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Flat-608 & 609, Raghava Ratna Towers, A-Block, VI Floor, Chirag Ali Lane, Abids, Hyderabad - 500001
Ph.: 040 - 66339625, 23200510, Email: meai1957@gmail.com Website: www.meai.org

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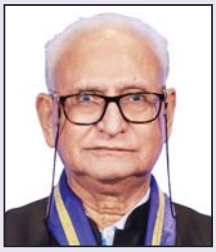

this issue contains...

Correspondence Address

MEAI National Headquarters

Contact: **Secretary General,**
Mining Engineers' Association of India
F-608 & 609, Raghavaratna Towers, 'A' Block, VI Floor,
Chirag Ali Lane, Abids, Hyderabad - 500 001.
Ph.: 040-66339625, 23200510

E-mail : meai1957@gmail.com
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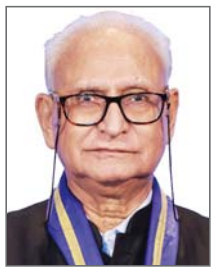
President's Message.....



Dear members..

A major setback for mining companies!

The Hon'ble Supreme Court in its recent verdict has allowed State Governments to impose a mineral right tax on royalty on mineral-bearing land from 1st April 2005. The Court has further directed that the States will not be allowed to tax transactions made before April 1, 2005; and the payment of tax can be staggered over 12 years commencing from April 1, 2006. Lastly, the court said that the interest and penalty on demands for the periods before July 25, 2024, shall stand waived.

In a landmark judgment delivered by a nine-judge bench ruled that the Royalty paid by the Mining leaseholders to the lessor was not a tax but a contractual consideration for the enjoyment of mineral rights. The court said the legislative power to tax mineral rights rests with the State legislatures and the parliament does not have the legislative competence to tax mineral rights.

It's a great setback for mining companies. We, of course, cannot challenge or question the Supreme Court's judgment but can at least deliberate upon the issue to find a possible way to get some direct or indirect relief. A suggestion was being made in some sections of the mining industry that the Mineral Rich states should consider lowering royalty rates to provide relief to some extent.

There may be more such ideas. I suggest that MEAI should organize, at the earliest, a virtual Open Forum, or else a panel discussion inviting some top mining industry leaders and tax consultants. And if we can afford to wait for some time, such discussions can be held in physical mode also when we meet for the next Council meeting. Let the Chairman of the MEAI Conference Committee consider this proposal and organize something in this direction.

In the last message for the MEJ August Issue, I missed acknowledging contributions of quite handsome funds to MEAI HQ by the Barajamda Chapter and the MSAK, Bengaluru. The Barajamda Chapter also contributed Rs 5 Lakh towards the Senior Citizen Welfare Fund. I apologize for my mistake due to oversight and extend my sincere thanks to both of these organizations.

In the last Council Meeting held at Jabalpur, the Chairman of the Udaipur Chapter volunteered to organize an International event jointly with the Jaipur and Jodhpur Chapters to help in the collection of some handsome amount to assist the Jaipur Chapter in clearing its outstanding liabilities. These three Chapters were expected to have convened a joint meeting to work out modalities. While waiting for their feedback, may I request the concerned persons to please expedite their actions?

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

The National Geoscience Awards (NGA) in India, originally established in 1966 as the National Mineral Awards (NMA), has evolved to reflect advancements in geosciences and changing national priorities. The Ministry of Mines instituted the NMAs to recognize outstanding contributions in mineral exploration, mining, and related activities. Initially, the awards primarily focused on mineral discovery, exploration, and mining technology, underscoring the significance of these sectors in India's economic development. In 2009, the NMAs were rechristened as NGAs to broaden their scope beyond minerals to encompass all aspects of geosciences such as basic and applied geosciences. This change facilitated the inclusion of awards recognizing contributions in various fields such as geology, geophysics, geochemistry, mining, mineral processing, and environmental sciences.

In 2022, the total number of awards was reduced from 21 to 12. This change streamlined the recognition process. The awards are categorized into three types: the National Geoscience Award for Lifetime Achievement, multiple National Geoscience Awards, and the National Young Geoscientist Award. The introduction of the National Young Geoscientist Award highlights the importance of nurturing new talent in the field, encouraging innovation and fresh perspectives. The selection process involves multiple levels of scrutiny, including Sectional Scrutiny Committees and a Screening Committee of Experts, ensuring a thorough evaluation of nominees. The awards are presented annually, typically in a formal ceremony attended by high-ranking government officials and dignitaries, emphasizing the importance of geosciences in national development.

The NGAs have evolved significantly since their inception, reflecting changes in the geosciences landscape and the need for sustainable practices. By recognizing a broader range of contributions and encouraging the next generation of geoscientists, the awards play a vital role in advancing the field in India. The continuous adaptation of the award structure and criteria demonstrates a commitment to fostering excellence and innovation in geosciences. The achievements of past NGA winners reflect a diverse range of contributions to the field, including innovative exploration techniques, sustainable mining practices, and significant geological research.

Based on available information, organizations that have won the maximum number of NGAs include the Geological Survey of India (GSI), Indian Bureau of Mines (IBM), NMDC Limited, Tata Steel, and Hindustan Zinc Limited, all of which have made significant impacts in their respective fields. National Young Geoscientist Award Recipients, since 2012, represented IIT-BHU, IIT-Kharagpur, IISER-Mohali, NIO-Goa, GSI, IIT-Roorkee, IIT-Kharagpur, NCPOR, IIT-Delhi, IISc-Bangalore, and University of Delhi. The consistent recognition of these entities highlights their commitment to innovation, sustainability, and excellence in geoscience research and mineral management. Despite the positive impact of the NGAs, challenges remain in the Indian mining sector, including regulatory hurdles, environmental concerns, and the need for technological advancement.

Recent advancements in mineral processing recognized by the NGAs reflect the industry's ongoing efforts to enhance efficiency, sustainability, and innovation in mineral beneficiation. Notable advancements highlighted through NGA recipients include innovative separation techniques, advanced flotation methods, eco-friendly approaches, utilization of low-grade ores, enhanced processing technologies, recycling and waste valorization, circular economy initiatives, integration of technology and automation, and innovative comminution techniques.

The NGAs represent a vital initiative to enhance performance and sustainability while promoting best practices for the growth and development of the mineral sector. The developments recognized by the NGAs in mineral processing emphasize the industry's commitment to innovation and sustainability. Through the development of new technologies and practices, awardees are addressing the challenges in processing increasingly complex and lower-grade ores while minimizing environmental impacts. As the mineral sector evolves, the NGAs will play a crucial role in shaping its future, ensuring it meets the challenges proactively.

As India reflects on critical and strategic minerals, it will face numerous challenges in discovering sizeable mineral deposits and greater challenges in enriching the mineral content from lean-grade and complex ores. ***As India has recognized several outstanding geoscientists through the NGAs, it is essential for the government to empower these awardees and their organizations by providing adequate funding, state-of-the-art infrastructure, and fostering effective collaboration***. The National Geoscience Awardees and their respective organizations, engaged in mineral exploration and mineral beneficiation fields, should be held accountable for discovering critical and strategic mineral deposits and developing optimal mineral beneficiation techniques.

- Editor

EDITOR

Dr. P.V. Rao
Off. : +91 (040) 23200510
Cell: +91 96180 91039
Email: editor.mej.meai@gmail.com

PUBLISHER

M. Narsaiah
Secretary General,
Mining Engineers' Association of India
Cell: +91 9177045204 / 7382087618

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NEWS FROM THE MINERAL WORLD

India to open its 1st lithium mines in Chhattisgarh after GSI confirmation

India is set to open its first lithium mines in the Katghora region of Korba district, Chhattisgarh, following the Geological Survey of India (GSI) confirming significant lithium reserves, according to a report by Times of India.

The announcement was made during the sixth governing body meeting of the National Mineral Exploration Trust in New Delhi. The GSI reported lithium concentrations ranging from 10 to 2,000 parts per million (PPM) over approximately 250 hectares, with the possibility of even higher concentrations.

Union Minister G Kishan Reddy chaired the meeting, which focused on the extraction and utilisation of minerals while also considering environmental conservation, the report stated. State health minister Shyam Bihari Jaiswal attended the meeting on behalf of Chief Minister Vishnu Deo Sai.

TOI quoted Jaiswal as saying that the opening of the lithium mine in Chhattisgarh would position the state as a key contributor to India's goal of becoming a developed nation by 2047.

The Ministry of Mines has issued a Notice Inviting Tender (NIT) on the Metal Scrap Trade Corporation (MSTC) portal for the allocation of 20 blocks containing critical and strategic minerals across various states, including Bihar, Gujarat, Jharkhand, Odisha, Tamil Nadu, Uttar Pradesh, Jammu and Kashmir, and Chhattisgarh. These blocks will be allocated through an e-auction process, reported *TOI.*

Among these 20 blocks is the lithium and Rare Earth Element (REE) block in the Katghora area. Preliminary surveys by the GSI revealed lithium concentrations between 10 and 2,000 PPM in an area of about 250 hectares, which also contains rare earth elements.

Critical and strategic minerals are essential for sectors like renewable energy, defence, agriculture, pharmaceuticals, high-tech electronics, telecommunications, and transportation. Currently, India relies heavily on imports for these minerals.

BS, Abhijeet Kumar, New Delhi | Aug 14, 2024

Geological Survey of India teams win big at National Geoscience Awards 2023

President Draupadi Murmu presented the awards at the Rashtrapati Bhavan Cultural Centre on Tuesday. This year, 12 awards, including three team awards, were presented to 21 geoscientists.

The Lifetime Achievement award was presented to Dhiraj Mohan Banerjee, geologist specialising in Precambrian sedimentology and formerly associated with the GSI.

Constituted in 1966 by the Ministry of Mines, National Geoscience awards is one of the oldest awards in the country which recognises the efforts of both individuals and teams working in the area of mineral discovery and exploration, mining technology, mineral beneficiation, applied geosciences among others.

The winners of the team award in the category of mineral discovery and exploration is the GSI teams, including Abhishek Kumar Shukla, Danira Stephen Dsilva, Parsuram Behera, M N Praveen and Sanjay Singh, Shailendra Kumar Prajapati, Shashank Shekhar Singh and Kevinguzo Chasie. Another GSI team that won the award in the Basic Sciences category include Krishna Kumar, Pragya Pandey, Triparna Ghosh and Debasish Bhattacharya.

Among the individual awardees, include Pawan Dewangan from National Institute of Oceanography; Harsh Kumar Verma, CSIR- Central Institute of Mining and Fuel Research; Narasimha Mangadoddy, IIT-Hyderabad; Rahul Mohan from National Centre for Polar and Ocean Research; Vikram Vishal, IIT-Bombay; Bantu Prasanta Kumar Patro, National Geophysical Research Institute and Srimanth Tirumala Gudemella Raghukanth, IIT-Madras.

The Young Scientist Award has been presented to Ashutosh Pandey, Indian Institute of Science Education and Research (IISER), Thiruvananthapuram.

The Indian Express , Bengaluru | August 21, 2024

Coal India looking at acquisition of critical minerals, says Chairman P M Prasad

Coal India Limited (CIL) is actively pursuing acquisition of critical minerals, including lithium, in the domestic market and overseas and will continue to take part in the auction of such blocks, the chairman of the world's largest coal producer said on August 21.

Critical minerals, including lithium, play a crucial role in the production of clean energy technologies, from wind turbines to electric cars. They are particularly in demand for the production of batteries for electric cars.

"With an objective to reduce the import dependence of critical minerals like lithium, cobalt, CIL is actively pursuing acquisition of these mineral assets in India and abroad," CIL Chairman P M Prasad said during 50th Annual General Meeting of the company.

CIL, he said, will continue to participate in e-auction of critical mineral blocks offered by the Mines ministry.

CIL has successfully opened its account in domestic critical mineral asset, emerging as the preferred bidder for Khattali Chotti graphite block in Alirajpur district of Madhya Pradesh, he said. It would be the company's first ever non-coal mineral mining venture.

Moneycontrol / August 21, 2024

➤ **Centre can lower royalties to minimise impact on mining companies post Supreme Court ruling: Ambit Capital**

New Delhi: Ever since the Supreme Court ruled that states can levy taxes on mining retrospectively from April 1, 2005, experts have been arguing that operating costs of Indian mining companies are likely to rise significantly post the apex court ruling.

Financial advisory firm Ambit Capital, however, citing a precedent, argues that there is a silver bullet that could somewhat minimize the net impact to companies from prospective dues. The financial advisory firm says that the Union Government can lower the royalty rate on mining to compensate companies.

"And there's a good precedent to it. When India Cement judgement took away state's power to levy tax, Union Government raised royalty rates multi-fold in 1991 in order to compensate states for the losses. And that's why we have the royalty rates where they are today," Ambit Capital said. In case states start levying taxes retrospectively, Ambit Capital said there is no need for royalties at current rate. "The Union Government can easily lower these rates. That doesn't even require Parliament approval."

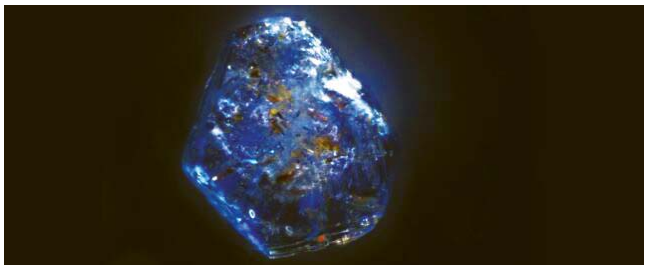
"Interestingly, since WB (West Bengal) has been collecting mining tax all these years, it's the only state that is deprived of enhanced royalty rate that was allowed in 1991. That's as clear a precedent as one needs. Therefore, net impact to companies from prospective dues would most likely be minimal," Ambit Capital said. On August 14, the Supreme Court ruled that mineral-rich states can collect past dues on royalty and taxes on mines and mineral-bearing land from April 1, 2005, from both the Centre and mining lease holders.

A nine-judge Constitution bench has directed that the past dues be paid in a staggered manner over the next 12 years, starting from April 1, 2026. On Monday, Fitch Ratings said operating costs of Indian mining companies are likely to rise significantly if states impose additional mining taxes, as allowed by the Supreme Court in the recent judgment. At the same time, Fitch expects limited financial impact on mining companies as the payment of past dues are to be paid in a staggered manner in a long time frame of 12 years. S&P Global Ratings had earlier asserted that a shift in the tax landscape for mining companies would have a pass-on effect on steel and other industries, and ultimately on the Indian consumer.

ANI / Aug 20, 2024

➤ **The Mysterious Origins of Sapphires Have Finally Been Deciphered**

Glittering blue sapphires, so suggestive of piercing cold, have remarkably hot origins deep beneath the surface.



