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MINING & QUARRY WORLD

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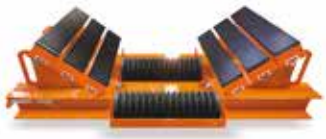

Combination Cradle

High Speed Impact Cradle

Effective belt support in load zones is essential for efficient, dust and spillage-free conveyor operation. Martin cradles are engineered to eliminate belt sag where it matters most – minimizing fugitive material and providing a stable surface for smooth, reliable performance.

Impact Cradles absorb material shock to protect belts and reduce wear at high-impact transfer points, while **High Speed Impact Cradles** withstand the toughest and fastest high-tonnage applications with unmatched durability. The **Modular Slider Cradle** offers edge-to-edge support with a low-friction surface, streamlined maintenance, and modular flexibility to extend coverage as needed. For superior adaptability, the **Combination Cradle** integrates roller and bar designs to reduce power consumption, eliminate sag and ensure a perfect seal in the load zone.

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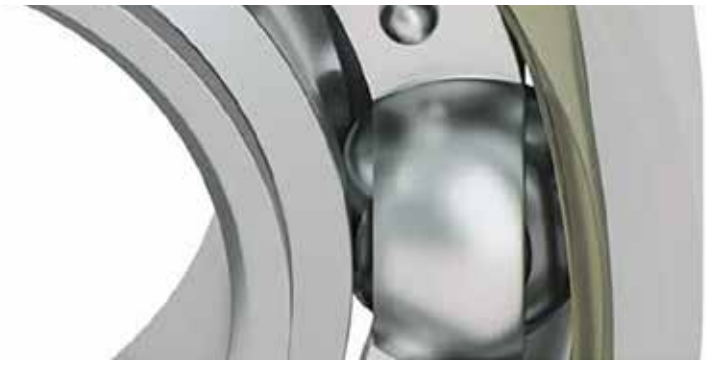

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A Technological Ecosystem for the Mining Industry

Orica Digital Solutions' grade control technologies are driven by a clear and forward-thinking strategy to enhance customers' ability to economically mobilise mineral resources. Their technological developments and value generating solutions for customers are centred on the following guiding principles:

- Unifying traditionally siloed and disparate data.
- Connecting crucial data sources and adding insightful context.
- Enriching applications and workflows with highly accurate predictive models.
- Fostering collaboration between stakeholders with user centric workflows.

At the core of this strategy is the Orica Digital Solutions (ODS) Platform, a unified ecosystem designed to enable collaborative workflows and informed decision-making. This ODS Platform integrates several cutting-edge technologies and tools which work together to provide mining companies with real-time insights and data-driven optimisation capabilities.

ENHANCING GRADE CONTROL PRACTICES WITH THE LATEST OREPRO™ ADVANCEMENTS

For customers around the world, understanding and managing material movement from mine to mill is central to success and operational efficiency. Orica Digital Solutions, a leader in advanced digital technologies for servicing mining, energy, civil construction and civil infrastructure sectors, is building the next generation of predictive models, and real-time decision-making tools.

Blasting is the first juncture in the material movement process as it disrupts the understanding of the in-situ models of rock. For some time, Orica has been on the journey of understanding blast movement and its impact on value recovery of minerals. Functionality in OREPro™ 3D for post-blast model creation and dig polygon optimisation, generates scenarios for maximum value recovery by mining teams.

The advancements gained from Orica Digital Solutions' Predict engine for blast movement enable operations to predictively and reactively understand the effects of blast designs on movement. This transformative technology helps regain knowledge of the material in the post-blast space with high spatial fidelity and accuracy. This precision is critical for blast movement modelling that is truly representative of typical blast movement dynamics, fragmentation size distribution and swell. Predict changes the narrative of grade control, empowering operations to optimise blast designs for maximum ore value return, even before drilling and blasting commence.

While so far, the technologies described significantly improve mining recovery, they are centred on grade control for individual blasts. The complexities of mine planning, blasting strategies, interactions between blasts and operational constraints effect the reconciliation of planned versus mined material. Advancements in OREPro™ 3D technologies now enable mining companies to unlock greater potential in resource extraction, providing real-time insights into material movement, and bridging gaps that traditionally hinder operational effectiveness.

INTRODUCING THE MODEL THROUGH TIME™

The Model Through Time™ is an innovative spatiotemporal digital twin is designed to solve these fundamental problems

present in all surface mine production geology:

1. Delineated in-situ material is used to estimate the tonnes and grade of material sent to the mill, despite blasting causing the material to change. The disconnect between achievable value pre-blast and achievable value post-blast is not well understood.
2. An in-situ model cannot accurately represent a partially mined blast.
3. Material can occupy different locations at different times.

These problems represent inherent complexities of material tracking and reconciliation from the moment of blasting. Mining operations face significant challenges when attempting to reconcile the material removed from the pit, especially when in-situ models fail to account for changes caused by blast movement and excavation.

Orica Digital Solutions' Model Through Time™ solves these problems by providing a high-fidelity representation of material as it moves through space and time. It integrates the operation's in-situ models such as resource and grade control models, with blasted models as created by the Predict engine. With the progression of time, these models are depleted on a granular level representing the excavation of material. Allowing accurate tracking of material states and supporting comprehensive reconciliation process that was previously unattainable in traditional mining practices.

THE MODEL THROUGH TIME™ ADVANCEMENTS

With the ability to track the state change of material in pit over time, the Model Through Time™ becomes a critical data source for model depletion and production reconciliation. Reconciliation reporting tools offer basic reporting functionality that allows users to perform material reconciliation quickly using topographies from each blast, or from pit wide topographic scans.

These features set the Model Through Time™ apart from traditional material tracking methods, enabling a more comprehensive and accurate understanding of material movement and improving the accuracy of resource depletion.

FUTURE DEVELOPMENTS AND ENHANCEMENTS

Orica Digital Solutions continues to advance with several developments on the horizon. New workflows with the Model Through Time™ aim to further solidify the collaboration between engineering and geology teams. To achieve this, future versions of the Model Through Time™ will be natively integrated with Next Gen SHOTPlus™, a game changing new solution for blasting engineers. By providing engineers and geologists with an interoperable technology ecosystem, they can begin to predictively plan the best value that can be recovered from the precious resource.

As the mining industry continues to embrace digital transformation, the Model Through Time™ will be a cornerstone of the future, providing the tools needed to optimise resource extraction, improve reconciliation processes, and ultimately unlock the full potential of the world's mineral resources.

Alfred Tsang
Senior Manager Spatial Products, Orica Digital Solutions

Vale's net profit drops 17% on lower iron ore prices

Brazilian miner Vale reported a 17% decline in its first-quarter net profit, hit by lower iron ore prices despite improved costs.

Vale, one of the world's largest iron-ore producers, posted a net profit of $1.39-billion for the quarter through March, slightly missing a consensus estimate of $1.68-billion by analysts polled by LSEG.

The company said earnings were hit by a decline in iron ore prices but the impact was partially offset by its production cost-cutting measures and the Brazilian real's appreciation against the US dollar.

"We had a consistent start to the year, aligned with our objectives for management in 2025," CEO Gustavo Pimenta said in the earnings report, noting a good cost momentum.

Vale posted adjusted core profit as measured by earnings before interest, taxes, depreciation and amortisation (EBITDA) at $3.12-billion, down 9% and close to the $3.16 billion expected by analysts.

The results came in line with expectations and cost performance was the highlight, Itau BBA analysts said. However, they added that "lower realized prices more than offset the improvement in volumes and lower costs in the yearly comparison".

Vale's so-called C1 cash cost of iron ore fines, which measures production costs from the mines to the ports, fell 11% in the quarter to $21 per ton.

The miner's operational report last week had shown iron ore volume production falling 4.5% due to heavy rainfall in Brazil, although Vale was able to increase sales volume with supply from inventories.

Still, a 16% decline in market reference prices of iron ore, Vale's main product, weighed on its own sales prices and led to a 4% net revenue decline to $8.12 billion, marginally above analysts' estimate of $8.03 billion.

Santander analysts said Vale presented "solid operational figures" but they were "already priced in".

Weir Joins the International Copper Association

The International Copper Association (ICA) proudly welcomes its newest member, The Weir Group (Weir – a global leader in mining technology and innovation. This strategic partnership reinforces ICA's commitment to connecting the entire copper value chain.

