO.

The earlier four training programs on Indian Mineral Industry Code (IMIC) approved by CRIRSCO were successfully finished by NACRI in January 2021, April 2021, April 2022, and April 2023 with the overwhelming participation of over 25 professionals in each program, representing all leading mining companies viz. NMDC Limited, Tata Steel, HZL, MSPL, MOIL, OMECL, NLC, JSW Steel, AMNS, Adani Enterprises, HGML, SCCL, APMDC, KSMC, ERM Group, Deccan Gold, Orient cements etc., consulting organisations viz. DMT, SRG, Geovale, Data Code, Capstone etc. and individual professionals from across the country and overseas. Most of the delegates have successfully passed the IMIC evaluation test and more than a third of them have registered as Competent Persons (RCP) with MEAI. The list of delegates that attended the previous IMIC training programs and subsequently registered/ renewed as CPs may be found in the MEAI website at www.meai.org.

About the Professional Development Program on IMIC

NACRI has formulated a 40-hour (5-day) in-person but non-residential training program on IMIC. This course, conducted by the domain experts from India and abroad, includes sharing of basic knowledge on all relevant aspects of IMIC and Code of ethics, mineral industry Best Practices, and general guidance to the prospective RCP. The course has been formulated in line with the JORC Code training program conducted by the AusIMM and imparted under six major modules viz. Why the IMIC standard? Context and Principles, Exploration Results and Targets reporting, How to properly inform Technical Studies to investors, Reporting of Mineral Resources, Reporting of Mineral Reserves, and The role of Regulatory Environment. The objectives of the training program would be to appraise the obligations and liabilities of the Competent Person under the IMIC, Role played by the IMIC in the Resources sector, Interpretation of the IMIC within the context of your working environment, Recognise and counter common misconceptions about the IMIC, Identify good and poor technical reporting, and Demonstrate the correct application of the IMIC.

Overseas domain experts from JORC (Australasia), PERC (Europe and UK), CBRR (Brazil), SAMREC (South Africa) etc. may speak on Best practices and present practical examples on reporting of Exploration results, Mineral Resources and Mineral Reserves, wherever possible. As of now, overseas domain experts confirmed to present on the following topics:

1. **Mr Peter Stoker**, Dy Chairman JORC, Rep of Australasia on CRIRSCO, Treasurer CRIRSCO. JORC Chairman 2005-2014. Recipient of Medal of the Order of Australia for services to the mining industry in 2020. Contributor for Monograph 23 (Mineral Resources and Ore Reserves Estimation: The AusIMM Guide to Good Practice) & Monograph 30.
   - The role of the Competent Person under the CRIRSCO Template, look at the variation in requirements for Competent/Qualified Persons of CRIRSCO NROs, Codes of Ethics and enforcement and the importance of disciplinary processes to credibility of the CRIRSCO governance system.

2. **Mr Roger Dixon**, SAMREC, Rep of South Africa on CRIRSCO, CRIRSCO Rep on UNECE, Director SRK Consulting, Chairperson & Founder member of SAMREC
   - Reporting Mineral Reserves - a team approach

3. **Dr Edmund Sides**, Dy Chairperson, CRIRSCO/ Chairman PERC
   - Consideration of risk and uncertainty aspects of mineral projects.

- The CRIRSCO-UNFC relationship and the updated CRIRSCO-UNFC Bridging Document.
- Effective use of the Table 1 Checklist

4. **Mr Edson Ribeiro**, Past Chair CRIRSCO, CBRR Brazil Rep on CRIRSCO since 2015, leading the Exploration and Mineral Projects area at Vale S.A.
   - Best practices in Mineral Resources estimation & reporting

5. **Dr Abani Samal**, Former founder Co-Chair NACRi, Principal, GeoGlobal, USA
   - Mineral Resource Reporting, Practical examples of Mineral Resource reporting

Prerequisites for the registration of a CP

RCP definition under Clause #9 of IMIC 2019 is as follows:

RCP is a mineral industry professional who is a member of a professional organisation headquartered in India and approved by NACRI or a member of a 'Recognised Professional Organisation' (RPO), as included in a list of similar bodies headquartered outside India available on the NACRI website. These organisations have enforceable disciplinary processes including the powers to suspend or expel a member. An RCP must have a minimum of ten years professional experience, which includes five years relevant experience in the style of mineralisation or type of deposit under consideration, and in the activity which that person is undertaking.