One of the sapphires, just 0.9 millimetres across, from the Volcanic Eifel. (Sebastian Schmidt)

For years, sapphires been turned up in volcanic deposits such as the Volcanic Eifel, where magma from Earth's mantle wells up into the crust over a long period of time, producing melts that are rich in sodium and potassium. Yet others are found in river beds, the robust crystals scoured clean of their source rocks.

While volcanism clear seems to play some kind of role, the exact provenance of these sapphires deep in our planet's ovens was something of a mystery, with geologists unable to determine with certainty whether they form solely in the mantle itself or are baked out of other minerals on the magma's ascent.

New research has found evidence that the azure gems can be forged in the fire and fury of volcanic upheaval as extreme processes heat and compress aluminum oxide within the crust into a crystalline form called corundum; the main mineral that makes up sapphires.

"One explanation is that sapphire in the Earth's crust originates from previously clayey sediments at very

high temperatures and pressure and the ascending magmas simply form the elevator to the surface for the crystals," explains geologist and petrologist Axel Schmitt of Curtin University in Australia.

The researchers wanted to know whether this was the case, that the sapphires formed in the upper mantle or lower crust and were picked up and borne upward by magma pushing its way towards the surface from below. To do this, they had to study the sapphires themselves.

They collected 223 microscopic sapphires from Eifel, and subjected them to secondary ion mass spectrometry. They were looking at two different characteristics: inclusions of rutile and zircon trapped in the sapphires as they formed, and the ratios of oxygen isotopes in the aluminum oxide.

Now, sapphires are predominantly made up of aluminum oxide in the form of corundum, but other elements can become mixed in.

The deep blue hue that sapphires are known for comes from titanium and iron tinting the corundum, for example. Iron on its own makes yellow sapphires and can also give us green stones. Chromium turns the corundum pink or red, and that's how we get rubies.

What's more, whole other minerals – such as rutile (titanium dioxide) and zircon – can get trapped within sapphires as they form.

Scientists can then use these minerals to determine when the crystal bloomed. That's because as these rutile and zircon form, they incorporate uranium, which then undergoes radioactive decay at a known rate. Scientists can study the ratios of uranium to lead inside the rocks to determine how long that uranium has been decaying.

In addition to the uranium, the researchers studied the sapphires' oxygen isotope ratios. An isotope is a form of an atom with a different number of neutrons, and there were two isotopes relevant to the study. Oxygen 16, with 8 protons and 8 neutrons, is the lighter isotope, and the most abundant form of oxygen on Earth. Heavier oxygen-18 has 8 protons and 10 neutrons, and is more abundant in minerals from the deep crust than in minerals from the mantle.

By studying the ratios of these isotopes, the researchers were able to determine that the Eifel sapphires had oxygen ratios that could be traced both to the mantle and to the crust.

Meanwhile, the uranium-lead dating showed that they formed at the same time as volcanism that delivered them to the surface.

Taken together, this suggests that the sapphires formed in the upper crust, no more than 7 kilometres (4.3 miles) below the surface. Some of this formation was from mantle magma melting the rock as it moved through, transferring mantle isotope ratios to the corundum. Other sapphires formed as melt permeated the rock around it, triggering sapphire formation via heat, resulting in gems with isotope ratios more typical of a crustal origin.

"In the Eifel, both magmatic and metamorphic processes, in which temperature changed the original rock, played a role in the crystallization of sapphire," explains geoscientist Sebastian Schmidt of Heidelberg University in Germany.

Nature, Michelle Starr | 18 August 2024

➤ **In a first, CIL to pay penalty for non-supply of e-auctioned coal**

CIL has started online signing of fuel supply agreements (FSAs), which is also being extended to include the SHAKTI B auctions | Photo Credit: AMIT DAVE/ REUTERS

In a historic step, the government has mandated that Coal India (CIL) which accounts for around 80 per cent of India's production and despatch — will now have to pay a penalty if it fails to supply coal procured by consuming industries through e-auctions.

Besides, aiming to enhance the ease of doing business, particularly for non-regulated sector (NRS) industries, CIL has started online signing of fuel supply agreements (FSAs), which is also being extended to include the SHAKTI B auctions.

These developments are part of Tuesday's announcement by the mining behemoth that power plants, including independent power producers (IPPs), will be supplied coal beyond their annual contracted quantity (ACQ).

In FY24, of the total 972.60 million tonnes (Mt) coal production, the despatch to power sector stood at 809.64 Mt (up 8.78 per cent y-o-y) and supplies to NRS was at 162.96 Mt (up by 22.32 per cent y-o-y). Coal share of the power sector stood at 83.24 per cent and that of NRS was 16.76 per cent.

Ease of doing business

A top government official said, "Consumer is king and we want to impress this upon everyone in the coal sector. CIL used to forfeit security deposits, which was earlier ₹200 a tonne before being raised to ₹500. But it has been slashed to ₹150 based on market movements and auction premiums.

"Now with a penalty for CIL for non-supply, the government is making contracts equitable and fair. Earlier there was no penalty on CIL if it failed to supply coal. This will also boost supplies to NRS industries, which have been complaining for long about reduced supplies and priority given to the Power sector."

Another senior official pointed out that India's coal production is increasing at a healthy pace and is expected to hit 1,080 mt by March 2025. The Ministry wants to ensure that higher quantities produced are consumed and miners are not left with supplies lying at pit heads, thereby leading to loss of income and wastage of the mined resource.

Online signing of FSAs, said another source, is a game-changer.

"Earlier consumers had to physically go to the coal companies' office to sign FSAs. Now, CIL has been signing FSAs of NRS consumers from VII Tranche of e-auctions. That apart, it is also being implemented for SHAKTI B (VIII) (a) auctions that are held about seven times annually," he added.

Focus on NRS

The Ministry has now started focusing on meeting requirements of the NRS customers, which includes captive power plants, steel, cement, sponge iron, etc. — important building blocks in India's expanding infrastructure and manufacturing base.

The traditional method was that coal was first supplied to the power sector and after meeting their demand, the requirements of the NRS industries were met, an official said.

"But this year, coal is in abundance. So, there are no restrictions or priority to power as there are good stocks at their end, from April till now. Resultantly for NRS industries, the supplies this fiscal so far are around 20 per cent higher y-o-y," he added.

The Ministry is now planning to offer long-term coal linkages to NRS consumers, without end use restrictions, a move that will not only boost supply of the critical fuel but also aid companies in better planning of the key resource.

Sources said the Ministry is already "contemplating" the proposal. Currently, it is holding stakeholder consultations on this issue. Accordingly, it is planning to amend the NRS linkage auction policy of 2016. Long-term coal linkages without end use restrictions has been a long standing demand by NRS consumers.

Rishi Ranjan Kala, Business line | August 15, 2024

➤ Govt awards 18 of 28 coal mines to leading private mining companies

The engagement of these mining developers-cum-operators (MDOs) promises to make substantial contributions to coal production.

The government on Tuesday said of the 28 coal mining projects identified to be operated through mining operators-cum-developers, 18 mines have been awarded to leading private firms.

The engagement of these mining developers-cum-operators (MDOs) promises to make substantial contributions to coal production, ensuring both enhanced output and operational excellence.

"Initially, CIL (Coal India) identified 15 coal mine projects with a combined capacity of 168 MT (million tonnes) for MDO implementation. This number has now expanded to 28 projects (18 opencast and 10 underground mines) with a total capacity of 257 MT.

As of today, 18 mines have been awarded to leading private parties, marking a significant milestone in this ambitious endeavour," the coal ministry said in a statement.

The primary goal of engaging MDOs is to significantly increase coal production by streamlining operations, enhancing productivity, and reducing mining costs.

These operators, selected through open global tenders, will oversee the entire mining process, from excavation and extraction to the delivery of coal, in line with the agreement, the statement said.

Press Trust of India New Delhi | Aug 13 2024

➤ India to offer incentives for critical minerals extraction, govt source says

India plans to provide funding for research institutes to give technical assistance to miners, according to a government source and a letter reviewed by Reuters, to try to develop a critical minerals industry.

The funding illustrates the efforts India is making to get the critical mineral industry off the ground and cut the country's near-total reliance on imports of lithium and rare earths mineral that are key to energy transition technologies.

So far, India's attempts to create a critical minerals mining industry have faltered. The country awarded development rights in June to a lithium block in Chhattisgarh state but a separate attempt to auction lithium blocks in Jammu and Kashmir found no takers because of low mineral concentration and high extraction costs.

The government could spend nearly $50 million to fund collaborations between research institutes and companies to develop extraction technology and better methods of beneficiation, or the improvement of mineral ores before processing into metals, according to a government source involved in the matter.

In a July 11 letter, the Ministry of Mines asked the CSIR-National Institute for Interdisciplinary Science and Technology (NIIST) to provide miners with know-how to extract critical minerals.

"The blocks auctioned by the central government contain critical minerals associated with other minerals and/or metals that need tailor-made case-specific extraction techniques," it said.

"As most of the critical minerals are not extracted in the country, the economical and successful extraction of these critical and strategic minerals by companies requires support and guidance on extraction and beneficiation techniques," it said.

The government source said similar letters were sent to five other research institutes in India the same day. The government will invite joint proposals from institutes and companies and those approved will get up to 75% of the total funding, said the government source, declining to be named as they were not authorised to talk to the media. The Ministry of Mines and NIIST did not immediately respond to Reuters' emails for comment.

Reuters | Aug 13, 2024

➤ **Big Win For Mineral Rich States In Court, Can Collect Past Dues On Royalty**

The court ordered that states can impose levies with effect from April 1, 2005 and the payments will be staggered in 12 years.

New Delhi: The Supreme Court today allowed mining-rich states to collect past dues on royalties from mining companies. The court ordered that states can impose levies with effect from April 1, 2005 and the payments will be staggered in 12 years.

The bench, however, directed the states to not impose a penalty of any kind on payment of dues.

The Centre has opposed the demand of states for refund of royalty levied on mines and minerals since 1989, saying it will impact the citizens and the PSUs will have to empty their coffers by 70,000 crore according to initial estimates.

CJI Chandrachud said this verdict will be signed by eight-judges of the bench who by majority decided the July 25 judgement giving the state's power to levy taxes on mineral rights.

He said that Justice Nagarathna will not sign Wednesday's verdict as she had given a dissenting view in the July 25 verdict.

Last month, the Supreme Court upheld state governments' right to levy royalty on mineral-bearing land, reasoning they had the competence and power to do so.

The landmark 8:1 verdict was delivered by a bench led by Chief Justice DY Chandrachud, which ruled 'royalty' is not the same as 'tax'; Justice BV Nagarathna delivered the dissenting verdict.

The verdict will benefit mineral-rich states like Odisha, Jharkhand, Bengal, Chhattisgarh, Madhya Pradesh, and Rajasthan, as their governments can now charge additional levies on mining companies operating in their territories.

PTI | August 14, 2024

➤ **JSW Steel submits notice to surrender lease of iron ore block in Odisha**

JSW Steel has submitted a notice to surrender a mining lease for a block in Odisha, citing "uneconomic operation". Jajang iron ore block in Keonjhar is one of the four iron ore mining leases that were acquired through an auction in 2020, JSW Steel said in a regulatory filing on Saturday.

"JSW Steel due to un-economic operation, has submitted a notice for surrender of mining lease on August 3 in respect of Jajang Iron Ore Block…," it said.

The proposed surrender of the aforesaid mining lease is subject to requisite approvals, JSW Steel said.

CNBCTV18.com | August 4, 2024

➤ **World's largest iron ore deposits formed over 1 billion years ago in supercontinent breakup**

Huge iron ore deposits in Western Australia's Hamersley Province formed when major tectonic events led to

the breakup of supercontinent Columbia and to the amalgamation of Australia.

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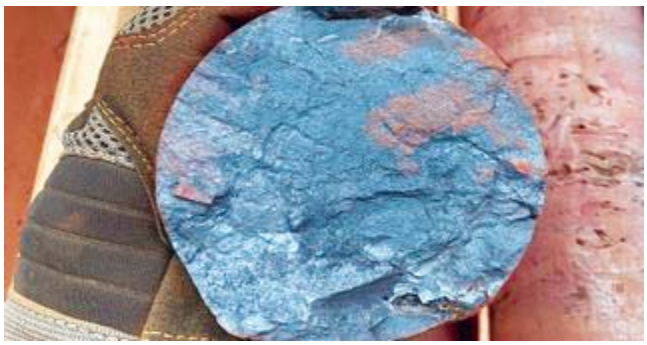

A core of 1.3 billion-year-old deep blue iron ore from the Hamersley Province. (Image credit: Liam Courtney-Davies, Curtin University)

The world's largest iron ore deposits formed when the ancient supercontinent Columbia broke up around 1.4 billion years ago, a new study suggests.

The deposits, located in what is now Hamersley Province in Western Australia, sit on a chunk of Earth's crust known as the Pilbara Craton. The Pilbara Craton is one of only two pieces of crust known to date back to the Archaean Eon (3.8 billion to 2.5 billion years ago) and hosts some of the oldest rocks on our planet. (The other Archaean crust is the Kaapvaal Craton in southern Africa.)

Rocks in the Pilbara Craton have witnessed the birth and breakup of several supercontinents, meaning they hold clues about the origins of the region's rich mineral deposits, researchers said in the new study. In particular, the breakup of supercontinent Columbia, which existed between 1.7 billion and 1.45 billion years ago, and the subsequent amalgamation of Australia between 1.4 billion and 1.1 billion years ago, could explain how huge iron ore reserves formed in the Hamersley Province.

"The energy from this epic geological activity likely triggered the production of billions of tons of iron-rich rock across the Pilbara," study lead author Liam Courtney-Davies, a geochronologist and postdoctoral associate at the University of Colorado, Boulder, said in a statement.

The Hamersley Province holds more than 55 billion tons (50 metric gigatons) of iron ore, which geologists previously thought formed around 2.2 billion years ago. But based on direct dating techniques, the new study found the deposits are actually much younger than that, forming between 1.4 billion and 1.1 billion years ago.

To pinpoint the age of the deposits, Courtney-Davies and his colleagues dated minerals in eight banded iron formations — giant blocks of sedimentary rock that feature alternating layers of iron oxides, such as magnetite and hematite, and iron-poor minerals like chert. The researchers used a new geochronology technique that involved analyzing uranium and lead isotopes within iron oxides in the rock, which gave researchers the first ever direct age measurements for the Hamersley Province deposits.

The measurements revealed the iron ore formed around the same time that supercontinent Columbia, also known as Nuna, was breaking up to give rise to a primitive Australian continent.

A satellite image of the Pilbara Craton in Western Australia. (Image credit: NASA/ Alamy Stock Photo)

"Our research indicates these deposits formed in conjunction with major tectonic events," study co-*author Martin Danisik, an* associate professor of geology at Curtin University in Australia, said in the statement.

These tectonic events would have taken place across the entire Pilbara Craton, providing the huge amounts of energy required and forcing enough mineral-rich fluid from deep underground to form the massive deposits, according to the study.