Weir provides world-class engineering solutions, combining materials science expertise with intelligent automation to create end-to-end mining technologies. These innovations accelerate the path to smart, efficient and sustainable mining.

Jon Stanton, CEO of Weir said: "We are delighted to join the International Copper Association. Copper has such a critical role to play in the energy transition and a full value chain approach is required to accelerate the productivity and sustainability improvements needed to support future demand. Delivering the energy transition is a team game, and we are looking forward to working together with other ICA partners to enable a more sustainable future."

By joining the ICA, Weir underscores its commitment to advancing copper's role in enabling the energy transition and addressing the world's most pressing challenges – from decarbonization to digitalisation.

"We are thrilled to welcome Weir to the International Copper Association," said ICA President Juan Ignacio Díaz and Chairman of the Board Stephen Rowland of Glencore in a joint statement. "The company's proven leadership in mining technology and deep commitment to innovation will strengthen ICA's efforts to promote responsibly produced copper and defending its critical role in building a more sustainable future. Together, we can amplify our impact as the voice of copper and drive meaningful progress across the value chain."

Ghana and Gold Fields reach transitional deal on Damang mine

Ghana and Gold Fields have reached an agreement on a transitional plan for Damang mine, the West African country's presidency said recently.

Ghana assumed operational control of the mine after it rejected an application from the South African company to renew its lease, breaking a tradition of automatically renewing licenses.

The presidency said in a statement that a new 12-month mining lease will be issued to a Gold Fields' subsidiary pending parliamentary ratification in May.

During the transition period, Gold Fields will resume open-pit mining and conduct feasibility studies to establish Damang's reserves and mine life, the presidency said in a statement.

Damang is the smaller of Gold Fields' two operations in Ghana, Africa's leading gold producer.

Alcoa reports $20m tariff hit on imports from Canada

Alcoa, the largest US aluminum producer, said President Donald Trump's 25% tariff on metal imports has cost the company $20-million since the duties went into effect.

The Pittsburgh-based company incurred the costs on imports of aluminum from Canada, its largest metal-producing region. The disclosure is one of the first indications that US companies are being adversely affected by the Trump administration's trade war.

Alcoa, in a statement, said it has "engaged with customers, suppliers and logistics companies to avoid supply disruption."

The aluminum producer said throughout the beginning of the year it was actively communicating with administrations, governments and policy makers regarding the impact of tariffs on trade. CEO Bill Oplinger warned investors in February that Trump's metal import duties would put about 100 000 US jobs at risk.

CMOC to acquire Lumina Gold in C$581m all-cash deal

Chinese mining company CMOC Group has agreed to acquire Canada's Lumina Gold in an all-cash deal valued at C$581-million.

The transaction, announced recently, will mark a step forward for the development of the Cangrejos gold project in Ecuador.

"After advancing the Cangrejos project for over ten years and taking it from no defined resources to being poised to be one of the largest gold projects globally, the Lumina Group is excited for the transition of the Cangrejos project to CMOC," said Lumina CEO Marshall Koval.

"This transition is the culmination of more than a decade of work advancing Cangrejos from grassroots to one of the world's largest undeveloped gold projects," said Koval.

"[We] look forward to working with CMOC and all existing stakeholders to ensure the successful future development of the project."

The Chinese-backed company will pay C$1.27 a Lumina share, representing a 71% premium to the company's 20-day volume weighted average and a 41% premium to the April 17 closing price. The transaction, to be completed via a court-approved plan of arrangement, has the backing of shareholders holding 52.3% of Lumina's stock.

In tandem with the acquisition agreement, CMOC has agreed to provide $20-million in interim financing through the purchase of unsecured convertible notes. The notes, maturing in April 2026 and bearing 6% yearly interest, are convertible into Lumina shares at C$1.00.

The transaction includes standard deal protections, including a C$23.3-million break fee and a C$2.8-million expense reimbursement clause. Lumina retains a fiduciary out, allowing it to accept a superior proposal, subject to CMOC's right to match.

According to Lumina, the Cangrejos project, in south-west Ecuador, is one of the biggest undeveloped gold projects globally, boasting a 26-year mine life. The latest available prefeasibility study outlined average payable production of 371 000 oz/y of gold and 41-million pounds a year of copper, with gold accounting for nearly 80% of the project's revenue. On a gold-equivalent basis, average output is expected to reach 469 000 oz/y over the life-of-mine.

The project is designed to scale up over time, starting as a 30 000 t/d operation in its first three years, doubling to 60 000 t/d in year four and reaching 80 000 t/d by year seven.

At base-case prices, the project delivers an after-tax net present value of $2.2-billion and a 17.2% internal rate of return. Initial capital costs are estimated at $925-million, and all-in sustaining costs are projected at $671/oz, net of by-product credits.

South Africa Needs All The Products And Transportation Fuels That Renewables Cannot Provide

Oil, coal, and gas are foundation to the global economy, contributing to thousands of products – estimated at over 6,000 – that underpin modern living standards. These fossil fuels drive economic activity by providing energy and raw materials for industries, transportation, and manufacturing, while their derivatives permeate everyday life, from plastics to medicines.

- Electricity came AFTER oil, as ALL electrical generation methods from hydro, coal, natural gas, nuclear, wind, and solar are ALL built with the products, components, and equipment that are made from the oil derivatives manufactured from crude oil,

- All EV's, solar panels, and wind turbines are also built with the products, components, and equipment that are made from the oil derivatives manufactured from crude oil.

- All transportation fuels for cars, trucks, merchant ships, aircraft, and military are made from refined crude oil.

- Getting rid of crude oil would eliminate electricity, and all the products that need electricity to operate, and ground all transportation!

Today, we have more than 50,000 merchant ships, more than 20,000 commercial aircraft and more than 50,000 military aircraft that use the fuels manufactured from crude oil. The fuels to move the heavy-weight and long-range needs of jets moving people and products, and the merchant ships for global trade flows, and the military and space programs, are also dependent on what can be manufactured from crude oil.

The IEA Oil Market Report – March 2025 forecasts global oil demand reaching 103.9 million barrels per day (mb/d) in 2025, up 1 mb/d from 2024, with non-combusted uses (e.g., plastics, chemicals) growing from 15 mb/d in 2022 to 20 mb/d by 2050 (BP).

US Energy Secretary Chris Wright affirmed that Africa must be free to harness its vast energy resources without interference. NJ Ayuk, Executive Chairman of the African Energy Chamber says Secretary Wright's message is a long-overdue recognition that Africa needs investment, not interference. "Africa's energy future must be decided in Africa, not dictated by foreign governments pushing policies that undermine our economic potential. The AEC welcomes this shift in U.S. policy and calls on African leaders to capitalise on this moment by accelerating oil and gas development, creating jobs and driving industrialisation."

Contributions to Living Standards

These products profoundly enhance living standards by powering modern infrastructure, mobility, and health. Transportation fuels the logistics that deliver EVERYTHING that people need to live productive and prosperous lives. The IEA Oil Market Report – March 2025 notes Asia, led by China, accounts for 60% of 2025 demand growth, driven by petrochemical feedstocks critical for plastics and fertilisers.

Plastics improve food preservation and healthcare affordability (e.g., medical devices 30-50% cheaper than alternatives), while gas-derived fertilisers boost crop yields by 50%, feeding half the world's population. Coal's role in steel and cement supports urban housing for 4 billion people, and synthetic fabrics (oil-based) cut clothing costs by 20-30%, benefiting billions. Pharmaceuticals from petrochemicals have historically extended life expectancy, and lubricants enhance industrial efficiency, stabilising supply chains.

Since 1900, fossil fuel products have doubled living standards by enabling industrialisation and access to goods.

South Africa's Energy Mix

The green factions are becoming louder in South Africa as their funding dries up from sources such as USAID and the JET. China is laughing all the way to the bank, building 95 GW of new coal and manufacturing subsidised renewables using products made from oil and ethically questionable rare earth minerals.

This while President Donald Trump has vowed to reboot the US coal industry to counter the economic advantage China has gained: "After years of being held captive by Environmental Extremists, Lunatics, Radicals, and Thugs, allowing other Countries, in particular China, to gain tremendous Economic advantage over us by opening up hundreds of all Coal Fire Power Plants, I am authorising my Administration to immediately begin producing Energy with BEAUTIFUL, CLEAN COAL," President Trump wrote on social media platform Truth Social.