In addition to the above, minimum professional experience required by the MEAI members for registration as RCP, the NACRI vide Article 2.2.ii further specifies that the potential RCP shall obtain at least 40 hours of mandatory professional development credits before making an application for registration and obtain at least 8-hour PD credits every year through participation in NACRI accredited seminars, conferences, workshops, training programs or webinars, for CP certificate renewal.

The initial CP registration fee as well as the yearly CP certificate renewal fee has been fixed at Rs 5,000 (Rupees five thousand only + GST @18%) and payable to MEAI. RCP certification shall be valid for a period of one year from the date of issue of the certificate and the same may be renewed thereafter.

IMIC training Venue

The 5th IMIC in-person training program will be held on 6-10 May 2024, in the state-of-the art Conference facilities available at MEAI Headquarters, Hyderabad. Working lunch on all 5 days, tea & snacks twice a day and a cocktail dinner on the inaugural evening are included in the course fee.

IMIC course fee payment details

The fee chargeable for attending the 5-day (40-hour) in-person but non-residential training program is Rs 25,000 (Rupees twenty five thousand only) plus applicable GST @18% for MEAI Members or Rs. 30,000 (Rupees thirty thousand only) plus applicable GST @18% for other delegates, and payable online to:

Account Name:	**MEAI-National Core Committee Fund**
Bank Name & Address:	**UCO Bank, Abids circle, Hyderabad**
S/B Account No:	**14410110037089**
IFSC:	**UCBA0001441**

Contact person

Interested mineral industry professionals may please contact Mr M. Narsaiah, Secretary General, MEAI at **meai1957@gmail.com**/ Office T: 040-66339625/ 040-23200510/ Mob: 9177045204 for seeking any additional details on this program.

Dr PV Rao
Co-Chair NACRI

CONFERENCES, SEMINARS, WORKSHOPS ETC.

ABROAD

4-5 Apr 2024: **International Conference on Geological Engineering ICGE**. Rome, Italy. Website URL: https://waset.org/geological-engineering-conference-in-april-2024-in-rome. Program URL:https://waset.org/conferences-in-april-2024-in-rome/program. Contact URL: https://waset.org

5 Apr 2024: **International Conference on Mining, Material, and Metallurgical Engineering**. Bangkok, Thailand. Website URL: https://academicsworld.org/Conference2024/Thailand/11/ICMMME/

17-18 Apr 2024: **Deep Sea Mining Summit**. London, UK, London, WC1 United Kingdom. Website: https://www.deepsea-mining-summit.com/index

22-23 Apr 2024: **International Conference on Recent Developments in Mining Technologies ICRDMT 2024**. London, United Kingdom. Website URL: https://waset.org/recent-developments-in-mining-technologies-conference-in-april-2024-in-london

23-25 Apr 2024: Exhibition Mining World Russia. 28th exhibition of machines and equipment for mining, processing and transportation of minerals. Moscow, Crocus Expo, pavilion For details contact: Ms. Natalia Medvedeva, Portfolio Director, ITE Group, Email: natalia.medvedeva@ite.group. Web link: https://miningworld.ru/en/media/news/2023/august/17/equipment-for-mining-industry-in-russia.

7-8 May 2024: **International Mining Geology Conference 2024 (IMG 2024)**. Perth Convention and Exhibition Centre, Perth, Australia. For details contact conference@ausimm.com

17-18 May 2024: **International Conference on Surface Mining and Land Reclamation ICSMLR 2024**. Sydney, Australia. Website URL: https://waset.org/surface-mining-and-land-reclamation-conference-in-may-2024-in-sydney

21-23 May 2024: **Discoveries 2024 Mining Conference.** Mazatlan International Center, Av. del Delfin 6303, Marina Mazatlán, 82103 Mazatlán, Sinaloa, Mexico. Website https://www.discoveriesconference.com/

17-19 Jun 2024: **Molten 2024**. Brisbane, Australia and Online. Contact AusIMM. T: 1800 657 985 or +61 3 9658 6100 (if overseas)

17 Jun - 7 Oct 2024 (Online): **JORC Reporting: Certification and Code Reporting Courses**. 40 PD hours. Fee: Members A$ 2644 – 2890 + GST; Non-members: A$ 3454 + GST. Contact: AusIMM T: 1800 657 985 or +61 3 9658 6100 (if overseas). Po Box 660 Carlton, VIC 3053, Ground Floor, 204 Lygon St, Carlton VIC 3053.

18-19 Jun 2024: **Direct Lithium Extraction Summit 2024**. Denham Grove Hotel, Tilehouse Ln, Denham, Uxbridge, UB9 5DG United Kingdom. Website:http://energy.apexevents.cn/

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

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

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

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

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

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

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

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

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

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

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