The findings could help geologists locate other iron deposits in the future. Iron ore is an essential ingredient in the production of iron and steel. As such, resource exploration companies are always searching for new iron ore deposits that they can mine.

(Continued on Page 37)

DISTINGUISHING ROLES AND RESPONSIBILITIES OF EXPLORATION GEOSCIENTIST AND MINING GEOLOGIST – PERSPECTIVES ON EMERGING CHALLENGES

Dr Sudesh Kumar Wadhawan

Abstract

The article briefly examines the relationship between Exploration Geoscientists (EG) and Mining Geologists (MG) that play distinct yet interconnected roles in the mineral exploration and mining industry. The roles of exploration geologist and mining geologists are essentially interlinked and build-up on each other's outputs. Understanding this dynamic relationship is crucial for successful and sustainable mining operations. Nevertheless, EGs utilize applied aspects of mineral exploration and exploitation, including mineral deposit modeling, geology, geochemistry, and geophysics, mining geology, mineral resource appraisal, estimation and reporting methods, environmental geology, and case histories are studied for geoscientific baseline data generation and integration. These attributes are evaluated prior to the next stage of mining or mineral exploitation, where the roles of mining geologist and mining engineer assume greater significance. Perspectives on emerging challenges, roles and responsibilities for the EG and MG are elucidated and ways forward suggested in this article.

Keywords: *Exploration Geoscientists, Mining Geologists, data integration, emerging challenges and remedies*

1. INTRODUCTION

Mining and geology are interconnected disciplines that play a fundamental role in the extraction of valuable resources from the Earth's crust. The purpose of geological exploration is to locate areas where mineral and petroleum resources may be present, to establish the quality and quantity of those resources, and to investigate the viability of extracting the resource. There are a range of activities that may be carried out as part of a geoscientific exploration program. These activities depend on a number of factors, including the nature of the mineral being sought and the geology of the area. Exploration generally starts with low impact activities to determine whether signs of minerals or petroleum are evident in a two-dimensional geological map before progressing to third dimensional subsurface probes, including more intense and costly activities such as pitting, trenching, drilling and bulk sampling. Exploration Geoscientists (EG) are majorly tasked with identifying areas with potential mineral resources. They use various methods such as geological mapping, geochemical analysis, geophysical surveys, and drilling to assess the presence and extent of economic mineral deposits. Exploration geologists' resort to conducting fieldwork to collect detailed geological data, analysing geological maps and satellite imagery, assessing the economic viability of potential mining sites, planning and overseeing drilling programs to collect core samples and interpreting data to create ore-body configuration and 3-D geospatial models of potential mineral deposits. All these geoscientific activities will necessarily require very strong fieldwork skills, geological knowledge, proficiency in data analysis and interpretation, familiarity with geological and data-mining software and analytical mapping tools.

On the other end, Mining Geologists (MG) work on-site to optimize the extraction of mineral resources. They are involved in the planning, development, and production phases of mining operations. Activities of a mining geologist involve collaborating with engineers and other professionals to design mine-plans; monitoring geological conditions in active mining areas, analysing ore quality and providing guidance for optimal extraction methods, conducting geological surveys to identify potential risks or opportunities for optimization and finally contributing to mine rehabilitation and closure plans. These professional skills and traits of a successful mining geologist require strong understanding of mining techniques and equipment, knowledge of ore body behaviour, ability to collaborate with multidisciplinary teams, proficiency in data analysis for production optimization. It is remarkable that mining geology is taught as structured course in only a few universities in India particularly in IIT-Dhanbad School of Mines and BHU, but mostly as part of the Applied Geology courses in several other IITs and leading Universities (Skill Plan for Mining Sector, Ministry of Mines, 2016; Monteiro et al. 2019; Wadhawan, 2017; 2023).

Although both the roles are critical for the mining industry, as exploration lays the foundation for future mining projects, while mining geology ensures the efficient and sustainable

Former Director General, Geological Survey of India, Adjunct Professor, Center for Wireless Networks & Applications (WNA) Amrita Vishwa Vidyapeetham, Amritapuri, India, wadhawansk.leo@gmail.com

extraction and utilization of mineral resources, the key differences include attributes such as: core geoscientific activities, focus and location of operational performance. In simple understandable terms Exploration Geologists focus on discovering new mineral deposits, while mining geologists concentrate on optimizing the extraction of known deposits; EGs spend much of their time in the field whereas mining geologists typically work at mine sites. Nonetheless. Their common objective remains central to augmenting mineral resources for sustainable development (Monteiro et al. 2019; Chatterjee, 2022).

India, with a mining history of over 3000 years, dating back to the days of the Indus-Saraswati (Harappan) civilization, produces as many as 95 different minerals commodities, including 4 fuel, 10 metallic, 23 non-metallic, 3 atomic and 55 minor minerals (including building and other materials), and produces about 5 billion tonnes of ore minerals annually. India has been self-sufficient in bulk mineable commodities required for the nation's infrastructure development, e.g., iron ore, bauxite, limestone, coal, manganese and chromite and leader in production of zinc and chromium ores in the world. However, India continues to import many ore minerals where large internal demands exist, including metallurgical grade coal, gold, copper, diamond, platinum group elements (PGE), coloured gemstones, fertilizer commodities like potash, phosphates and others (Ministry of Mines, 2022; 2023).

The Indian mining industry is characterized by a large number of small operational mines. The number of mines which reported mineral production (excluding atomic, fuel, and minor minerals) in India was 1319 in 2021-22 as against 1375 in the previous year. Out of 1319 reporting mines, most of the mines reported are in Madhya Pradesh followed by Gujarat, Karnataka, Odisha, Chhattisgarh, Andhra Pradesh, Rajasthan, Tamil Nadu, Maharashtra, Jharkhand and Telangana. Urbanisation and economic growth with rising aspirations for modern standards of living would require increasing use of strategic and energy critical minerals and special metals, like lithium, niobium, tantalum, rare earth, vanadium, zircon, tin, tungsten, elements of platinum group, nickel, cobalt, cadmium, scandium, molybdenum, rhenium, etc. (USGS, 2023). Mineral commodities for most of these metals have significant exploration potential in India's fascinatingly diverse geological set-up, but are yet to be explored in detail. Mineral resources in particular need to be extracted in ways that are economically feasible, environmentally sound and socially responsible (Wadhawan, 2017; 2021; Ministry of Mines, 2023). Besides, National Geoscience Data Repository (NGDR) is a flagship initiative conceptualised by Ministry of Mines as a part of National Mineral Exploration Policy (NMEP), 2016 for hosting all exploration related geoscientific data for dissemination to all the stakeholders so as to expedite, enhance and facilitate the exploration coverage of the country. Geological Survey of India is selected as the nodal agency for the implementation of NGDR (Ministry of Mines, 2022).

As per World Mineral Production, 2016-20, British Geological Survey, India's ranking in 2020 in world production in term of quantity was 2nd in Steel (crude/liquid) followed by 3rd in Zinc (slabs) and aluminium (primary); 4th in chromite and iron ore; 5th in Manganese ore; 6th in Bauxite; 7th in copper (refined); 15th in apatite & rock phosphate; and 17th in magnesite. Tata Steel Ltd is India's leading mining company based on revenue in 2024, with a revenue of around 28.1 billion U.S. dollars. In second place has been occupied by the Hindalco Industries Ltd, with a revenue of nearly 27 billion U.S. dollars (Ministry of Mines, 2023). International concern for augmenting mineral security and search for new mineral deposits stems from the fact that known shallow depth mineral occurrences are fast getting depleted and in order to sustain their current living standards, it is imperative to locate and exploit new mineral resources. Odisha is presently recognized as the Mineral State of India because it contributes significantly to the country's mineral production. The state is rich in various minerals like iron ore, manganese, chromite, bauxite, and limestone. Odisha also hosts the largest coal deposits in areas like Angul and Jharsuguda. It is remarkable to record that these achievements have been possible due to dedicated contributions of highly skilled field geoscientists, mining geologists, engineers and entrepreneurs. However, R&D projects need to be initiated/ funded for recovery of Indium from the sphalerite ore and Ge from Pb-Zn circuit and REE recovery from Khondalite or similarly low value minerals. Beneficiation of lean / scattered strategic minerals and development of mining techniques such as In-situ leaching and Electro-kinetic mining needs to be taken up for exploitation of lean and scattered strategic mineral occurrences

In today's information-driven age and enhanced digitization and use of geospatial tools, credible high quality geoscientific information is not only useful in providing metrics that determine better ways to engage or work for mining sector businesses, but it is of utmost importance for organizations and managers to take informed decisions for improved productivity. Although EG and MG have been carrying out significant responsibilities for the growth of the mining sector, in view of the advancements in technology and emerging challenges in the field, this paper elucidates my perspectives on the need for their integrated involvements and upgrading their skills and application of advanced technology.

2. METHODOLOGY

Present contribution is prepared based on personal field surveys, mineral investigations and visit to several mining centres, interactions in Conferences and extensive literature survey, appropriate integration of culled data in insightful

ways to provide a considered perspective on roles and responsibilities of EG and MG and emerging challenges of advancement in modern technology to achieve sustainable growth with integrated application of applied geoscience concepts and zero-waste green mining practices.

3. ROLES AND RESPONSIBILITIES OF EXPLORATION GEOSCIENTIST AND MINING GEOLOGIST

3.1 Exploration Geoscientist (EG)

Earth science or the Geology employs scientific methods and principles to understand geological phenomena, such as rock formation, mineral composition, fossil records, plate tectonics, and geological hazards. Geologists use observational, experimental, and analytical techniques to gather data, formulate hypotheses, and make interpretations about the Earth's past, present, and future. Exploration geologists are involved in data collection, analysis, and resource estimation, and data integration. They often work in remote locations and need to be adaptable to different environmental conditions. Therefore, the ultimate goal of exploration geologists is to locate mineral deposits that can be developed into profitable mining operations. Geoscience is primarily a field science where actual observations on the material and natural phenomenon are recorded and mapped. They investigate how rocks were formed and what has happened to them since their formation. Exploration geologists and mining geologists both work in the field of geology, but focus on different aspects of the mining industry.

Geological mapping is carried out by walking over the ground of interest and systematically recording field observations. Geologists observe the location, structural orientation and characteristics of rocks or sediments exposed at the surface. This information is used to prepare a geological map of the area, recording the rock types and structures. Similarly, geochemical surveys are generally undertaken to interpret geochemical anomalies and target areas for further exploration. The surveys usually involve collecting samples of soils, rocks and/or sediments. These samples are subject to chemical analysis at a laboratory. Representative fractions of these samples are geochemically evaluated using portable X-ray fluorescence and inductively coupled plasma-mass spectrometry elemental analytical methods, etc. Besides, soil and subsoil sampling are usually carried out using hand-held tools such as shovels, picks and hand augers. Samples are usually collected in a grid pattern and involve collecting small (approximately one kg) samples of soil. Holes and pits excavated during the program are usually back-filled immediately following sampling to avoid any accidental mishaps.

Exploration geophysical surveys include application of exploration geophysics which is an applied branch of geophysics and economic geology, that uses physical methods at the surface of the Earth, such as seismic, gravitational, magnetic, electrical and electromagnetic, to measure the physical properties of the subsurface, along with the anomalies in those properties. Exploration geophysics can be used to directly detect the target style of mineralization by measuring its physical properties directly. For example, one may measure the density contrasts between the dense iron ore and the lighter silicate host rock, or one may measure the electrical conductivity contrast between conductive sulphide minerals and the resistive silicate host rock. Geophysical surveys assist in mapping different rock types and can help identify resources without the need for direct observation. Multi-parametric geophysical surveys/mapping include systematic recording of different gravity, magnetic, electromagnetic, radiometric, seismic surveys, etc., that record and analyse physical properties of the Earth, and have different applications and equipments. Geophysical surveys can be conducted from the air, at surface, and down drill holes. They include:

Airborne Surveys. They are typically undertaken using low-flying helicopters or aircraft which fly in a grid pattern. The instruments may be either mounted on or towed beneath the aircraft. Depending on the type of survey, the aircraft may fly between 25 m and 60 m above the ground, with flight lines spaced between 25 m and 200 m apart. Recent advancements in geophysical exploration have been realized through reliably integrating unmanned aerial vehicle platforms with lightweight, high-resolution magnetometer payloads. Unmanned Aerial Vehicle (UAV) aeromagnetic surveys can provide a contemporary data product between the two end-members of coverage and resolution attained using manned airborne and terrestrial magnetic surveys. This new data product is achievable because unmanned aerial vehicle platforms can safely traverse with magnetometer payloads at flight elevations closer to ground targets than manned airborne surveys, while also delivering an increased coverage rate compared to walking conventional terrestrial surveys. This is a promising new development for geophysical and mineral exploration applications, especially in variable rugged terrains. GIS based integrated and enhanced interpretation potential provided by this approach can also aid in delineating structural controls and hydrothermal fluid migration pathways (e.g., a pair of adjacent shear zones) related to for instance, the gold and base-metal mineralization on site. It is therefore essential to integrate the results of geophysical and geological surveys for appropriate interpretation of geoscientific variables. As a dynamic monitoring tool, UAV survey related activities have proved to be useful in identifying ongoing mining activities in accordance with the leasehold areas. Indian Bureau of Mines (IBM) has also issued Standard Operating Procedures under sub rule (5) of rule 34A of MCDR, 2017 for carrying out drone surveys and submission of Digital Aerial Images of Mining areas to IBM. A register of receipt

of drone/ satellite data submitted by the lessees under rule 34A of MCDR 2017 is being maintained at IBM (Ministry of Mines, 2023).

At times where obtained geophysical data may not be positively matching with sub-surface geological probes by exploration geologists, it becomes imperative to go deeper into the details to learn from such lack of success and account for the availability or absence of the appropriate geophysical signals.

3.1.1 National Mineral Exploration Trust (NMET)

The National Mineral Exploration Trust (NMET) was established by the Government of India vide Gazette Notification in August 2015, in pursuance of subsection (1) of Section 9C of the Mines and Minerals (Development and Regulation) Act, 1957, with the objective to boost the regional and detailed mineral exploration activities, particularly through financial assistance and participation of recognised/ Notified Private Exploration Agencies (NPEAs and junior mineral exploration aspirants. NMET has disbursed 120 crore for exploration / financial assistance and procurement of machinery equipment, projects of baseline data generation, incentive to state governments for successful auction of mineral blocks and advance for newly sanctioned 51 projects. NMET has announced an Exploration Incentive (EI) of 25% of the approved cost of the project for G4 items in Greenfield areas for gold, base metals, other precious minerals, strategic/ critical minerals and fertilizer minerals. Exploration Incentives will be paid if the block is successfully auctioned or upgraded from G4 to G3 Stage (Ministry of Mines, 2022).