Equally concerning is the refining capability and gas cliff situation in South Africa, as Sasol projects the LNG supply from Mozambique to run dry by 2027. Sasol's

CTL process exemplifies coal's added value, producing synthetic fuels and chemicals, contributing over $10 billion yearly to South Africa's economy and supporting 30,000 jobs. Why would the country not exploit the opportunity to make use of its rich coal supplies, and further reduce its reliance on imported refined products.

Local petrol, diesel, jet fuel and gas (LNG) prices are exacerbated by USD/ZAR exchange volatility and drastic price increases in refined fuel products will immediately put inflationary pressure on consumers. South Africa currently only has two operating refineries left, Astron in the Western Cape and Natref in Gauteng (Interior). The rest have been mothballed or shut.

The South African State owned utility, Eskom with its coal fleet, earned the Best Power Company in the world in 2001, but has since been hollowed out by failed policies, corruption and mismanagement. Coal still provides over 80% of South Africa's energy supply, but it has been under extreme pressure from the EU and other pro-renewables organisations to transition to purely renewables that can only generate electricity but CANNOT make any products or fuels. This is simply not an option for South Africa. It will lead to the continuation of the rolling blackouts that the country has been facing, despite 14 years of an extensive Renewable Independent Power Producer program that has cost billions of dollars.

The so-called "renewables", ONLY generate electricity but CANNOT make anything. Thus, the country needs all the Products and Transportation fuels that Renewables CANNOT provide, along with Nuclear Power stations. This is the only viable option that will lead to a fair and equitable chance to prosperity for the 62 million in South Africa, and the 1.2 billion people living in Sub-Saharan Africa who rely on essential goods and services.

Barrick advancing projects to support 30% growth by 2030

New York- and Toronto-listed gold and copper mining company Barrick is now advancing its portfolio of growth projects to support a planned 30% growth in gold equivalent ounces by the end of the decade.

Barrick delivered on the goals it set for 2024, meeting its gold and copper production guidance and maintaining its record of reserve replacement while adding substantially to its resource base, Barrick chairperson John Thornton states in the company's 2025 Information Circular.

"We improved our financial performance, despite higher costs, with an increase in net earnings of 69% – the highest in a decade – operating cash flow growth of 20%, and a doubling of free cash flow relative to 2023," Thornton notes in a release recently.

At the same time, a portfolio to achieve sustainable production and profitable growth was developed.

"We continued to ramp up Pueblo Viejo, started prefeasibility work at Fourmile, and restarted the Porgera mining operation.

"We completed feasibility studies for Reko Diq, one of the world's largest undeveloped copper/gold deposits, and the Lumwana Expansion project, which will become one of the world's largest copper mines," Thornton reports.

Both projects will support Barrick's goal of organically growing production volumes, particularly in copper, and as such the company is proposing to change its name from Barrick Gold Corporation to Barrick Mining Corporation, to reflect the company's changing production profile.

Despite rising metal prices, mining equities have underperformed, with Barrick no exception. "We viewed our equity as undervalued and consequently repurchased $498-million of shares in 2024 and we will continue to pursue share buybacks whenever we believe our shares are trading below their intrinsic value.

"We have an industry-leading balance sheet, substantial liquidity and a global portfolio of Tier 1 assets. These qualities, along with our fully funded pipeline of organic growth projects, put us on track to grow the company and increase per-share returns over the long term," Thornton highlights.

Also in the Information Circular, lead director Brett Harvey says that board renewal remained a priority in 2024, enhancing Barrick's global business expertise to achieve representation that reflects the people and regions integral to its operations.

"During the year, we conducted a rigorous and structured selection process to identify potential board candidates, and we're pleased to nominate Ben van Beurden and Pekka Vauramo for election at this year's annual and special meeting. At the same time, we would like to express our heartfelt gratitude to Christopher Coleman and Andy Quinn, who will retire from the board," Harvey adds.

The board also appointed new chairs for its key committees. They are Isela Costantini for the compensation committee, Loreta Silva for the audit and risk committee, and Brian Greenspun for the environmental, social, governance and nominating committees.

Shareholder attendance at this year's annual and special meeting on May 6 will be by way of live webcast.

Genesis sees bump in gold ore reserves

Genesis Minerals has increased its group ore reserves by 12%, strengthening its position as a high-quality, ASX-listed gold producer.

Based on a gold price of $2800 per ounce (oz), Genesis' group ore reserves now stand at 54 million tonnes (Mt) at 2.1 grams per tonne (g/t) for 3.7 million ounces (Moz) of gold, with the mineral resources totalling 210Mt at 2.2g/t for 14.7Moz.

The Gwalia gold operation holds 1.1Moz and the Tower Hill gold project holds 1Moz of the group ore reserve respectively, representing 57% of the total.

The group ore reserve also includes Genesis' maiden 370,000oz reserve at the Westralia open pit, which Genesis acquired when it took over Dacian in late 2023.

"The strong growth in reserves not only bolsters our current 10-year production outlook but also highlights the growing potential to accelerate the planned increases in the production rate," Genesis managing director Raleigh Finlayson said.

"Increasing reserves is a key step towards realising our 'ASPIRE 400' growth objective, with the cost reductions and increased cashflows which would follow.

"The scope to accelerate the production growth strategy is shown by the maiden reserve at the Westralia open pit, which already stands at 370,000oz and clearly has substantial upside."

The Westralia reserve was not included in Genesis' current 10-year production outlook, which aims to produce 3Moz over the next decade.

Finlayson said Genesis is drilling Westralia to de-risk the asset and grow the reserves while progressing various mining studies and assessing development and milling options.

"Our 10-year production outlook is comfortably underpinned," Finlayson said.

"In fact, our published production target plus surface ore stockpiles are sufficient to fill the Leonora mill for 26 years and our Laverton mill for 10 years."

Genesis has also carried out drilling at the Gwalia, Admiral, Hub and Bruno-Lewis deposits, with each deposit remaining open along strike and at depth.

Finlayson said the drilling at these deposits "continue to increase the robust nature" of the production models and forecasts.

Genesis plans to complete infill drilling at the Jupiter gold project in the June 2025 quarter to de-risk preparation for open pit mining in the 2025–26 financial year.

The company will also conduct early-stage reverse circulation drilling on the Chatterbox shear within the Maritiema prospect, which hosts significant gold deposits.

"These are the foundations of our commitment to be a reliable, sustainable and growing gold producer which can fully leverage our team, assets and infrastructure," Finlayson said.

Nobel to earn 100% of four copper projects in Chile

Nobel Resources Corporation has completed a transaction to acquire four copper projects in Chile from Austral Exploraciones.

Nobel has the option to acquire 100% of each of the projects – Cuprita, Janett, Pampa Austral and Anais – after issuing 2.5 m common shares in the company to the shareholders of Austral Exploraciones and paying $70 000 in cash to the optionors of the projects.

Nobel has also issued 2% net smelter royalty options in respect of the various projects.

To maintain each of the options in good standing and acquire a 100% interest in each of the projects, Nobel must pay amounts of between $20 000 and $1 m after 12, 24, 36 and 48 months from signing the option agreement for each project, respectively.

The Cuprita project is the most advanced among the four and is now Nobel's main focus. The site is highly prospective for copper, with multiple near-surface targets having been identified during recent rock sampling campaigns.

Cuprita is located in the renowned Chilean Paleocene Porphyry Copper Belt that hosts several major copper deposits.

The Janett and Pampa Austral sites also have abundant copper oxide mineralisation at surface and multiple small-scale artisanal operations – past and present. Historical results at Pampa Austral have returned 70 m of copper grading 0.7%.

The Janett and Anais sites have had little exploration work done despite the multiple past-producing copper mines in the surrounds.

Tirupati maintains future output targets despite below-expectation production.

Tirupati Graphite's Vatomina project, in Madagascar, produced about 388 t of flake graphite concentrate of various grades in March.

Production was below the planned monthly target owing to a combination of plant shutdowns and lower-than-expected ore grade.

To support mining of higher-grade ore, grade control and mine planning drilling was restarted in late March following the return to service of the company-owned drilling rig.

First results from this drilling campaign have demonstrated "encouraging" higher ore grades and indicate that daily production rates of about 25 t/d of flake graphite concentrate at the Vatomina plant should be achievable from two pre-concentration units (PCUs), the company highlights.

The third and fourth PCUs being transferred from the Sahamamay operation, also in Madagascar, to the Vatomina mine area will be installed during the month.

Production guidance of 1 000 t a month by July and 1 500 t a month by December remains unchanged.

Tirupati says that interest from customers across all product grades has been strong in the intervening period since the last update.

As at March 31, 220 t of legacy prepaid orders (received and paid for in 2024 under the previous leadership) remain outstanding to be produced, with production and incurred costs for these orders expected to be completed by mid-April.

From that point on, all sales will benefit current cashflows.

The audit of the overdue financial statements for the year ended March 31, 2024, has now resumed, following the need to rebuild the accounting system after the denial of access to IT systems by the previous CEO.

Meanwhile, Tirupati reports that subscriptions for its placing of zero-coupon convertible notes have surpassed £2.5-million.

The placing remains open for additional subscriptions until 17:00 on April 11.

To date, the company has received £1.56-million of the proceeds of the convertible loan notes offering, with the balance due by April 15.

Is this the largest nickel sulphide deposit in Australia?

Western Mines Group has completed the mineral resource estimate (MRE) for its flagship Mulga Tank project – believed by the company to be the largest in Australia – in the eastern Goldfields of Western Australia.

Mulga Tank's MRE stands at 1.9 billion tonnes (Bt) grading 0.27% nickel, 131 parts per million (ppm) cobalt, 82ppm copper and 17 parts per billion (ppb) platinum and palladium.

The Mulga Tank resource comprises 5.3Mt nickel, 257,000 tonnes (t) of cobalt, 161,000t copper and 1.1 million ounces of platinum and palladium of contained metal.

"This is a very significant milestone for both the project and the company and my thanks and congratulations go to the entire exploration team for the progress achieved over the last three years," Western Mines Group managing director Caedmon Marriott said.

"Our exploration results from Mulga Tank have been continuously building as we unlock knowledge of the complex and this mineral resource marks a culmination of that. It demonstrates what we have long stated – that the main body of the complex hosts a globally significant nickel sulphide deposit, we believe the largest nickel sulphide deposit in Australia and top 10 in the world."

The Mulga Tank mineral resource builds off a combination of diamond and reverse circulation (RC) drilling.

The RC drilling was undertaken to infill and prove up the extent of shallow disseminated nickel sulphide mineralisation, and the diamond drilling – which remains ongoing – tests deeper targets for basal massive sulphide.

Since revealing Mulga Tank's exploration target of 350Mt-2.2Bt in February 2024, Western Mines Group has completed two further phases of RC drilling totalling 36 holes for 11,536m.

"The mineral resource estimate focuses on just the shallow disseminated mineralisation, constrained by our current drilling, in what could be a large open pit scenario," Marriott said.

"We've got more than enough tonnes, and it will get bigger still as we extend in a number of directions.

"We will continue to infill and upgrade the resource confidence with further drilling but really the key now is to focus our exploration on the higher-grade areas within this huge open-pitable volume – looking to follow up on the 23 intersections greater than 1% nickel, including results up to 4.5% nickel and 4.8% cobalt, clustering in various zones across the complex."

DRDGOLD stronger than ever as it hits 130-year mark at time of sky-high gold pricing

Friday, April 25, marked the remarkable 130th anniversary of the uninterrupted listing on the Johannesburg Stock Exchange of South Africa's resilient gold producer, DRDGOLD.

Born out of the gold rush in 1895, 130 years later, DRDGOLD has an impressive market capitalisation of more than R27-billion.

In March, the company declared its eighteenth consecutive financial year of dividend payout while self-funding its Ergo Two and Far West Gold Recoveries projects.

In addition, Ergo Two's vital new thrust is the cost-cutting 60 MW solar power plant at the tailings reprocessing plant, plus the commissioning of a 160 MWh battery energy storage system.

DRDGOLD has transitioned well from underground mining to becoming the global on-surface leader in recovering gold from waste dumps in a property-value-adding manner that restores the environment so credibly that original game have returned to one of the restored sites of their own volition.

"We hold deep appreciation for organisations like DRDGOLD," an upbeat Johannesburg Stock Exchange CEO.

As a stock exchange that has long championed sustainability and which is dedicated to being a hive of innovation for financial markets on the African continent, Fourie described DRDGOLD as being a commendable example for broader industry in carving out a sustainable future for South Africa amid the Johannesburg Stock Exchange itself continuing to fortify its position as a capital-raising venue and global investment destination of choice.

"We'll continuously work with you and the broader ecosystem to grow the South African economy," Fourie promised.

Looking forward, DRDGOLD CEO **Niël Pretorius** expressed the hope that in 20 years' time, the solid foundations being laid by the company now would underpin the 150th anniversary of the listing of the company "in hopefully this very same Johannesburg Stock Exchange venue".

"A lot of capital is being spent to extend the life of Ergo, extend and fully optimise the life of Far West Gold Recoveries. It's wonderful to be part of that and it's wonderful to see the older generation, that have laid the initial foundation, and the new generation of leadership coming through the ranks, who will take this forward, and hopefully some of you will be here in 20 years from now, to celebrate the 150th anniversary of DRDGOLD. Let's look forward to that next 20 years of developing the full potential of this wonderful company and this wonderful orebody," Pretorius added.

DRDGOLD CFO Riaan Daval spoke of the DRDGOLD story being intertwined with the story of Egoli, 'the place of gold', Johannesburg, as well as "the Johannesburg Stock Exchange, where we are today being very much the stock exchange established to facilitate trading during the first South African gold rush".

"Our company now has a very different business model. Yes, still in gold, and, wow, what a time to be involved with gold, but with a different purpose. Over 130 years, waste was created through the processes of mining gold but not deposited in the best of places.

"As the city of Johannesburg expanded, these yellow mountains lay scattered in between where people live and work, and represent the scar tissue of a much smaller industry now, but in its place a bustling city represented by many other industries and sectors, also on the Johannesburg Stock Exchange.

"Our purpose is to roll back this environmental legacy of mining by reprocessing this waste and producing gold. We have a vision of mining all the gold waste material still left on the East Rand and on the West Rand of Johannesburg, and depositing it on modern facilities, away from where people live.

"We plan to achieve this through an extensive capital programme and anticipated production increase, which we refer to as Vision 2028. I encourage you to think back to 25 April 1895, exactly 130 years ago, and to celebrate DRDGOLD being the Johannesburg Stock Exchange's longest continuously listed company," Daval enthused.

The long horizon that still lies ahead for DRDGOLD was pointed out by DRDGOLD nonexecutive chairperson **Tim Cumming**.

"We were here right at the very beginning and I assure you we'll be here right at the very end, because when all those deep-level gold mines are finished, we'll still be treating those dumps that have been left, because there's a lot more gold to be had. So, this is an important milestone, but only one in a continuing journey," Cumming highlighted.

More than 14 years after Ergo was recommissioned, and having mined through the entire initial reserve base that supported that first capital investment to get it up and running, DRDGOLD is adding more years of production beyond 2040, an endeavour that is providing ongoing employment, restored ecosystems and more land being made available for sustainable use.

Moreover, Far West Gold Recoveries is benefiting from Ergo's learnings to build another mega-project.

The model is dynamic and capable of being transported to other mining operations in Africa and beyond at a time when DRDGOLD has expressed keenness to collaborate with other mining companies in the same way as it has over the past seven years with Sibanye-Stillwater to activate the income-generating potential of its mine waste and apply a significant part of it to environmental restoration.

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Caterpillar's major step in autonomous haulage technology

Caterpillar (Cat) has released its new Cat 775 off-highway truck at Bauma Munich 2025, marking a major step forward in autonomous-ready haulage technology.

Cat's off-highway truck line is a first next generation design, with a 65-tonne payload hauler built with full autonomy in mind.

"The design of the next gen 775 represents a significant leap forward in off-highway truck technology, offering unmatched power, efficiency and safety features," Cat president of construction industries Tony Fassino said.

"Visitors at Bauma will see our full range of technology offerings, from remote control to semi-autonomous to the future of autonomous machines in construction."

Cat is leveraging its autonomous hauling system, also known as AHS, Cat MineStar Command for hauling, which is already being used at mine sites across the globe.

Now, the company is refining this system to suit smaller-scale quarry operations.

"We are using the lessons learned from working with our US-based customer, Luck Stone, where we have MineStar Command for hauling installed on four Cat 777 trucks," Cat resource industries group president Denise Johnson said.

"The shift to the aggregate industry, where we are automating fewer trucks that don't haul material 24 hours a day, is helping transform our technology and processes to manage smaller operations."