3.1.2 Upgradation of Laboratory Analytical Techniques and Equipments

Exploration Geoscientists also understands the nuances of formation of economic metallic mineral deposits or ore-genesis that is invariably the result of a complex interplay of magmatic, tectonic and hydrothermal processes that are recorded by the trace element composition of ore minerals. Various trace elements of geochemical affinity are incorporated into minerals during the ore-forming process through a variety of mechanisms, either as inclusions or substitutions within the crystal structure, and changes in their geochemistry over time can indicate changes in the fluid and metal sources or variations in the physicochemical conditions during ore formation. The geochemical signature of minerals, if well understood, may be used in exploration as a vectoring tool towards high-grade mineralization (Keith et al. 2023). Many of these elements are often identified as “critical” due to growing demand caused by their specific application in electronics and renewable energies and potential supply chain disruption. Improved knowledge of trace element behaviour during ore formation and throughout the extraction process is therefore crucial for building a sustainable resource utilisation and future of the mining industry (Ministry of Mines, Critical Minerals for India, 2023b). However, this requires a detailed mineralogical and geochemical characterization at the micro- and nano-scale. This is an emergent challenge that would be addressed through upgradation of skilled man-power and well-equipped laboratories. Lackadaisical and slow laboratory support are impediments to targeted mineral exploration programmes and needs to be countered with modernisation of the sample processing (rock pulverisers, etc.).and analytical facilities. Upgradation of laboratory analytical techniques has been a continuing process in GSI to adopt the advanced technology for quick and reliable results through development of robust R&D infrastructure in the form of National Centre of Excellence in Geoscientific Research (NCEGR) situated in Kolkata, Bangalore and Delhi NCR (Faridabad) and six regional laboratories across the country. These centres are well equipped with state-of-the-art laboratories and trained geoscientists. Besides regular R & D, it is incumbent upon EGs to resort to critical review of literature, particularly references on published case studies on economic geology and mining technology which are important attributes and in-built positive and daring attitude of successful exploration geoscientists.

3.2 Mining Geologist

Mining geologists are involved in the extraction and production phases of mining operations. They work on-site at operating mines to ensure the efficient extraction of minerals while minimizing environmental impact. Their role and responsibilities include monitoring ore quality, designing and implementing drilling and blasting plans, providing geological input for mine planning, and ensuring compliance with safety and environmental regulations. However, additional interpersonal skills are valued amongst mining geologists as they will require to be multi-tasking and need a strong understanding of both geological principles and mining engineering concepts. While mining geologists are more involved in operational aspects such as mine planning, production monitoring, and ore quality assessment, and post-mining sequential land use / land cover planning and restoration for regional development and environmental sustainability, they must also be able to collaborate with mining engineers, technicians, and other professionals to optimize mining processes and production. As the mining advances MG is subject to evaluation of their interpretation skills for inherently variable geoscientific attributes and geospatial behaviour of ore-deposits. Mining geologists aim to maximize the recovery of valuable minerals from ore deposits while minimizing costs and environmental impact.
Mining Geologists also play a crucial role in assessing geological hazards that may pose risks to mining operations. This includes identifying unstable rock formations, potential seismic activity, and the presence of hazardous materials. Their geoscientific insights inform safety protocols and

risk management strategies. From conducting geological surveys, analysing remote sensing data, and performing geochemical sampling to overseeing core drilling operations and creating geological models, geologists play a central role at every stage of mining operations. Recently, in a bid to promote seamless integration and continuity, the Ministry of Mines introduced a composite licence scheme which is a two-stage operating right granted for the purpose of conducting exploration operation followed by production operation.

Fig. 1A, on left: Surface excavation of coal mining blocks in eastern India. Fig. 1B, on right: Rampura Agucha Pb-Zn-Ag Mines; world's largest zinc mine and the third largest open pit. in terraced open cast excavation up to 376m followed by 955m deep underground mine, in Bhilwara, Rajasthan, India (Source: HZL report/ Wikipedia)

Mining geology is an applied science which combines the principles of economic geology and mining engineering to the development of a defined mineral resource. Mining geologists and engineers work to develop an identified ore deposit to economically extract the ore with least wastage of resources. Mining engineering is associated with many other disciplines, such as mineral processing, detailed exploration, excavation methods, metallurgy, geotechnical engineering and surveying. A mining geologist is also trained to manage any phase of mining operations, from exploration and discovery of the mineral resources, through feasibility study, mine design, development of plans, production and operations to mine closure. Based on proper understanding of geochemistry and principles of applied geology, it is desirable to plan for mineral beneficiation of low-grade ores for extraction of desired metals and recover several associated trace metals as byproducts.

Mining operations generate large amounts of wastes and tailings which are usually stored into large scale storage facilities which may pose major environmental concerns. They must be properly monitored by MGs to manage the risk of catastrophic failures and to control the generation of contaminated drainage. In this context, non-invasive monitoring techniques such as time-lapse electrical resistivity tomography (TL-ERT) are promising since they provide large-scale subsurface information that complements surface observations and traditional monitoring tools, based on point measurements. Recent advances in instrumentation, data acquisition, processing and interpretation for long-term monitoring are now available (Owen et al. 2020;). It also draws future research perspectives and promising avenues which could help to address some of the potential challenges that could emerge from a broader adoption of TL-ERT monitoring for mine waste rock piles (WRP) and tailings management or storage facility (TSF) monitoring (Rubio R Fernández and B Kleinmann, 2021; Wadhawan, 2022).

3.3 District Mineral Foundation (DMF) and Pradhan Mantri Khanij Kshetra Kalyan Yojana (PMKKKY)

The Government of India had introduced a scheme in early 2015 for welfare of the people and development of areas affected by mining activities. Section 9B of MMDR Act empowers State Governments to establish District Mineral Foundation (DMF) to work for the welfare and benefit of persons, and areas a ected by mining related operations and make rules for composition and functions of the DMFs in the State. Under section 20A of the MMDR Act, the Union Government circulated *Pradhan Mantri Khanij Kshetra Kalyan Yojana (PMKKKY)* guidelines on 16.09.2015 with directions to State Governments to incorporate the same into the DMF rules framed by them. DMF is funded by statutory contributions from holders of mining leases. Funds under DMF are accrued at the districts concerned and are utilized by the DMF as per the guidelines for implementation of projects under *PMKKKY*. Accordingly, DMF has been constituted in 644 districts of 23 States (Ministry of Mines, 2023). A balance has to be maintained between mining affected people and mining affected areas while planning mitigation, lively-hood generation and infrastructural improvement related investments, thereby avoiding ad-hocism in outcome-oriented plans and ensuring inclusive governance and equitable development. Besides, to ensure transparency and public accountability of operations, DMF should be established as a 'Trust' with listed beneficiaries in each mining district.

Accordingly, the Mining Geologist and Mines Manager have been entrusted with additional responsibility that issues related to DMF and PMKKY are adequately addressed and remedied. DMF is meant to address the long-standing demand of the local people in mining affected areas for inclusive growth. As per MMDR Amendment Act 2015, the

funds for DMF will be met from additional contributions of 30% of royalty by existing miners and 10% of royalty by miners granted mines w.e.f. 12.01.2015. Further the MMDR Act has been amended through MMDR Amendment Act, 2021 w.e.f. 28.03.2021. The sub-section (5) and (6) of Section 9B of the MMDR Act has been amended for clarifying the rates of DMF to be paid by different categories of mines (Ministry of Mines, 2022; 2023). Details are available on the web link: https://mines.gov. in /write read data/Upload File/ mmdr28032021.pdf

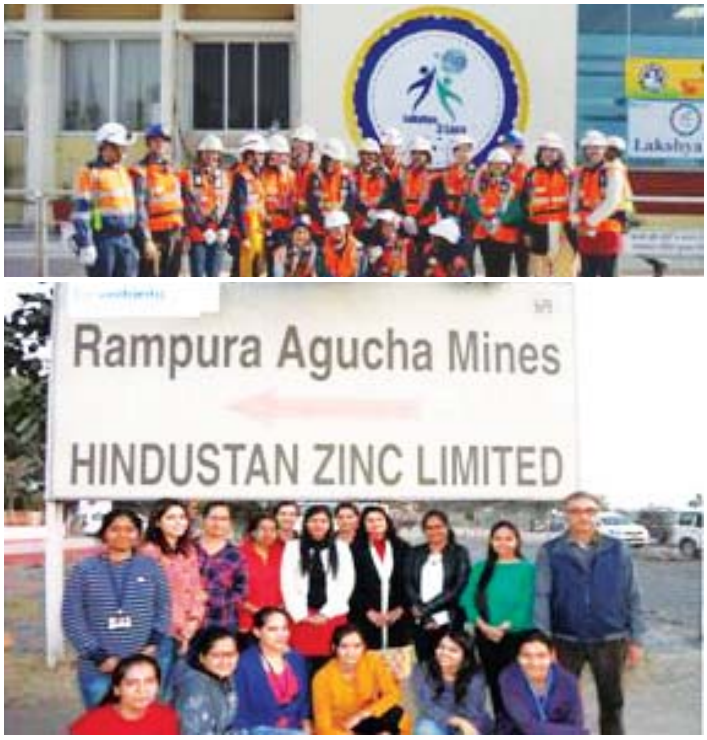

Fig. 2: *A visit to Rampura-Agucha Zn-P-Ag mines of HZL in Bhilwara district of Rajasthan by University students serve purpose of educational and geotourism mining site for single largest sphalerite (ZnS) deposits in the world (Photos by Dr. S. K. Wadhawan)*

Mining Geologists also get engaged with the following mine related activities such as waste limitation and management; water resources (including groundwater conditions and conservation) and soil management and regulatory approaches, rehabilitation, re-purposing of historical mines (e.g. re-processing of mine wastes for extracting critical minerals); and building public appreciation for how mining environmental management, waste management and mining engineering contribute to employment generation, public safety and the sustainable utilisation of national resources.

It is noteworthy that some mining, including much of the rare earth elements and uranium mining, is done by less-common methods, such as in situ leaching. The extraction of target minerals by this technique requires that they be soluble, e.g., potash mineralisation in northwestern Rajasthan, etc., which dissolves in water and other solvents.

4. DISCUSSION ON EMERGING CHALLENGES

Mineral Exploration in India has largely been carried out mostly to assess the resources up to depth of 120 m even though exploration and exploitation techniques for deep seated bodies exist up to a depth of 2,500 m. Further, it requires quality geological, geophysical and geochemical data. Synergy amongst key stakeholders (states, industry, concerned ministries and departments, local communities) is to be ensured for hassle free sustainable mining (Schoenberg, 2016; Nathalie et al. 2019; Wadhawan, 2020; 2021).

In addition to Geological Survey of India (GSI), several organisations in India have been engaged in mineral exploration investigations that include Atomic Minerals Directorate (AMD), Mineral Exploration and Consultancy Ltd., major PSUs and other mining giants. The largest and oldest among them, the GSI has a repository of more than 8,500 geological reports of mineral investigations carried out since 1941 put up in public domain (the Geoscientific Repository "Bhukosh", the GSI portal can be viewed from the link: https://www.gsi.gov.in/webcenter/portal/

However, geological mapping needs to be updated on a continuous basis. Quality tests of these reports will surface once exploration companies bid for permits on the basis of these reports. Further, the GSI has plans to intensify geochemical mapping of 60/62 elements (target to cover the entire Obvious Geological Potential (OGP) area and to cover the entire OGP with geophysical mapping [Gr.< 0.1mGal & Magnetic data at 2.5 sq. km interval]. Integration of such voluminous data should lead to promising outcomes and identification of potential mineralised zones has been a persistent challenge.

4.1 Probing Deep Seated/ Concealed Mineral Deposits

In a major thrust to apply concept based geoscientific exploration and use of advanced technology, GSI had initiated international collaborative projects for probing deep seated/ concealed mineral deposits. This involved characterizing India's cover, Regolith characterization (transported/ local, weathered source rock), investigating India's lithospheric architecture, resolving 4D geodynamic and metallogenic evolution, and detecting and characterizing the distal footprints of ore deposits. Project "Uncover (India)" is being executed to probe for deep seated/concealed mineral deposits by Geological Survey of India involving integrated teams of exploration geoscientists. Three pilot scale projects (1) Northern Transect (2) Southern Transect (3) Eastern Transect were taken up in parts of Aravalli and Bundelkhand cratons falling in parts of Rajasthan, Madhya Pradesh and Uttar Pradesh. Multidisciplinary approach had yielded several gravity and magnetic anomalies with anomalous hydrogeochemical signatures for base metal that were detected below the sand covered areas of Churu-Jhunjhunu districts as well as Dausa districts of Rajasthan.

Similarly Deep Crustal Mapping across Western and Eastern Dharwar Cratons for searching concealed and deep-seated mineral deposits, in parts of Andhra Pradesh and Karnataka. Project Uncover-Phase-II has focused mainly on the integration of geology, geophysics and high-end lab data in order to search deep-seated mineralization across the Southern Transect. Mapping of deep crustal architecture across Singhbhum Craton and North Singhbhum Mobile Belt covering parts of West Bengal, Jharkhand and Odisha for study of mineral system and to target deep-seated mineralizing environment. The Eastern Transect spans over three distinct terrains of Eastern Indian shield which are, Singhbhum Craton, North Singhbhum Mobile Belt (NSMB) and Chotanagpur Granite Gneissic Complex (CGGC). The interfaces of these terrains are marked by trans-crustal shear zones, viz. Singhbhum Shear Zone (SSZ) between Singhbhum Craton and NSMB and South Purulia Shear Zone (SPSZ) between NSMB and CGGC. Besides, GSI must consider launching a detailed rock and mineral geochemistry mapping including isotopic (O, S) geochemistry, extensive geochronological studies, sequence stratigraphy and a country-wide geochronology-based mineralization event mapping programme to ascertain metallogenic provinces in India (Deb and Thorpe, 2004; Golani, 2021, Chatterjee, 2022).

It is desirable that both the mining geologists and exploration geologists must also be fully informed about activities of IBM through reference to their regular publications elaborating on mineral conservation and mine environment, mineral beneficiation studies, utilization of low-grade and subgrade ores and analysis of environmental samples; mineral economics and above all the National Mineral Inventory (NMI). Such dedicated involvement will facilitate optimum functioning of *Khanij Bidesh India Limited* (KABIL), the Joint Venture Company set up by Ministry of Mines, in August, 2019, with equity participation of NALCO, HCL and MECL which is currently focusing on sourcing of Lithium and Cobalt for the domestic market and engaging with few companies / projects in Australia, Argentina and Chile (Ministry of Mines, 2023; 2023b).

Antiquated drilling machine operation for subsurface probes need to be replaced with high quality and deep drilling technology by all agencies engaged in Mineral Exploration; and ensuring expeditious forestry and environmental clearances and early revision of existing norm (of permitting for limited number of drill holes in forest areas) by MoEF & CC.