While the Cat 775's autonomous capabilities are still under development, the truck is set to be introduced commercially in 2026.

Beyond autonomy, the model also features a new frame design, enhanced suspension and refined serviceability.

"Compared to previous models, our next generation 775 off-highway truck features an industry-first frame design that reduces empty weight, delivering the potential for larger payloads and lower fuel burn," Cat senior engineer and team lead for the Cat 775 David Holthaus said.

"Plus, its 10% more body volume and improved turning radius helps to boost productivity and performance."

The truck's enhanced cab includes 360-degree surround cameras, radar-based Cat Detect technology, and upgraded operator comforts such as a deluxe seat and automatic climate control.

Serviceability is also improved, with ground-level access, remote diagnostics and extended filter intervals helping to increase uptime.

The new Cat 775 represents a bold step toward the future of mining and quarry operations, setting the stage for the next era of connected, autonomous haulage.

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Develon Unveils Next Generation '-9' Excavators at Bauma

DEVELON's '-9' range sets new benchmarks in productivity, safety and operator convenience

The centrepiece of the first appearance at Bauma 2025 by DEVELON, formerly Doosan Construction Equipment, is the unveiling of the first models from the company's new Next Generation '-9' Smart Crawler Excavator range. The Next Generation -9 range represents the latest stage in a proud legacy at Develon that can be traced back through five generations of excavators that began with the Solar range in the 1980s.

At Bauma, Develon is revealing two new -9 smart heavy crawler excavators being presented for the first time in Europe at a special ceremony on the company's stand. The 23 tonne DX230LC-9 crawler excavator is part of the static display and the 26 tonne DX260LC-9 model is showng its paces in the demonstration area throughout Bauma.

With the -9 range, Develon is aiming to set a new standard for future products and technologies in construction equipment. Like all -9 models, the DX230LC-9 and DX260LC-9 models achieve this goal by combining 10 (ten) ground-breaking technologies and will redefine and set new industry levels of Productivity, Safety, Operator Convenience and Sustainability. The -9 range not only endorses the company's forward-thinking vision but also underscores Develon's unwavering dedication to innovation and excellence in the construction equipment sector.

Develon has integrated cutting-edge innovations into every aspect of the new -9 models, refining both overall product design and essential functionalities. These advancements enhance daily operations with significantly increased performance, reduced fuel consumption, and ensure industry-leading uptime. The improvements can be categorised into four key areas:

- Safety & Smart Features
- Operator Convenience & Cab Comfort
- Increased Productivity & Efficiency
- New Product Design

Safety & Smart Features

The **Smart All-Around Viewing Monitor** (SAVM) is an AI-based Object Detection technology to effectively identify both moving and stationary individuals in close proximity to the machine. Upon detection, the system promptly alerts operators through a combination of visual signals and audible alarms on the monitor, ensuring a heightened awareness of the surrounding environment.

The **Advanced Lift Assist** system provides clear and immediate visibility of the machine's tip-over possibility, serving to mitigate accident risks and keep the operator focused on driving.

The innovative **E-Stop** and **Virtual Wall** functions prevent accidents the operators are not aware of. To help ensure safety, the area surrounding the machine is clearly defined into specific zones: a yellow warning zone (Zone 2) and a red danger zone (Zone 1).

The SAVM and E-Stop system utilise 6 cameras and 3 radars and work in 3 stages with a detection range of 13 m and 330°:

1. People detection from 13 m range
2. Warning and slowing down the speed from 6 m
3. Stopping the machine from 3 m (swing and reverse)

The E-Stop is an essential safety feature designed to control or halt a machine's movement, such as driving or swinging, in cautionary or dangerous areas, thereby ensuring operator safety.

The Virtual Wall feature significantly enhances operation by allowing users to confine the machine's movement within predefined areas where the risk of collision may be heightened. This is especially useful in tight urban or underground sites with obstacles like wires and pipes, ensuring safer operations.

Operator Convenience & Cab Comfort

The -9 machines feature an ergonomically designed user interface that enhances ease of use. It includes a thoughtfully arranged keypad, a jog shuttle and a monitor that is easily accessible, among other features. One standout aspect is the wide and intuitive 12.8-inch monitor, available in dual configurations for diverse needs. Additionally, the machine comes with a comfortable seat that has a built-in cooling function, as well as a cab designed for improved visibility, providing operators with best-in-class convenience in the industry.

Develon provides customised solutions through its FEH (Full Electric Hydraulic) system on the -9 models. The operatability and controllability of these machines can be fine-tuned, according to the unique characteristics of different workspaces and user preferences. This personalisation maximises both efficiency and comfort, allowing operators to access optimised settings even when multiple individuals utilise the same equipment.

Operators have tuning options and can customise joystick sensitivity and more to match their driving habits and job site needs. Develon's solutions ensure a comfortable, precise, and efficient machine handling experience for a variety of attachments and work styles.

Ultimately, Develon is committed to delivering customised solutions that boost productivity and efficiency, tailoring equipment to operational needs and operator preferences for optimal performance and success.

One of the standout features of this service is the Digital Key, a sophisticated Bluetooth combined with high speed Ethernet network (5G) communication-based tool that empowers users to unlock the cab door, ignite the engine and adjust the air conditioning settings from the MY DEVELON app, all without the need for a physical key. This remote-control functionality allows for efficient management of the machine from a distance.

Furthermore, the platform enables users to view and analyze operational history, aiding efficient equipment management, especially in fleet or rental scenarios.

Increased Productivity & Efficiency

Compared to the previous -7 models, the new -9 machines provide a 12% increase in productivity and an 8% reduction in fuel consumption. This enhancement is primarily attributed to the powerful output of Develon's self-developed engine, which significantly boosts digging power and lifting capacity.

The incorporation of a Full Electric Hydraulic (FEH) control system – featuring electronic pumps, electronic Main Control Valves (MCV), and electronic Relief Control Valves (RCV – has resulted in fuel savings of between 1700 l (for the DX230LC-9) and 2700 l (for the DX260LC-9) for every 1500 hours of operation compared to earlier models. In addition, the new -9 generation machines offer unparalleled lifting capacity and machine stability within their categories.

The implementation of Develon's cutting-edge, in-house developed technologies, such as **2D Machine Guidance** and **Smart Control** functions, enhances productivity by helping operators perform their tasks more easily and safely, reducing both time and costs. Additionally, these features are designed specifically for Develon machines, delivering economical and effective solutions.

The innovative **Breaker Assist** technology prevents blank firing, which helps protect the excavator and its components while minimising operator fatigue, leading to increased productivity. Additionally, the **Auto Breaker** function allows operators to perform breaking seamlessly without the need for continuous button pressing, further reducing operator fatigue.

The **Weighing Assist** system is designed to accurately monitor production levels and manage volume, ensuring that dump trucks are loaded to their appropriate capacities. By effectively addressing the problem of overloading, the system enhances road safety and streamlines the operational processes previously required for weight compliance, ultimately leading to increased productivity.

The new -9 models are equipped with Develon's advanced **Prognostics and Health Management (PHM)** technology. This technology continuously monitors key components like hydraulic oil, engine oil, pumps and motors, enabling timely predictions and proactive maintenance.

New Product Design

The external design truly encapsulates Develon's vision of SMART construction equipment. Notable features include the industry's first welcome light, strategically placed horizontal beacon lamps at the four corners of the cab's upper surface, and signature lighting that adapts to the work environment by changing colour.

Additionally, the counterweight in the new design powerfully embodies a straight line, the Linear Core, serving as a design element that reflects Develon's heritage of being both 'refined and dignified' as well as 'stable and reliable' to the company's customers.

Effective lubrication and sustainability

The mining industry's drive for increased productivity, utilising ever-larger machinery, places immense pressure on maintenance and lubrication systems. In mines and quarries worldwide, operators strive to minimise costs and maximise uptime in challenging environments. This evolution demands that machinery designers and lubricant system manufacturers create systems capable of handling the increased loads and sizes of modern mining equipment. Effective lubrication is essential for reliable and economical operations, and selecting the right lubricants and services is crucial to meeting these evolving demands and improving profitability.

Gordon Barratt of Mining & Quarry World **looks at the current challenges for the maintenance of machines and components.**

The unprecedented productivity levels of modern equipment create significant challenges for maintenance staff. Larger components and increased load limits demand that machinery designers and lubricant system manufacturers create reliable systems that can effectively lubricate and sustain these machines.

Indeed, lubrication is a critical aspect of maintaining mining equipment. The right combination of lubricant and its timely application can make a significant difference in the efficiency and lifespan of the machinery. To understand the importance of lubrication in mining operations there is a need to examine the key challenges faced by lubricants within the mining sector.

CHALLENGES OF LUBRICATION IN MINING OPERATIONS

Key challenges include:

- **Harsh Environment:** Mining sites are filled with dust and contaminants that can significantly degrade lubricants, affecting machinery performance and longevity.

- **Heavy Loads:** Equipment used in mining operations must withstand extreme loads, requiring high-performance lubricants with strong load-bearing capacities, such as those designed for high weld load or Timken load conditions.

- **Difficult Application Areas:** Large and heavy machinery like draglines and shovels pose difficulties in lubrication, as certain components are hard to access for regular maintenance.

- **Moisture Exposure:** Mining environments are often high in moisture, which can compromise lubricant effectiveness, leading to increased wear and potential equipment failures.

- **Extreme Temperatures:** Mining operations are exposed to fluctuating temperatures that can accelerate lubricant degradation, making it crucial to select temperature-resistant solutions.

- **Monitoring and Maintenance Challenges:** Due to the remote locations of mining sites, monitoring and maintaining equipment such as excavators, dumpers, and shovels can be difficult. For example, in 2020, one of Coal India's subsidiaries, BCCL, managed 36 coal mines, including 11 underground, 16 open-cast, and 9 mixed mines, along with 8 coal washeries, demonstrating the scale of maintenance complexity.

- **Centralised Control Issues:** Mining areas are often vast and spread across remote locations, making it challenging to implement streamlined lubrication and maintenance programs efficiently.

- **Health and Environmental Concerns:** Modern lubrication solutions must balance performance with safety by eliminating carcinogenic and toxic ingredients while maintaining efficiency. Additionally, the demand for eco-friendly lubricants is rising to minimise environmental impact without compromising effectiveness.

KEY CONSIDERATIONS FOR EFFECTIVE LUBRICATION IN MINING OPERATIONS

- **Selection of Lubricant:** Choosing the right lubricant is crucial for optimising machine efficiency and reducing wear and tear. A well-suited lubricant enhances performance and extends equipment lifespan.

- **Frequent Reapplication:** Regular lubrication ensures smooth operation, preventing unnecessary friction and damage to critical components.

- **Economic Benefits:** Proper lubrication minimises equipment failures and reduces maintenance costs, leading to significant long-term savings.

- **Environmental Impact:** Using an efficient lubrication system helps lower energy consumption and reduces environmental impact by minimising waste and emissions.

- **Monitoring and Adjustment:** Continuous monitoring and periodic adjustments of lubrication systems improve their effectiveness, ensuring optimal performance and reliability.

By addressing these factors, mining operations can enhance equipment durability, improve efficiency, and promote sustainable practices.

MINING LUBRICANTS: CLASSIFICATION BASED ON THEIR CHEMICAL COMPOSITION

Lubricants consist of base oils and additives. Depending on the base oil type they are classified into mineral and synthetic. Mineral oils are derived from naturally occurring petroleum. Even though they are more affordable than their synthetic counterparts and are still used in the largest amount, they have several drawbacks. First they are made out of natural components and consist of chemical elements such as sulphur or phosphorus that are considered major contaminants.

Additionally, they are typically sensitive to temperature changes and have a lower pour point and flashpoint compared to synthetic ones. These disadvantages are compensated by adding performance boosting additive packages after oil Purification. Synthetic oils are made synthetically, through chemical reactions. The goal is to create purer and more innovative alternatives to conventional industrial lubricants. Unlike their mineral counterparts, synthetic oils have a higher viscosity index, meaning they are more stable at different temperature ranges. Their high flash point means they are a perfect solution for heavy duty industries like mining, where there are common fire related safety hazards.

ADDITIVES

Performance boosting additive packages are used to enhance the performance of both mineral and synthetic oils. They increase their existing properties as well as add new traits to them. Many additives are used in today's high performing mining lubricants. Some of them are detergents, dispersants, friction modifiers, corrosion inhibitors, antioxidants, foam inhibitors, and viscosity index improvers.

Mining lubricants classification based on their application
Modern mining machines are bigger, faster and more powerful. Lubricant manufacturers continue to produce and enhance their products to meet the ever changing needs of sophisticated heavy mining equipment.

HYDRAULIC OILS

Hydraulic fluid serve as an energy transfer medium in hydraulic machinery that plays a fundamental role in mining. Additionally they serve as excellent sealants and lubricant agents. Hydraulic fluids are highly versatile and are used across various heavy- equipment and heavy-duty industries such as mining. They remain stable even when exposed to the harshest temperatures which makes them suitable for demanding working conditions.

GREASES

Greases are a mixture of base oil, performing enhancing additives, and thickeners. Heavy duty greases are purposefully created to ensure the highest performance in the most unfavourable working and climatic conditions. Like in engine oils, base oils and greases can be mineral or synthetic. On the other hand, based on the thickener type, greases are classified into calcium greases, aluminium complex greases, lithium greases, bentone greases, polyurea greases, sodium greases and so forth.

INDUSTRIAL OILS

Industrial oils are specifically designed to support heavy mining equipment even in the most demanding working environments. These oils are highly versatile. They provide exceptional anti wear, anti friction, and anti corrosion properties. Additionally industrial oils have great thermal stability, low foaming properties and water separation properties.

GEARBOX AND TRANSMISSION OILS

Gearbox and transmission oils are used in different transmission types and have different chemical compositions. There are various semi-truck and heavy duty applications. As such they are used in various heavy equipment industries including mining and construction

Today’s machinery can be as large as houses, with some booms extending up to 300 feet. Depending on the machine type – whether it's a shovel, dragline, or drill – key components can be either electrohydraulic or electromechanical. Some draglines possess enormous hydraulic systems and electrically driven gears, with sump capacities reaching thousands of gallons. Rolling stock, including bulldozers and large haul trucks, are powered

by diesel engines. Many loading and hauling equipment designs feature hydraulic systems powered by diesel generators.

Given the rising operational costs, mining companies must continuously monitor the performance of their heavy mobile equipment. Profitability depends on the ability to accurately diagnose performance issues before they lead to production downtime.

Equipment maintenance costs represent between 30% and 50% of direct mining expenditures. Most often, mining companies employ traditional preventative and reactive maintenance programs for critical equipment, which accept much of the maintenance peoples time. It is pure fallacy to suggest that even in today's automated operations that maintenance people are non-existent, every one's car for instance suffers occasional breakdowns and to have to wait several hours for a mechanic can be mega frustrating.

New advancements in equipment monitoring technology enable time constrained technicians and engineers to discover, diagnose and act on a fault before it results in production downtime or considerable damage to the equipment or operator. By remotely accessing onboard equipment data, personnel can immediately view and analyse equipment and operator performance through a variety of dashboards, user defined key performance indicators and alarms, to facilitate immediate action.

While equipment monitoring is not new to the mining industry, traditional methods, unstable technology, and the extreme mining conditions have; often plagued the effectiveness of these first- generation solutions.

Maintenance personnel can now monitor the entire mining fleet and receive early warnings of developing problems, prompting action, and reducing negative impact on operations. Vital equipment spends less time on the shop floor and more time in the mining field.

Similarly, it is always suggested that maintenance personal take advice and support from lube marketing companies to get their oil analysis and trends monitoring done for each individual equipment. Such expertise in Condition Based Monitoring (CBM) and Total Fluid Management (TFM) services are now available to operations worldwide. It is important for mine companies to partner with lubricant suppliers that can understand and account for the diverse needs of each operation. For example, in today's off-highway equipment world, the driving force in new product development is to enable end users to have lower operating costs. Equipment manufacturers have responded by increasing equipment efficiency, primarily by increasing equipment size, increasing the load carrying capacity and operating speeds while constantly striving to reduce both equipment cost and weight. Increasing equipment size has triggered the increase in the engine's size and horsepower, which in turn has placed more demand on the drivetrain hardware components (i.e., transmission, axles, hydraulics, and gears) and correspondingly on the fluids that lubricate these components and keep this equipment running optimally for their expected useful life cycle.

Typically, there have been increases in power, power density and torque with each successive model. This increase in power density generates more heat, raising oil sump temperatures throughout the drivetrain. Transmissions, differentials, and final drives are subjected to increasingly higher loads as machines become capable of shifting larger quantities of material and much faster. The surface finish of components, their design and metallurgy have steadily improved, but they still require the highest level of lubrication to deliver maximum performance and remain durable.