4.2 Efforts to attain self-reliance in Critical and Strategic Minerals

In recent years, critical and strategic minerals have been a focal point which are essential for the country's economic development and national security. Critical and strategic minerals are in high demand in India and the same is usually met by imports. The lack of availability of these minerals or concentration of their extraction or processing in a few countries may lead to supply chain vulnerabilities. The future global economy will depend on technologies that utilise minerals such as lithium, graphite, cobalt, titanium and rare earth elements (REE). India has committed to achieve an ambitious plan of 50% of cumulative installed power capacity from non-fossil sources by 2030 that would entail increasing demand for these critical minerals (Ministry of Mines, 2023b). As Beryl and other beryllium-bearing minerals, Lithium-bearing minerals, Niobium-bearing minerals, Titanium bearing minerals and ores, Tantalum-bearing minerals and Zirconium-bearing minerals and ores have been delisted from the list of atomic minerals specified in Part-B of the First Schedule to the MMDR Act, exploration and mining of these minerals is expected to increase significantly in the country.

5. CONCLUDING REMARKS

Concluding remarks are presented with a view to emphasise understanding of demand-supply issues for mineral-water-energy resources and urgent need for capacity building and to upgrade skill levels to meet emerging challenges through synergy amongst stakeholders: industry, academia, and national geological surveys and exploration agencies. It is appreciated that geology is the cornerstone of successful mining operations. It provides the essential knowledge and data needed to locate, evaluate, and extract valuable minerals from the Earth. The synergy between geology and mining ensures that operations are conducted efficiently, safely, and with a keen focus on environmental sustainability and accruing benefits to the local community.

A thorough professional approach is needed in mineral exploration - utilising interdisciplinary competency, multiple skills and risk appetite attitudes. A steady pool of skilled man-power including Ore Petrologists and group of mentors for different mineral commodities need to be nurtured through training and capacity building, Skill levels of Geologists in DMGs' be upgraded. Training for Trainers [ToT] programmes with focus on accepted best international practices needs to be adopted on continuing basis

The Ministry of Mines has constituted 12 thematic Geoscience Committees for Central Geological Programming Board in GSI with membership drawn from various Geoscience Departments and expert groups in India. The priorities assigned and recommendations made by these Committees need to be implemented subject to periodic review through collective and inclusive mechanisms for desired outcomes in a time bound manner.

There has to be India specific best practice, policies that are conformable with Indian socio-economic and political ethos, sensitivities of indigenous people and environmental

concerns. The number of participants in the Indian exploration sector can indeed be broad based from the current 11 (compared to 400 or more for Canada and Australia each).

Deep-seated minerals, such as gold, silver, copper, zinc, lead, nickel, cobalt, platinum group of minerals, diamonds, etc. are difficult and expensive to explore and mine as compared to surficial or bulk minerals and thus share of deep-seated minerals in total mineral production is meagre at present. The country is mostly dependent on imports of these minerals. In order to promote ease of doing business and attracting direct foreign investments, a simplified 'exploration-friendly' mineral concession regime for seamless/ unified geological exploration and mining protocol would facilitate, encourage and incentivize private sector participation in all spheres of mineral exploration for critical and deep-seated minerals.

The world over, the present century has already experienced enormous advances in the applications of geoscience, technology, and communication tools. The Ministry of Mines also encourages Digital Innovations with special focus on demonstrating the potential use of 4G/5G technology in the mining sector can significantly improve mining operations, making them safer, more efficient and environmentally responsible. India's geological exploration sector needs to be modernised and adopt sensor-based real-time and dynamic data collection processes (IoT), large data analytics, Artificial Intelligence, use tools for 3-D visualization, application of nano-sciences and others for geodata acquisition, processing, analysis and modeling.

As a measure for geoconservation of rare geological and mining heritage sites for their scientific and educational values, converting abandoned mines into geoheritage sites is imperative to highlight the role such mines played in the economic development of the country.

Finally, it is appreciated that exploration geologists focus on finding new mineral deposits, while mining geologists are involved in the extraction and production of minerals from existing mines. Both roles are essential for the mining industry, with exploration geologists laying the groundwork for future mining operations and mining geologists ensuring the efficient and sustainable extraction of minerals from existing mines. A coordinated synergistic overlapping role is envisioned for a win-win situation for growth of the mining sector.

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REVIEW ON CONTROLS AND GUIDES OF BASE METALS MINERALISATION AT NORTHWESTERN PART OF INDIAN SUBCONTINENT

Anirban Das* & Suryanshu Choudhury**

Abstract

Indian Subcontinent is endowed with different type of significant mineralisation predominantly out of which northwestern part of India is identified as one of the largest base metallic ore deposit regions because of its typical regional geological formations. This region which is geologically part of the Aravalli Delhi orogen in the state of Rajasthan and Gujarat in India, hosts extensive bodies of mafic metavolcanic rocks within the Archaean Banded Gneissic Complex (BGC) basement and in the Proterozoic supracrustal belts of Bhilwara, Aravalli, Jharol and Delhi. The Mineralised zone in this belt occurs in intercalated series of Talc-Tremolite schist and Biotite-Quartz schist or quartzite with either sharp contacts or grading through talc-tremolite-quartz-schist. The massive lodes contain well developed crystals of pyrite uniformly distributed in fine grained galena, sphalerite rich groundmass. The base metal mineralisation occurs as thin veins and stringers along with foliation planes, as thin films along with fracture planes or randomly disseminated grains in the interspaces of the host rock. Mineralisation in Biotite-quartz-schist is less intense than the talc-tremolite-quartz-schist. Arenaceous rock types predominantly contain pyrite and chalcopyrite.

In present study, a scientific approach has been carried out with modern algorithm-based tools to establish the controls and guides of base metals mineralisation at Northwestern part of Indian subcontinent based on the historical exploratory data along with geological mapping details of the region. Correlation for lithological and mineralisation at different levels and sections were established considering litho-structural control of mineralisation in this area.

1. INTRODUCTION

Indian Subcontinent is enriched predominantly with different type of mineralisation at its different regions. How far base metal mineralization is concerned, northwestern part of Indian subcontinent hosts one of largest mineralised zone. This region is mainly confined to the state of Rajasthan and Gujarat in India. The metasediments of the region are correlated with Ajabgarh formation of the upper Delhi supergroup. The lower and middle part of the stratigraphic sequence has predominant calcareous sediments which are associated with subordinate argillaceous and arenaceous rock types. These are followed by arenaceous rock types in the upper part. The arenaceous sediments have a series of pockets of calc-magnesium sediments. Talc schist group of rocks are the chief host rock of mineralisation in the region confirming that lithological control is prominent. The mineralisation is of layered type concordant to the bedding and foliation directions. Both the host rocks and the mineralisation are spatially enclosed, either in part or on the whole by sub-parallel shear zones. This mineralisation is considered here to be stratiform of marine association occurring with calc-magnesian and arenaceous metasediments of Upper Delhi Supergroup. The sulphide bearing lodes occur as a series of closed spaced parallel to sub-parallel lenses separated by poor or barren horizons. The richer mineralisation is generally associated with carbonate layers and less common with arenaceous calc-arenaceous sediments. The Neo Proterozoic stratiform of Volcanogenic mafic sulphide type deposit popularly called as VMS-type deposit is mainly associated with Zn–Pb–Cu mineralisation which is hosted within meta-sedimentary sequences of the South Delhi Fold belt. The mineralized zones are well correlated with geochemical anomaly zones and particularly concentrated in the subparallel shear zones. During formation of VMS deposits in basic volcanic terrains, magnetite is transformed to sulphides that lead to sudden decrease in magnetic susceptibility. Such ground magnetic signatures of sudden lowering of susceptibility have proved to be useful in picking mineralization horizons at basic volcanic-hosted Danva Cu-Zn (Au) in the Mesoproterozoic Delhi Fold Belt in western India (Tiwari et al. 1987).

All these rock types are intruded by concordant types of basic igneous rocks. The sedimentation is followed by folding and regional metamorphism. Calcareous sediments are represented by crystalline limestone, marble and calc-gneiss, while argillaceous sediments by phyllites and mica schist. The arenaceous sediments are characterised by quartzite,

**Sr. Manager (Geology), Gujarat Mineral Development Corporation*
***Head- Mine Planning, Gujarat Mineral Development Corporation*

quartz-schist, while the calc-magnesium sediments by talc-tremolite schist. The basic igneous rocks are represented by the epidote-hornblende schist. The massive sulphide deposits of this belt are also compatible with a back arc environment, where high heat flow and extensional tectonics provide the power and plumbing system necessary for such ore generation (Vance and Condie, 1987).

2. INDIAN SCENARIO OF VOLCANOGENIC MAFIC SULPHIDE(VMS) DEPOSITS

The South-Delhi fold belt has several base metal prospects and deposits of which the Basantgarh multi-metal deposit occurring in the younger division of Delhi Super group (Ajabhgarh Group). A regional Location map along with details of all base metal prospects attached in Figure 1.

According to the metal ratios of Zn, Pb and copper, the mineralisation belongs to kuroko type of deposits hosted by bimodal volcanic rocks (Bhattacharjee et al., 1988) while all others are seemed to be Cu-Zn type back arc type and cyprus type. Although many of these prospects are small and/or low grade, the belt continues to attract considerable Exploration interest.

It is generally recognised that, the broad tectonic studies of the region is rift-related while Basantgarh is of Oceanic (Ophiolitic) affinity. Deb and Sarkar (1990), using geochemical characteristics of mafic volcanics suggested that Ambaji-Deri zone represents a back arc set up while lateral zone towards Basantgarh shows an Island Arc affinity.

3. GEOLOGY OF THE STUDY AREA

The geological prospect consists of a suite of arenaceous metasediments represented by quartzite, quartz schist and biotite-sericite-quartz schist. They are intruded by concordant

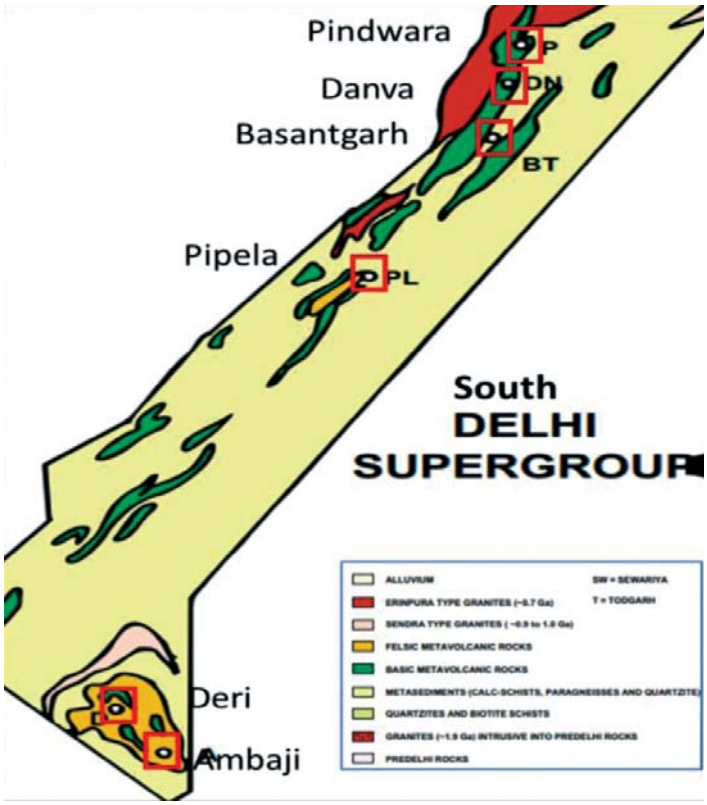

Figure 1: Geological map of the Region (Modified after Bhattacharjee et al., 1991)

bodies of basic igneous rock, which are the products of regional metamorphism represented by mainly epidiorite, hornblende schist and granulite. The talc schist group of rocks are the chief host rock of base metal mineralisation, occurring as irregular lensoid bodies along the shear zones at the contacts of metasediments, or within the body of the metasediments themselves.

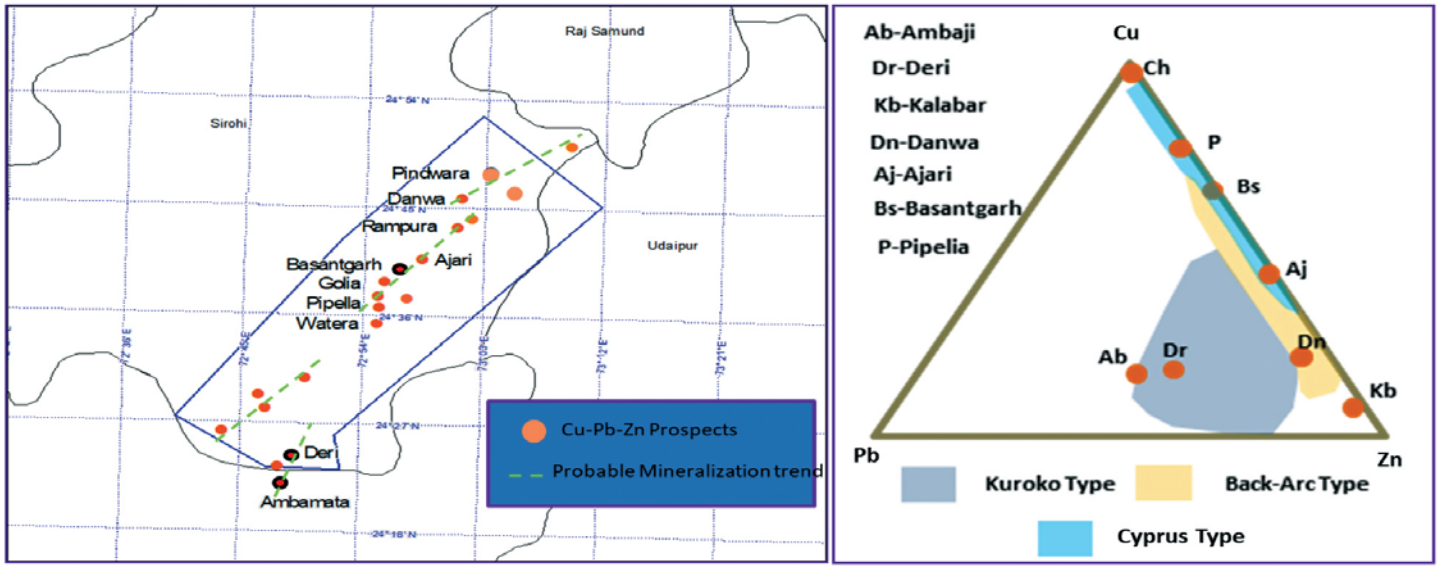

Figure 2: Location of the base metal prospects for multi-metal deposit occurring within the Delhi Super group rocks.