Lubricant manufacturers have developed specialised engine oils, transmission, and drivetrain oils to provide the appropriate level of performance. Over the past few years for instance, Indian lubricant manufacturers have developed specialised power transmission fluids designed to provide the appropriate level of performance required

to meet stringent OEM specifications. Higher operating temperatures coupled with higher load factors has driven the development of new oils with increased wear protection, enhanced friction performance, in addition to a number of other performance attributes.

Power transmission fluids (in SAE 10W , 30 & 50) are specially designed heavy duty transmission fluid for off-highway power shift and certain non-synchronised manual transmissions, wet brakes, final drives and hydraulic systems meeting the rigorous performance requirements of Caterpillar TO-4, Allison C-4 and other off-road equipment specifications. It contains carefully selected base oils assuring the up most oxidation, thermal and shear stability for long oil life while the specialised additive system provides additional oxidation resistance, balanced frictional performance, wear protection and maximum power transfer during operation. They also contain additional special additives to enhance cold temperature performance, rust, corrosion, and foam protection, along with outstanding compatibility of clutch friction material and seals. The use of such dedicated driveline fluids brings in huge benefits in terms of increased performance and massively increased protection. There are also the final drive axle oils (FDAO) and synthetic gear oils which are available in not just the Indian market.

For shovels, hydraulic oils are now available from lube marketing companies which can increase productivity and even help in reduced fuel consumption leading to substantial savings for the users. Long drain hydraulic oils are also available which can provide 50%-100% increase in the oil drain interval (ODI). All such oils have passed the tests during various field trials conducted in Indian conditions.

In engine oils selection, the mining industry needs to move from the API CH4, CI4, CI4 Plus to the CJ4 grades in SAE 15w40 viscometrics. To increase fuel economy, some users contemplate using lower viscometrics like 5w30 etc., but many OEMs have their reservation about engine durability. Extending oil drain intervals in off highway engines and machines can be challenging though. Dirt ingress and coolant leaks occur more frequently, and at times oil drain intervals are established to minimise damage from such problems. The cost reduction associated with longer oil and filter change intervals must be balanced against the risk of shortened engine life and the cost associated with less reliability if oil drain intervals are extended too far. Thus, correct fluid and adherence to proper lubrication regimes is important not only to achieve higher productivity but also to reduce cost of repairs and downtime. Using the correct specialised fluid undoubtedly can cost more, but that cost is still insignificant when compared to the cost of the equipment, repairs, and lost revenue in downtime. Low-price generic fluids are not robust enough, nor do they have the correct specifications to protect gear and transmissions components in high performance and heavy machinery operating in hostile conditions.

Given the use of the correct lubricant, maintaining fluid integrity is still an important consideration. Machines are usually working in dusty conditions so filter conditions must be maintained properly to achieve extended equipment life. As an alternative to manual lubrication, automatic lube-delivery technologies have been introduced specifically for machinery in the off-highway marketplace. Automatic centralised lubrication systems in different configurations have gained significant ground by enabling the right lubricant to be supplied at the right time and at the right lubrication point -- without manual intervention. The size of a machine, type of required lubricant, number of lubrication points and other factors will guide initially in choosing the most viable centralised lubrication system for an application. The primary purpose is to supply lubrication points continuously with metered lubricant while the machinery is in operation and all the bearings are moving.

CONCLUSION

Today's centralised lubrication systems factory-installed on mining machinery have minimised the need for lube techs in most cases. These computerised systems are now capable of dispensing the right product, in the right amount, to the right point, and at the right time.

There are several centralised lubrication system manufacturers that offer a wide range of system types and designs to meet the needs of any mining application.

Most lubrication systems consist of a grease pump, a motor to drive that pump and some sort of injector or valve to control or measure lubricant volume. Most utilise a programmable logic controller (PLC) to program the frequency of the lubrication replenishment cycle. As sophisticated as some of these systems are, maintenance and proper set-up is essential to ensure that their benefits are realised.

Lubricant manufacturers have continued to improve their products to meet the needs of bigger, faster machines. Although most lubricant suppliers are not lubrication system specialists, many have the resources to provide technical support, offering sound advice for selecting the products best suited for the applications.

The products commonly used in mining equipment can be divided into three groups: heavy-duty lubricating oils, such as EP oils for enclosed gear drives; multipurpose engine, circulating and hydraulic oils for engine, bearing lubrication and fluid power; and general-purpose grease, for normal industrial bearing applications and specialised mining products.

Walking draglines for example may require lubricants for the exceptionally large plain bearings that support the entire frame of the unit as it moves through the walking process.

These lubricants may have a high concentration of lubricating solids or soft metals dispersed into a stiff grease and delivered in small bags (for the walking mechanism without an automatic delivery system) just ahead of the peak loading area. This grease is referred to as a Walking Cam lubricant.

An effort to reduce the number of lubricants on a machine has driven the development of multipurpose products designed to meet several different applications from a single lubrication system. The various components to be lubricated may include the open gears, guide rails, main table bearings and various smaller slides and bearings.

Unplanned conveyor stoppages – causes, effects and solutions

When a conveyor is shut down to carry out running repairs or unplanned maintenance, the materials it is carrying may stop flowing but the costs most certainly do not. In fact, quite the contrary because the cost of the remedial work can be multiplied many times over by every minute of lost productivity. It is an excellent example of the maxim 'Time costs money'. Losses caused by conveyor stoppages run into many millions every year. The root causes fall into two categories: the conveyor belt and the conveyor structure itself. The frustrating part is that much of the loss is entirely avoidable. Conveyor specialist *Bob Nelson* explains

THE CONVEYOR BELT – UNRELIABLE SPLICE JOINTS

The weakest point of any conveyor belt is the splice joint. Consequently, splice joint problems are widely regarded as the most common cause of conveyor stoppages. Because of the serious loss of output, as well as the safety implications caused by sudden splice joint failure, it is critically important to maximise the strength and long-term durability of the joint.

Apart from poor workmanship, joint problems are prevalent in low-grade, imported belting. Within that, the two most common causes are poor adhesion within the belt or between belt and splicing materials, and insufficient elongation of the belt. Having the optimum level of adhesion has an enormous impact on the creation and ongoing reliability of splice joints. Adhesion levels that are too high can cause significant difficulties and delay when making both hot and cold vulcanised joints, but not necessarily affect the end result. At the opposite end of the scale, and far more commonplace, is that an inadequate level of adhesion compromises the strength of the joint.

As with nearly all other failings in conveyor belts, the root cause of poor adhesion is the use of low-grade (low cost) raw materials, the quality of the rubber and other cost-cutting methods used to manufacture so-called 'economy' belts. Low grade ingredients such as polymers, fillers such

Splice joint problems are a major cause of stoppages for repair or replacement.

as carbon black, vulcanising agents and curatives all have a negative impact on adhesion levels, even when fresh and high-grade splicing materials are used.

On multi-ply belts, insufficient elongation is symptomatic of low-grade belting due to poor quality rubber and fabric ply material. This is mostly an issue in areas where the belt needs to stretch, such as troughing and bending round pulleys and can cause localised tension build-up, which can have an especially negative effect on the splice joint.

In addition, low elongation can lead to shear stresses that may in turn cause delamination (ply separation) issues. On the flip side, too much elongation can result in insufficient tension, which can lead to premature wear and tear.

Insufficient elongation can cause delamination.

HOW TO IMPROVE SPLICE JOINT RELIABILITY.

The most common method of making a splice joint is the step splice, which requires the removal of one of the layers of fabric plies so that the belt ends can be overlapped and then either cold glued or hot vulcanised together. This method is popular because it is regarded as being easier and quicker. However, although it may take a little longer to make, a far stronger and more reliable joint is achieved using the finger splice jointing method, where a zigzag pattern is cut into both sides of the belt ends, creating several interlocking ‘fingers’. These are then aligned, interlocked together and finally bonded using a hot vulcanising press to make a splice that is very strong and flat. An additional benefit is that this flatness makes it almost impossible for the joint to be damaged by scrapers.

Finger splices are far stronger and more reliable and retain a much higher tensile strength. (Image courtesy of Fenner Dunlop Conveyor Belting).

Crucially, when the belt is working under load, the finger splice is vastly superior to a stepped splice in terms of resistance to dynamic failure. The superior strength and durability of finger splices therefore reduces the frequency to repair and re-splice.