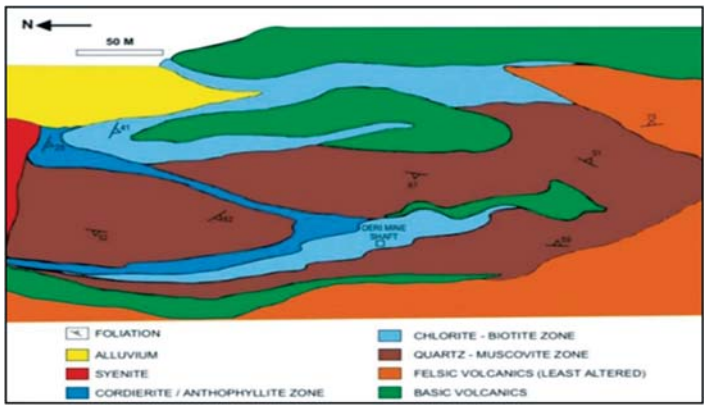

Figure 3: Detailed geological map of the hydro-thermal alteration zones in the region with dominated volcano-sedimentary sequence in south-western Rajasthan, Western India (Modified after Golani and Narayan 1989).

The Rocks encountered within these areas are quartzite and quartz-biotite-schist. These are enveloped by granite in north-western portion of the area, where the intrusions resulted in the feldspathisation of the Quartzite. These rocks are intruded by amphibolite and hornblende schist, which have been altered to chlorite schist by retrograde metamorphism. The frequent development of talc in chlorite schist has been formed along shear planes. The Talc-chlorite-biotite-schist is generally gossanized. Chlorite schist forms the host rock for mineralisation. Talc is frequently associated with development of sericite. The rock shows gradation of amphibolite indicating the chlorite schist has been derived from amphibolite by retrograde metamorphism.

Amphibolite and hornblende schist contain specks of pyrite and chalcopyrite. At places mineralisation is associated with these rock types as well and forms the footwall of mineralised zones. Granite is generally very fine grained near the contact with other types and is intrusive in nature. It is frequently mylonitised, becoming coarser away from the contact.

4. MINERALISATION AND GENERAL STRUCTURES OF THE STUDY AREA

The general trend of the formations is north-south with a variation up to 20° towards East or West. Dips are generally steep varying from 60° to vertical in either direction with the study area. The prospect of mineralisation within the study area forms the part of the eastern limb of doubly plunging syncline plunging at moderate angles towards south-southwest. Several minor folds ranging from a few millimetres to 2m in wavelength are observed within the limb. Shear joints occur in a series of sub-parallel zones and are well developed in the talc-chlorite group of rocks. Their trend is also roughly north-south, with steep dips either towards west or east. F1 folding is accompanied by the development of two prominent sets of faults and shears. One set trend parallel to the axial plane of the fold and another at an acute angle in north to N20W direction.

The manifestations of sulphide mineralisation are evident at surface at locations within the region in the following forms:

(a) Presence of oxidation products like malachite and azurite in the debris of the ancient workings and in-situ exposures. These are generally developed in talc-tremolite-schist.

(b) Intense limonitisation in various shapes or colour generally occur in the debris of ancient mining.

(c) Sericitization, kaolinitisation and silicification of the country rocks around the mineralisation at the surface also noticed.

(d) All these are supported by the presence of ancient workings of various shapes and sizes, debris and slag dumps in around the mineralised zones.

The sulphide orebodies occur as replacement zones within the quartz, chlorite-amphibole schist and at the contact of talc-chloride schist. Pyrite-chalcopyrite occurs at the hanging wall and the footwall, while main body containing galena and sphalerite in the centre. The Ore zones are in the shape of elongated funnel with steep dips and plunges.

5. EXPLORATION HISTORY AND DATA INTERPRETATION

The detailed geological mapping of the area on the scale of 1:2000 covering the prospects area was undertaken historically followed by geophysical and geochemical work. Old pits and large slag heaps were observed in the area which supported presence of ancient mining activity. Samples collected from limonitised gossans within the area gave appreciable values of lead, zinc and copper. Geological Survey of India (GSI) carried out their exploratory campaign and completed drilling in January 1972 in the western part of the prospect. The Geological survey of India (GSI) also identified six parallel zones based on surface manifestation.

5.1 Interpretation of Geological data

Historical geological data compiled to create a geological database which was imported into Datamine Studio RM. Data validation and data verification were done to ensure that the database is robust and error-free before using it model preparation. Histogram plot for Zn (%), Cu (%) & Pb (%) of combined ore zones shows the mean value of 8.15%, 1.63% and 6.17% respectively (Figure 4).

Composite hole file of each ore lenses has been analysed separately to understand the preference of base metal mineralisation in different host rock. Triangular Plot of QBS (Quartz biotite schist) indicates the concentrations of Pb (%) and Zn (%) are less as compared to other host rocks, wherein Cu (%) are significantly high than other host rock. Zn (%) and Pb (%) values seemed to be depleted in metamorphosed basic rock (MBR), wherein Cu (%) seemed

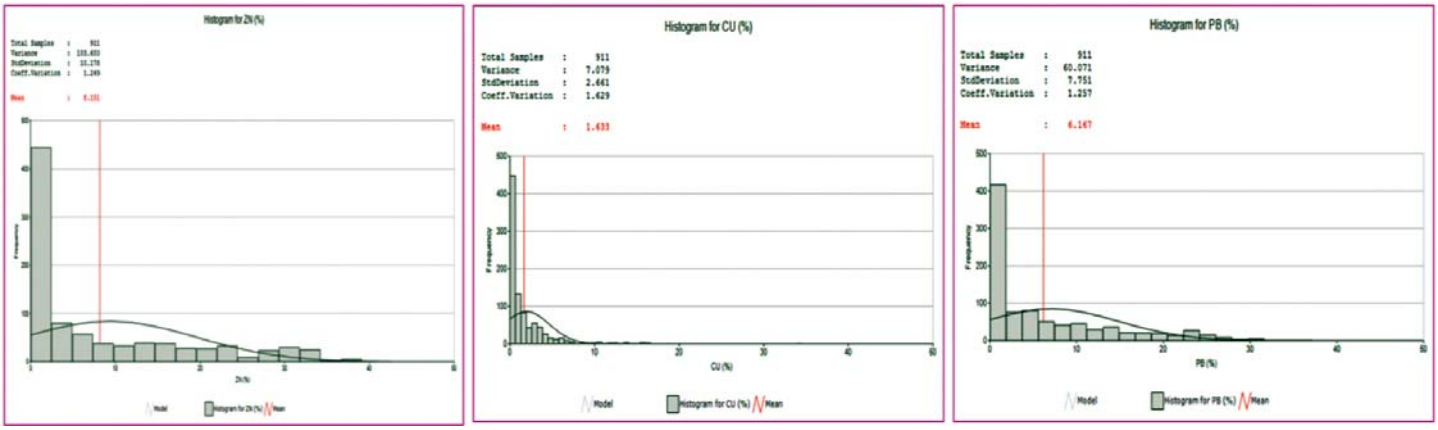

Figure 4: Incremental histogram plot of Part of the mineralisation showing the Mean value and other parameters for Zn (%), Cu (%) & Pb (%).

to be high in this rock type. It is also noted that this type of high-grade copper orebody in this rock type is found in L4 lens where plenty of drilling gap has been observed, depicts the exploration potential of the area.

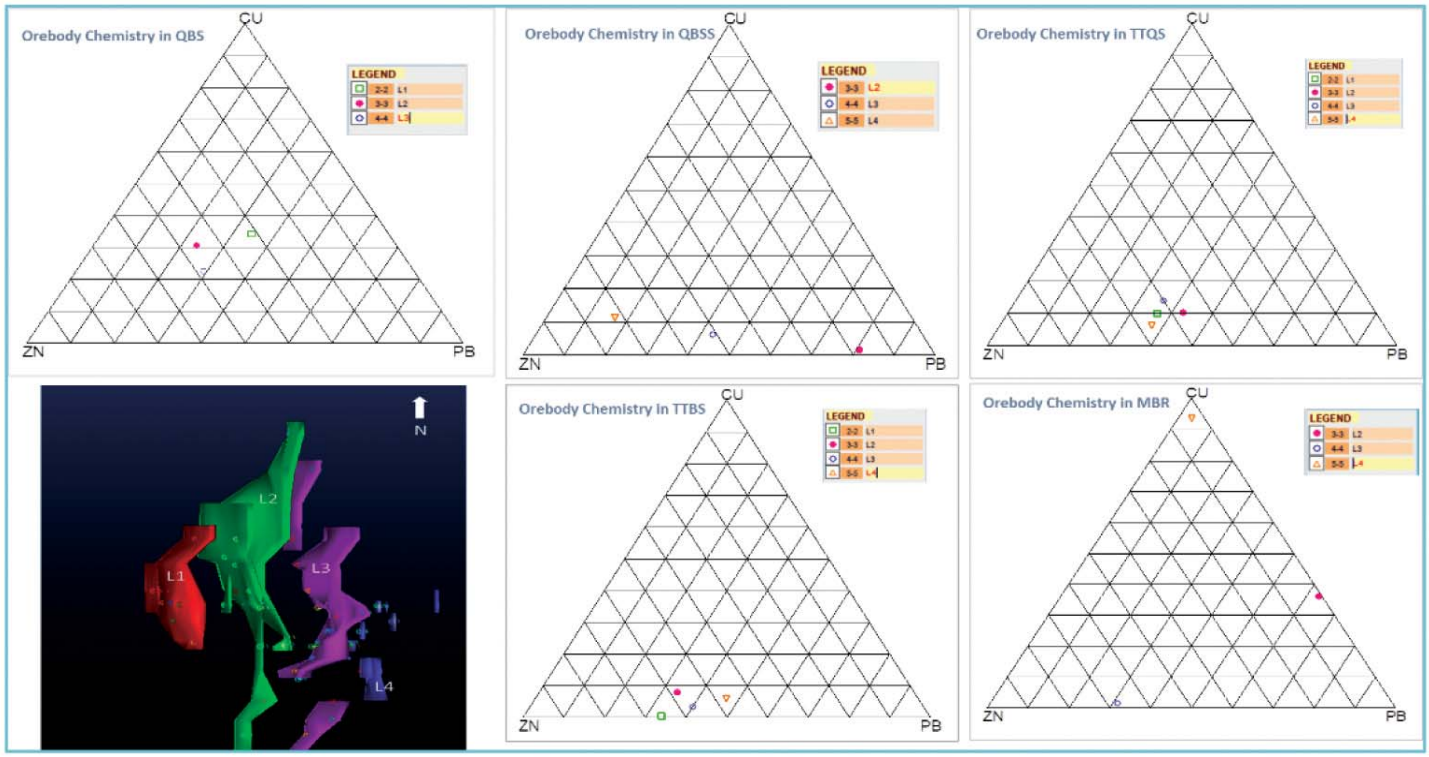

Figure 5: Plan view of ore lodes (L1, L2, L3 & L4). Ternary plot of different host lithology chemistry.

5.2 Lode Wise Comparison of Geochemistry

For the purpose of creating a model, sections were created for mineralised areas having 0.5% Copper Equivalent as it is a polymetallic deposit. This 0.5% of copper equivalent is considered based on the economic viability and other factors like metal recovery in mining and smelting process and cost of different services. Thus, four ore lodes were correlated in 0.5% copper equivalent. Further, the geochemical and lithological information were extracted and processed separately (lens wise L1, L2, L3 & L4 respectively) to understand the variability of chemical composition.

Mean value of different ore lodes was plotted in Ternary diagram (Figure 8). It appeared that broad chemical composition of L1, L2 & L3 orebody are similar in nature. The mean value of Pb (%), Zn (%) and Cu (%) varies between (5.22% to 6.50%), (6.90% to 8.17%) & (1.42% to 1.85%) respectively. However, L4 lens is enriched in copper & depleted in Pb-Zn. Mean value of Pb (%), Zn (%) and Cu (%) for L4 lens is 2.65%, 4.35% & 4.19% respectively.

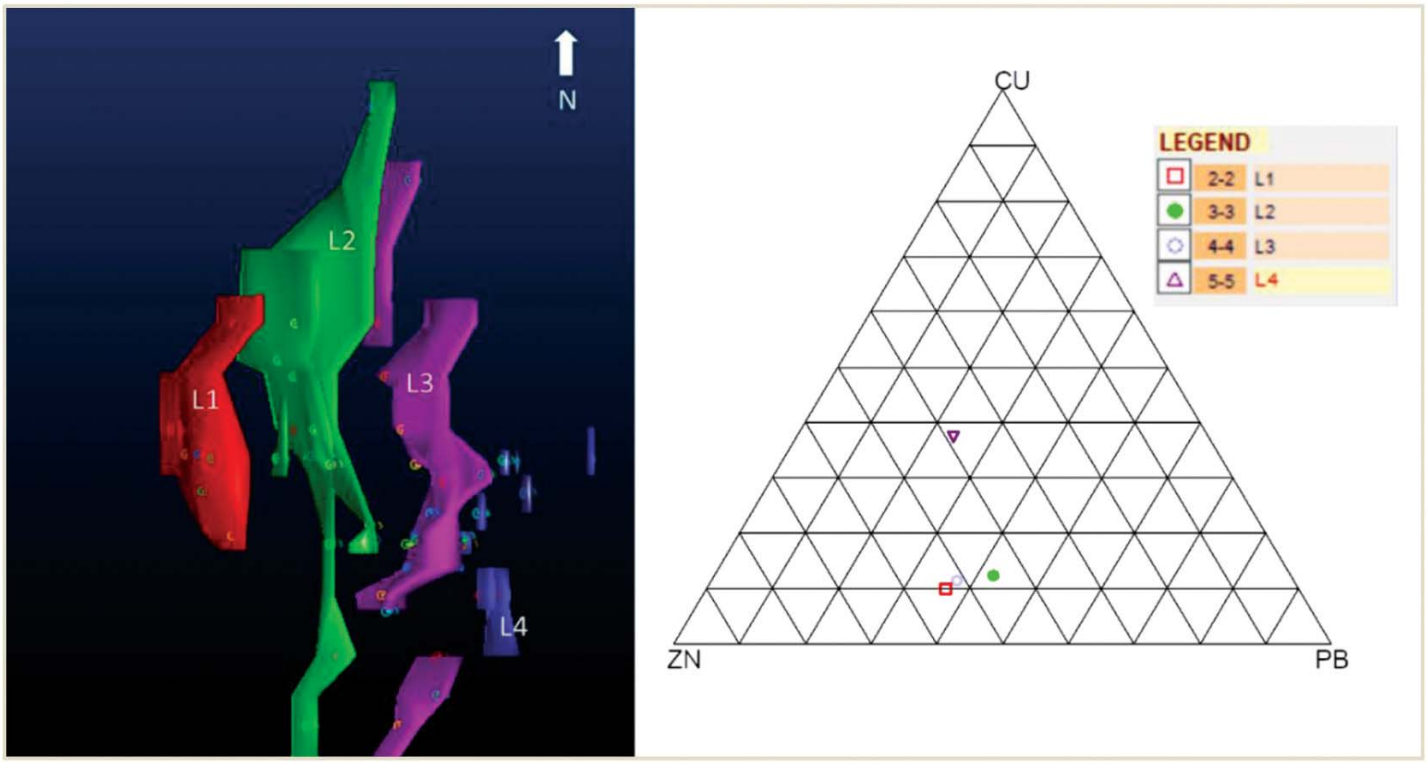

Figure 6: Plan view of ore lodes (L1, L2, L3 & L4). Ternary diagram of Cu-Zn-Pb showing the mean value for different ore lodes.

6. CONCLUSION

The South-Delhi fold belt as part of Northwestern part of Indian Subcontinent has several base metal prospects and deposits which occurs in the younger division of Delhi Super group (Ajabgarh Group). In the present paper, as approach has been made to establish the controls and guiding factors for base metal mineralisation based on the Interpretation of the available geological information of the area and regional geological data and litho-geochemical characterization of the mineralised zones. The structural features and litho-contacts can be well delineated by magnetic anomaly zones. The previous geological/geophysical studies in this area indicate that the high magnetic basic intrusive rock types are well associated with the sulphide mineralization. This kind of similar features may be investigated for Exploration target generation for multi-metal mineralisation. The interpretation of the prepared longitudinal vertical section indicates that there is a potential for the orebody to continue in depth. Low resistivity and high chargeability are expected in disseminated type of volcanogenic massive sulphide system. To identify the extensions of the deposit identification of the major alteration zones (e.g. chlorite, sericite) through hyperspectral imaging or alteration mapping would help in identification of the regional exploration targets. Low resistivity and high chargeability are expected in this disseminated type of volcanogenic massive sulphide system. IP resistivity survey may detect the hidden potential of whole region. Currently India is deficit in terms of copper resources and discovery of any additional resources in the belt would assist immensely towards achieving Atmanirbhar Bharat.

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HINDUSTAN COPPER LIMITED, THE COPPER MINER OF INDIA DOING RESPONSIBLE AND SUSTAINABLE BUSINESS

Message from CMD, HCL

As I pen this foreword for Mining Engineers Journal, I take this opportunity to congratulate the publication for its brilliant job in chronicling the strides of the mining sector which plays a significant role in our economy.

India has a rich history of copper mining dating back to the Paleolithic age. HCL is the torchbearer of this legacy, owning seven mining leases across the country. Since its inception in 1967, Hindustan Copper Limited has shouldered the onus of ensuring efficient mining of the country's Copper resources in a sustainable manner.

The global demand for Copper is on the rise due to its indispensability cutting across all sectors. Furthermore, as we move towards a green economy with solar panels, wind turbines, and electric vehicles, all relying heavily on Copper, the metal has emerged as the core driver in our quest for Net Zero Emissions.

In a bid to nurture the self-generating economy of our nation, HCL is presently implementing mine expansion scheme to enhance its capacity from around 4 million tonnes (approx.) per annum to 12.2 million tonnes per annum in the next 5 years.

Prioritizing safety is the cornerstone of our operations. Awards like the 5-Star Rating from the Indian Bureau of Mines and National Safety Award for the Malanjkhand Copper Mine are acknowledgments of our unwavering commitment to safe and sustainable mining practices. Recently, HCL has also been awarded MSA Award 2024 - Third Prize, Category: Metal Belowground Medium, for Khetri Copper Mine, Rajasthan, at the Mines Safety Award 2024 held in Kolkata.

Environmental sustainability is crucial to our functioning. Initiatives such as the Zero Liquid Discharge System, installation of solar plants and water harvesting in all our Units delineates our concern for the environment.

To conclude, I would like to aver that the future of copper is bright and full of possibilities, and Hindustan Copper Limited is poised to lead the vital sector of Copper mining in India. Dedicated to the mission of sustainable mining of Copper, efforts of Team HCL will continue to resonate with the enduring spirit of the metal and play a significant role in nation-building.

Wishing Mining Engineers Journal grand success.

Ghanshyam Sharma
Chairman and Managing Director,
Hindustan Copper Limited

A. Ankh

The Romans gave Copper its name. They called it "aescyprium" (ore from Cyprus) because, in ancient times, most Copper came from Cyprus. The word was later modified to "cuprum", from which we have our modern day "Copper".

In ancient Egypt, Copper was symbolized by Ankh "☥" in Egyptian hieroglyphics which represented "eternal life". The logo of Hindustan Copper Limited, inspired by Ankh, reflects the same resilience.

Copper is one of the most versatile metals known to man across civilizations. In a world where today's technology becomes obsolete tomorrow, Copper has continued to move from strength to strength. Hindustan Copper Ltd., in service to the nation since 1967, carries forward the undying spirit of this amazingly versatile metal.

B. New Age of Doctor Copper

Copper plays a pivotal role in the green economy of the future. To mitigate climate change, clean energy is the fastest growing segment to support electrification, with solar panels and wind turbines requiring around 12 times more Copper than previous generation methods for capturing, storing and transporting energy. Copper demand will also increase due to implementation of electric vehicles worldwide, each of which need four times the amount of Copper used in an internal combustion engine. Copper being the green metal and also termed as new oil, has been considered as a core driver for moving the global economy toward net zero emissions.

Meanwhile, the global demand for Copper is also on the rise due to its indispensability in the expanding sectors like power, electronic products, telecommunication, transportation, construction, defense, railways, manufacturing of industrial machinery, consumer and general products, etc. The consumption of Copper in health sector is seeing a steady rise due to its remarkable anti-microbial properties. All these demand drivers have ushered in a new age of Copper.

Due to Copper's widespread applications in most sectors of the economy, from homes and factories to electronics, power generation and transmission, demand for Copper is often viewed as a reliable leading indicator of economic health and is reflected in its market price. Researchers have found a correlation between Copper prices and a number of measures of global economic activity. Hence, this base metal is known as Doctor Copper (as a market lingo) for its ability to predict turning points in the global economy.

C. Copper in India

India's heritage of mining and metallurgy dates back to the Paleolithic age. Copper mining and smelting flourished in ancient India in the present states of Rajasthan and Andhra Pradesh as well as the Kulu-Garhwal regions of the Western Himalayas. Archeological evidence from the excavations at Mohenjo-Daro has revealed that Copper was used for making weapons, bric-a-brac, ornaments and currency. Time passed, the Copper industry faced bad patches in the middle ages. Then again, in the mid-nineteenth century, renewed interest in Copper production was witnessed. In the recent times, India, with its treasure trove of mineral resources, has thrown her gates open to its large-scale mining in a big way.

D. The Copper Miner of India

Hindustan Copper Limited was incorporated on 9th November, 1967, as a Central Public Sector Enterprise under the administrative control of the Ministry of Mines, Govt. of India, to ensure efficient mining of the country's Copper resources on a sustainable basis.

HCL has the distinction of being the only Copper mining Company of the nation, owning seven mining leases across the country. Conferred with the status of Miniratna Category -I, the Company has registered its presence across the entire value chain of copper with products acknowledged for their superior quality and reliability.

E. Mining and Plant facilities

- Malanjkhand Copper Project, Malanjkhand (Madhya Pradesh)
- Khetri Copper Complex, Khetrinagar (Rajasthan)
- Indian Copper Complex, Ghatsila (Jharkhand)
- Taloja Copper Project, Taloja (Maharashtra)
- Gujarat Copper Project, Bharuch (Gujarat)

a) Malanjkhand Copper Project (MCP) at Malanjkhand, Madhya Pradesh

- Established in 1982
- Single largest Copper deposit of India
- The Malanjkhand Copper Mine was working as Open Pit Mining with strike length of 2200 m, maximum pit width of 650 m and ultimate pit depth of about 240 m. The open pit mine has been exhausted and has being converted into an underground mine.
- The underground mine below the open pit has achieved the capacity of 2.5 Mtpa and further mine development is under progress to achieve the rated capacity of 5.0 Mtpa.
- The existing capacity of beneficiation plant is 2.5 Mtpa.

b) Khetri Copper Complex (KCC) at Khetrinagar, Rajasthan

- Established in 1967
- Mechanized underground mines namely Khetri and 'Kolihan (Underground Mine)
- Beneficiation plant with capacity 1.80 Mtpa capacity.

c) Indian Copper Complex (ICC) at Ghatsila, Jharkhand

- Established in 1930
- Underground Mines: Surda, Rakha and Kendadih
- Beneficiation Plant with 0.4 Mtpa capacity.

d) Taloja Copper Project (TCP) at Taloja, Maharashtra

- Established in 1989
- Plant with per annum production capacity of 60,000 tonnes of Continuous Cast Copper Wire Rods of diameter 8 mm, 11 mm, 12.5 mm, 16 mm and 19.6 mm based on technology sourced from South Wire, USA.
- Currently operating in tolling mode from third party cathodes.
- Bureau of Indian Standards (BIS) has granted license (No: CM/L 7800116010) to use ISI mark in the Continuous Cast Copper Rod produced at TCP under IS:12444:2020 standard for Copper Wire Rods for Electrical Applications.

e) Gujarat Copper Project (GCP) at Jhagadia, Gujarat

- The assets of Jhagadia Copper Limited (JCL) were acquired in 2015.
- Plant with capacity to produce 50,000 MT of LME “A” grade Copper Cathodes annually through secondary smelting and refinery process.

F. Committed to Sustainable Development through CSR

While the whole world is pondering and initiating strategic action over the crucial issue of “sustainable development” for last couple of decades, Hindustan Copper Limited is contributing significantly to this imperative global mission. Since its inception, apparently much before the popularization of the concept of CSR and the legal framework for CSR under the Companies Act came into effect in India, HCL across its Units is engaged in ethical business operation through its unceasing commitment on sustainable development. It is functioning under an overarching framework of sustainability within which CSR is firmly embedded. Its CSR is built upon the Sustainable Development Framework (SDF) that addresses the social and environmental issues at all the stages of mining life-cycle i.e. exploration, planning, construction, mineral extraction, closure, reclamation and rehabilitation. The core principles taken into account for developing the SDF are: Safety, Efficiency, Economy, Environment and Community. SDF-based CSR helps in minimizing negative effects and maximizing positive effects.

At present its CSR & Sustainability initiative are based on the provisions of:

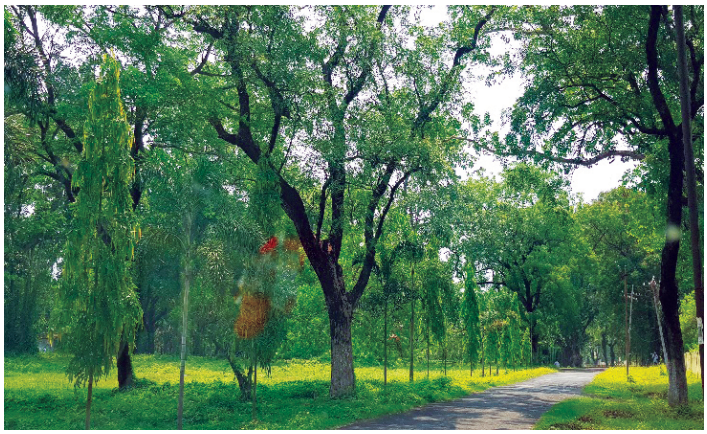
a) Section 135 of the Companies Act 2013, Government of India,

b) Guidelines on CSR & Sustainability for CPSEs, by DPE, Government of India

Also, the Company adheres to the 10 Principles (under Human Rights, Labour, Environment & Anti-corruption) of United Nations Global Compact (UNGC). It is also certified by ISO 14001 (EMS) and ISO 18001 (OHSAS). Hence, the concern for sustainability is addressed by the company in

addition to compliance with the mandatory provisions for CSR under the Companies Act 2013. However, its CSR is more value-driven than compliance-based, and it spends "beyond compliance.

Solar power plant: a step towards Renewable Energy



Afforestation initiative

Water Preservation in Ponds

HCL is committed to the highest standards with respect to the health, safety and environmental wellness for its employees and the neighboring communities. The Company abides by a stringent Corporate Environmental Policy which focuses on:

- Environmental protection
- Compliance with applicable environmental laws and regulations
- Employee awareness and involvement in environmental protection

Zero Liquid Discharge (ZLD) System has been adopted in all Units of HCL with the intent to contain pollution of soil, ground water and surface water in the surrounding areas. In this system, waste water and effluents of mine, tailing dam, waste dumps and workshops is recycled to the Plant and is used in the process for production of copper concentrate. In the project area waste water is collected in several numbers of stone-pitched and cement-grouted sumps of adequate capacity and pumped back into the reclaim pond. Due to this waste water is prevented from percolating into the ground and running off into other water bodies around the project.

Qualities of product and customer services are the areas of prime importance to HCL. All the Units of the Company have adequately modernized control tests and analysis facilities to ensure proper quality at all stages of operation. The raw material input checks, in-process controls and final testing of the product are all carried out as per established guidelines.

G. Corporate Social Responsibility (CSR)

HCL's CSR and Sustainability agenda is realized by execution of long-term and short-term projects on various thematic sectors identified through a sound and inclusive stakeholder engagement process. In the process the needs, priorities and values of different communities are taken into consideration. The key strategies for implementation of the CSR activities are-

- Baseline formation & Need Assessment of communities
- Community participation in Planning, Execution and Monitoring
- Partnership with NGOs/CBOs and Government Agencies
- Community ownership and management of services provided and infrastructure created
- Stakeholder communication

HCL has ventured into several thematic areas like Environment, Livelihood, Healthcare, Water & Sanitation, Community Development and Promotion of Rural Culture and Sports in the process of addressing the issues and concern of its target population under its CSR and Sustainability Programme. HCL has been spending beyond the mandated 2% CSR expenditure, in its efforts towards sustainable development.

Some of the key and continuous initiatives taken up under CSR are:

a) Sustainable Livelihood

- Promotion of Organic Farming practices

- Provision of agricultural inputs like seeds, saplings, farm equipment and training to farmers
- Revival and Promotion of Millet cultivation
- Skill building of younger generation on both traditional and new-age trades; and creation of opportunities for employment
- Support to Self-help Groups (SHGs) for their income generation and sustainability

b) Healthcare

- Free and subsidized medical facilities to poor people (Consultation from specialized doctors, Diagnostic services and Medicines)
- Creating healthcare infrastructure (Provision of Ambulance, Hearse Van, Testing Equipment, etc)
- Providing support to National and State Governments during COVID through various means
- Organizing Rural Health Camps and Blood Donation Camps
- Promotion of AYUSH

c) Water and Sanitation

- Drinking water supply to nearby villages
- Constructing household and public toilets under Open Defecation Free (ODF) campaign
- Contribution to GoI's "Swachha Bhaart Abhiyan" through awareness generation.

d) Environment

- Plantation of saplings
- Rainwater harvesting at public buildings
- Renovation of water bodies
- Installation of solar energy-enabled lighting facilities.

e) Education

- Development of libraries at schools and villages
- Promotion of STEM education
- Provision of infrastructure to schools
- Promotion of Menstrual Hygiene

f) Community Infrastructure

- Making villages/communities well-equipped with community halls, open stages, roads, drainage system, market complexes, health infrastructure, etc

g) Rural Culture and Sports

- Working towards preservation and promotion of indigenous culture of tribal groups like “Baiga”
- Conducting training for youths and students on sports like Hockey, Badminton, Kabaddi, archery, etc
- Provision of sports kits to schools and village clubs..

READERS’ VIEWS

Dear Dr Rao

MEAI - MEJ August 2024 Issue.

I thank MEAI for mailing the August 2024 issue of the MEJ. Your Editorial has come out very well. The content is excellent and timely. You have very aptly analysed the current situation of exploration and mining of Critical and Strategic minerals in the Indian Context. I congratulate you on this very useful Editorial which, I hope, your Editorial will be noticed by the Ministry of Mines.

While concluding, you have exuded optimism on the efficacy of the MoM's decisions and actions in promoting mining and processing of the Critical Minerals. I, however, doubt it. As long as MoM hangs on to the Auction system, the expected deliverables will be jeopardised.

Regards
Vasudev
August 8, 2024

LIFE INSTITUTIONAL MEMBER APPROVED

LIM-85 SN Mining Private Limited

LIST OF FELLOW MEMBERS APPROVED

Fellow No.	Name	Chapter
148	Mr. Mallikarjuna SHM	Bellary Hospet
149	Mr. P Venkateswara Rao	Bellary Hospet
150	Mr. D.B. Sundara Ramam	Barajamda

LIST OF LIFE MEMBERS APPROVED

Life No	Name	Chapter
6346	Mr. Ayan Giri	Udaipur
6347	Mr. Praveen Vikram K	Singareni
6348	Mr. Gouri Shankar Roy	Kolkata
6349	Mr. Atree Bandyodadhyay	Kolkata
6350	Ms. Sulagna Banerjee	Kolkata
6351	Mr. Mrinal Kanti Sarkar	Kolkata
6352	Mr. Rahul Yadav	Udaipur
6353	Mr. Dhaneswar Tudu	Bhubaneswar
6354	Mr. Dharmendra Goyal	Bhubaneswar
6355	Ms. Lalima Priyadarshani Sahoo	Bhubaneswar
6356	Mr. Tapas Kumar Naik	Jaipur
6357	Mr. Nishikanta Samal	Bhubaneswar
6358	Mr. Pranabananda Das	Bhubaneswar
6359	Mr. Deepak Kumar Singh	Mumbai
6360	Mr. Sujeet Kumar	Dhanbad
6361	Mr. Ravichandran Nannuri	Mumbai
6362	Mr. S. Hareesh Babu	Hyderabad
6363	Mr. Vineeth Balakrishnan	Dhanbad
6364	Mr. Makavana Maheshkumar Jayantibhaibhai	Ahmedabad
6365	Mr. Jignesh Sukhlal Ruperi	Ahmedabad
6366	Mr. Kamlesh Tak	Jodhpur
6367	Mr. Sakthi Saravanan Chinnasamy	Mumbai
6368	Mr. Sampat Raj Deora	Jodhpur
6369	Mr. Indranil Bhattacharjee	Kolkata
6370	Mr. Moodu Raj Bharath Nayak	Bailadila
6371	Mr. Shailesh	Bailadila

MEAI NEWS

DHANBAD CHAPTER

Minutes of the AGM

A meeting of the Dhanbad Chapter members was held in the committee room of CSIR-CIMFR, Dhanbad on 11/07/2024. The key purpose of the meeting was to conduct the election for selecting Office bearers and Executive members of the Dhanbad Chapter for the term 2024-2026. The following persons were present at the meeting:

1. Prof. A.K. Mishra, Director, CSIR-CIMFR
2. Dr. Santosh Kumar Ray
3. Prof. D.P. Mishra
4. Prof B.S. Choudhary
5. Prof. R.K. Sinha
6. Prof. Sahendra Singh
7. Dr. Sanjay Kumar Roy
8. Dr. C Sawmliana
9. Dr. M.P. Roy
10. Dr. Prabhat Kumar Mandal
11. Dr. Niraj Kumar Mohalik
12. Dr. Arka Joyti Das
13. Dr. Vivek Kumar Himanshu
14. Dr. Pallabi Das
15. Mr. Kartik Varwade
16. Mr. Nillabjendu Ghosh
17. Mr. Rana Bhattacharjee

At the outset, Prof. B.S. Choudhary, Secretary of the Dhanbad Chapter welcomed the MEAI members and briefed the work done in the past. Dr. Santosh Kumar Ray, Vice-Chairman opened up the meeting for electing the new Office bearers and Executive members of the Dhanbad Chapter for 2024-2026. The following Office bearers and Executive members were elected unanimously for 2024-2026.

Office Bearers

1. Chairman: Prof. A.K. Mishra, Director, CSIR-CIMFR Dhanbad
2. Vice Chairman: Dr. Santosh Kumar Ray, Chief Scientist, CSIR-CIMFR Dhanbad
3. Secretary: Prof. B.S. Choudhary, Dept. of Mining Engg. IIT-ISM Dhanbad
4. Joint Secretary: Dr. Vivek Kumar Himanshu, Scientist, CSIR-CIMFR Dhanbad
5. Treasurer: Mr. Kartik Varwade, Scientist, CSIR-CIMFR Dhanbad.

Executive Committee Members

1. Dr. P.K. Mandal, Chief Scientist, CSIR-CIMFR Dhanbad
2. Dr. Sanjoy Kumar Roy, Chief Scientist, CSIR-CIMFR Dhanbad
3. Dr. M.P Roy, Chief Scientist, CSIR-CIMFR Dhanbad
4. Prof. D.P. Mishra, Dept. of Mining Engg. IIT-ISM Dhanbad
5. Prof. Sahendra Singh, Dept. of Applied Geology IIT-ISM Dhanbad
6. Prof. R.K. Sinha, Dept. of Mining Engg. IIT-ISM Dhanbad
7. Dr. N.K. Mohalik, Sr. Principal Scientist, CSIR-CIMFR Dhanbad
8. Prof. P. Sahu, Dept. of Mining Engg. IIT-ISM Dhanbad
9. Prof. Ashok Kumar, Dept. of Mining Engg. IIT-ISM Dhanbad
10. Dr. Arka Joyti Das, Scientist, CSIR-CIMFR Dhanbad.

The above Office bearers and Executive members will be functional for the next two years (2024-2026) with immediate effect.

The meeting ended with a vote of thanks to the Chair.

SINGARENI CHAPTER

Election of New Executive Body

The AGM of Singareni Chapter was held on 8.8.2024 at 5.00 PM in the Conference Hall, Project Planning Dept., Kothagudem, both offline and online Mode. The VC link was provided to all members and the meeting proceeded as per the agenda circulated.

Agenda 1: The Secretary of the Singareni Chapter welcomed the members for the General body meeting. In his address he gave details of various programs and activities conducted during the previous tenure like the celebration of IMDs on 1st November, the Technical workshop on 12.5.2022, the National seminar on 19.11.2022 along with the 6th Council Meeting of MEAI, and the commencement of student chapter at JNTU, Manthani.

He also stressed the activities to be taken up in the coming days. He requested the members to encourage the professionals to join MEAI as a part of the membership drive. He urged the members to enroll as many new members as possible.

Agenda Point 2: Election for the posts of Chairman, Vice Chairman, Secretary, Joint Secretary, and Treasurer and Five Committee members.

The following office bearers were elected unanimously.

Chairman	:	Sri G.V. Reddy, Director (P&P)
Vice Chairman	:	Sri K. Saibabu, GM (PP)
Secretary	:	Sri A.L.S.V. Sunil varma, SOM
Joint Secretary	:	Sri Dundra Ramesh, Dy. Manager
Treasurer	:	Sri Gone Babji, Addl. Manager

Executive committee members

1. Sri Thandra Srinivas, Dy. Manager,
2. Sri Marikanti Suresh, Dy. Manager,
3. Sri P. Siva Kumar Dy. Manager,
4. Sri G.V.R. Karthik Sharma, Sr. Under Manager
5. Sri Ch. Ravi Kiran, Asst. Professor (c), UCE KU

Agenda Point 3: Planning the future activities.
It was decided to hold a workshop on the theme "Singareni – Opportunities and Challenges ahead" in September 2024 and various programs on 1.11.2024 on the occasion of **INDIAN MINING DAY**. It was resolved to make the Singareni Chapter the most active and best Chapter and also to help disseminate technological improvements/advancements among the mining fraternity.

Agenda Point 4: To take up the membership drive for life and student members. Initially, the Target for the Life Members shall be 240.

Agenda Point 5: The Singareni Chapter has a savings account in Andhra Bank, Kothagudem bearing A/C number: 015710100055849. It was decided that the Vice-Chairman, Secretary, and Treasurer would be signatories for operating the Bank account.

The account has been dormant for the past few months due to the retirement of some office bearers. Since the new Executive body has been elected, the account shall be operated by the new office bearers as detailed above.

Secretary, Singareni Chapter thanked the authorities of the Project Planning Dept., Kothgudem for sparing the conference hall and other VC facilities to conduct the General body meeting. He also thanked Secretary General Sri M. Narsiah for providing guidance and Sri M.S. Venkataramaiah for extending support in operating the Chapter actively and efficiently.

The meeting ended with a vote of thanks to the Secretary General who attended through VC and all the members present.

Newly elected Office Bearers of the Singareni Chapter

Sri G.V. Reddy, Chairman

Sri K. Saibabu, Vice Chairman

Sri A.L.S.V. Sunil Varma, Secretary

Sri Dundra Ramesh, Joint Secretary

Sri Gone Babji, Treasurer

Glimpses of Singareni Chapter AGM

(Continued from Page 14)

"The discovery of a link between these giant iron ore deposits and changes in supercontinent cycles enhance our understanding of ancient geological processes and improves our ability to predict where we should explore in the future," Courtney-Davies said.

Live science, Sascha Pare | August 1, 2024

➤ India to offer incentives for critical minerals extraction

India plans to provide funding for research institutes to give technical assistance to miners, according to a government source and a letter reviewed by *Reuters*, to try to develop a critical minerals industry.

The funding illustrates the efforts India is making to get the critical mineral industry off the ground and cut the country's near-total reliance on imports of lithium and rare earths mineral that are key to energy transition technologies.

So far, India's attempts to create a critical minerals mining industry have faltered. The country awarded development rights in June to a lithium block in Chhattisgarh state but a separate attempt to auction lithium blocks in Jammu and Kashmir found no takers because of low mineral concentration and high extraction costs.

The government could spend nearly $50 million to fund collaborations between research institutes and companies to develop extraction technology and better methods of beneficiation, or the improvement of mineral ores before processing into metals, according to a government source involved in the matter.

In a July 11 letter, the Ministry of Mines asked the CSIR-National Institute for Interdisciplinary Science and Technology (NIIST) to provide miners with know-how to extract critical minerals.

"The blocks auctioned by the central government contain critical minerals associated with other minerals and/or metals that need tailor-made case-specific extraction techniques," it said.

"As most of the critical minerals are not extracted in the country, the economical and successful extraction of these critical and strategic minerals by companies requires support and guidance on extraction and beneficiation techniques," it said. The government source said similar letters were sent to five other research institutes in India the same day. The government will invite joint proposals from institutes and companies and those approved will get up to 75% of the total funding, said the government source, declining to be named as they were not authorized to talk to the media. The Ministry of Mines and NIIST did not immediately respond to *Reuters*' emails for comment.

Reuters | August 13, 2024

➤ Coal-rich Indian state to pass mining tax after court ruling

The Indian state of Jharkhand has passed a bill imposing mining taxes, according to people familiar with the matter, a move that's set to inflate the prices of minerals from coal to bauxite.

The state assembly has approved the Jharkhand Mineral Bearing Land Cess Bill and it now awaits the assent of the governor, the people said, asking not to be named as the deliberations aren't yet public. A sum of 100 rupees ($1.19) a ton will be levied on coal and iron ore production once it's passed, they said.

Jharkhand in India's northeast is one of the country's top coal-producing states and also has major reserves of iron ore, bauxite and manganese. The bill follows a Supreme Court ruling that gave Indian states the right to impose levies on mining, in addition to collecting existing royalties. Local governments will also be allowed to recover any overdue payments from April 2026.

Jharkhand government's public relations department didn't respond to calls or an email seeking comment.

"India's mining industry is already saddled with very high taxation and any new taxes could burden the industry and risk investments," said B.K. Bhatia, additional secretary general at Federation of Indian Mineral Industries. The court ruling has given "unbridled powers to states" and with such large expenses looming "companies will be looking to prioritize arrear payments instead of making new investments," he said.

FIMI, an industry lobby group, estimated the historic arrears could be as high as 2 trillion rupees for miners in states including Odisha, Jharkhand and Karnataka. States are yet to release an official figure.

In addition to coal and iron ore, Jharkhand will impose taxes of 70 rupees a ton on bauxite, and 50 rupees on limestone and manganese, the people said. For other minerals, the miners will pay a sum equal to 50% of the royalty levied on them by the state government, they said.

Bloomberg News | August 20, 2024

CONFERENCES, SEMINARS, WORKSHOPS ETC.

INDIA

26-28 Nov 2024: **Plate tectonics, sedimentation and metallogeny through time & Annual Convention of the Geological Society of India**. Location: SDM Coollege of Engineering & Technology, Dharwad. Contact: Dr Venkatramana S Hegde, +91 9164718435, vshegde2024intesem@gmail.com

27-28 Sep 2024: **National Seminar on Current trends in mining, processing and beneficiation of beach sands industry, it's value addition and- mining laws & Acts**. Organized by Department of Geology, Andhra University, Visakhapatnam. Contact: Prof A. Yugandhara Rao, 8332946475, ctbmau2024@gmail.com

ABROAD

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.

4-6 Sep 2024: **International Fairs EXPO KATOWICE 2024**. plac Slawika i Antalla 1, 40-163, Katowice, Poland. Contact: enquiries@globalminingreview.com

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

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

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

14-16 Oct 2024: **CRIRSCO Annual General Meeting**. Hotel Hyatt Regency, Vancouver, Canada. Contact: CRIRSCO EA, Gabriel Serrano at gpaivaserrano@gmail.com

16-19 Oct 2024: **MRMR 2024 Conference: Innovation and integration**. Jointly hosted by CRIRSCO and CIM, Canada. Hotel Hyatt Regency, Vancouver, Canada. Contact: CIM MRMR EA, Jennifer Breaux at jbreaux@cim.org

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

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

29-31 Oct 2024: **International Mining and Resources Conference (IMARC) 2024**. Sydney, Australia. Contact: 1800 657 985 or +61 3 9658 6100 (if overseas)

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

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

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

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

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

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

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

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

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

10 - 13 Aug 2025: **Application of Computers & Operations Research in the Mining Industry**. #APCOM2025. PCOM Conference 2025, Perth Convention and Exhibition Centre, Perth, Western Australia. 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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Corporate Office:

ERM HOUSE, #4006,
K R Road, BSK 2nd Stage,
Bengaluru - 560 070.

Email: mail@ermgroup.in
Tel: +91 80266 55930
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