The conveyor belt – carcass related stoppages. The inner carcass is the core structural element of every conveyor belt, tasked with supporting the materials being conveyed, and providing inherent characteristics such as tensile strength and elongation (elasticity or 'stretch' under tension).

There can be enormous differences in the strength and quality of the synthetic fabric used to create the carcass. This is entirely dictated by whether the belt manufacturer is at the 'quality end' of the market or the 'cut-price' end. Although they may be the same specification on paper, the strength under load both longitudinally and transversely can be inconsistent. Although the amount of material used in the longitudinal strands of the fabric may be sufficient to achieve the required tensile strength, in an effort to reduce cost, the use of the more costly nylon transversal weft material is kept to a minimum.

As a consequence, rip and tear resistance are reduced, leading to stoppages to carry out patch and clip repairs and, in more serious cases, inserts or whole belt replacement. In addition, the low elongation common to low-quality fabric plies can cause problems with transition distances, a general inability to accommodate the contours of the conveyor and its drums and pulleys and, as mentioned earlier, unreliable splice joints.

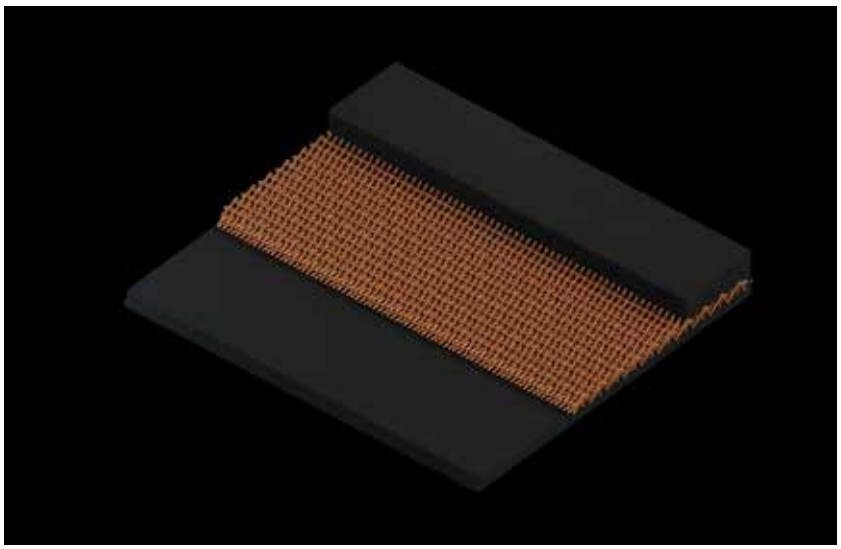
THE CONVEYOR BELT – COVER RELATED PROBLEMS

The physical properties of the rubber are the single biggest influence on the length of a belt's operational lifetime. The primary cause of cover damage is the use of rubber with an inadequate resistance to wear & tear, ripping, cutting and gouging rather than rubber that is deliberately engineered to withstand such demands.

Much also depends on the overall strength of the rubber and its resistance to cut and tear propagation. If the latter is insufficient, then even a seemingly insignificant area of damage can easily increase in size due to the continuous material loading and the flexing around the drums and pulleys. In time, this spreads and links up with another area of damage causing pieces of rubber to be cut out

'Cheap' imported belts are much more prone to ripping.

Surface cuts in low grade rubber propagate more quickly and link up with other areas of damage, causing pieces of rubber to detach completely.



Special weave design, super-strong fabric plies are the best way to combat rip, tear and impact damage.

from the surface and becoming yet another reason to stop and carry out running repairs.

Although the standard of its physical properties plays a critical role in minimising the need to intervene and carry out repairs, it is important to bear in mind that rubber represents some 50% of the material cost of producing a conveyor belt. Consequently, it provides an irresistible temptation for manufacturers to sacrifice standards of resilience who want to create a price-competitive edge. This is why the sharp stone that finds its way between the drum and the belt will cut into low-grade rubber with ease whereas it will hardly make a mark in higher quality, more resilient rubber.

Thicker is not always better. When faced with recurring stoppages caused by belt damage, there can be a temptation to fit a thicker, heavier belt but almost invariably, this is not necessarily the solution. First and foremost, it is the quality, strength and design of the rubber and the inner plies that have the biggest influence rather than the thickness of the covers and the number of plies. There are also a number of downsides including increased dynamic stress within a carcass that is too thick for the size of pulleys and drums and reduced flexibility in both length and width leading to troughing and handling problems. Thicker covers will also not prevent surface damage and its propagation, and neither will they prevent rip and tear. For rip, tear and impact damage problems, the only true solution is to fit belts that have been specifically engineered to handle such demands including super-strong, special weave pattern fabric plies.

The conveyor. Under-pinning all the issues concerning conveyor belts is the conveyor itself. Design elements suited to the installed belt are critical, for example trough transitions, convex curve radii and pulley dimensions. You can have the best quality belts in the world, but stoppages will still occur unless the conveyor, including all its components, are inspected daily. Regular, preventive maintenance, good quality components and a clean working environment all help to prevent stoppages and extend conveyor belt life. Other factors include making sure that any scrapers are correctly adjusted and that drum linings (where applicable) are in good condition. Belt tracking is also important because a

mis-tracked belt can catch on the conveyor framework. Again, cleanliness is important because mis-tracking is often caused by material build-up on the bottom side of the conveyor belt or drums and pulleys.

A big cause of stoppages to carry out running repairs is damage to conveyor belts caused by material becoming trapped. When lodged in part of the conveyor mechanism or simply finding their way between the belt and the drum, even small, sharp stones can puncture the belt cover. Larger objects can penetrate the carcass and, in some cases, cut the belt lengthwise. The first step in reducing the risk is to identify where foreign objects and rogue material is most likely to become trapped and take preventative measures such as installing skirts or screening for example.

Apart from increasing the chances of an object becoming trapped, waste build-up is a common cause of damage to idlers and drums, which can cause a lot of collateral belt damage. A significant proportion of belt damage is caused by incorrect installation of auxiliary equipment, damaged, protruding steelwork and components vibrating loose and ultimately becoming detached, all of which can be identified and rectified through regular inspection.

SUMMARY

Downtime is hugely expensive and, as I have hopefully explained, the use of low-grade components is the primary cause. It is therefore essential that the cost of such stoppages in terms of lost output, together with the actual costs of repairs and replacements, becomes an integral part of the calculation when evaluating the cost rather than just the price of primary components such as the conveyor belt and ancillary equipment such as idlers and rollers for example. As the old adage goes, price is what you pay but cost is what you spend.

Bob Nelson

Double trouble – a damaged component and an unclean environment.

Technological transformation in mining

Automation, artificial intelligence (AI), and digital mine technologies are fundamentally changing mining operations. These innovations promise increased efficiency, safety, and productivity. Examples include autonomous haul trucks, AI-driven exploration, and IoT-enabled real-time monitoring. These technologies offer benefits like improved profitability, reduced environmental impact, and enhanced safety. However, they also necessitate a shift in workforce skills.

THE SKILLS GAP AND WORKFORCE PREPAREDNESS

A significant challenge is the gap between current workforce skills and the demands of these new technologies. A survey indicates that approximately 65% of mining professionals believe their teams are not adequately prepared for these changes. This highlights the urgent need for proactive education and training.

STRATEGIES FOR BRIDGING THE GAP

Effective solutions involve collaboration between mining companies, educational institutions, and training providers. Examples include:

- **Company-led training:** Rio Tinto's autonomous systems training programs, which upskill operators for autonomous truck fleets.
- **Industry-academia partnerships:** Collaborations like the University of Queensland's tailored programs, addressing technical and leadership skills.
- **Government-backed apprenticeships:** Programs in countries like Canada and Australia, providing hands-on experience with emerging technologies.

These initiatives aim to build a foundation for continuous learning within the industry.

INDUSTRY FORUMS AND WORKFORCE DEVELOPMENT

Events such as Mining Indaba play a crucial role in fostering discussions on workforce transformation. These platforms facilitate dialogue among experts, educators, policymakers, and industry leaders, focusing on solutions like collaborative recruitment and integrating soft skills into technical training.

MOVING FORWARD: ACTION AND DIVERSITY

Sustaining growth and innovation in mining requires investing in education, skill-building, and leadership development. Additionally, creating a diverse and inclusive workforce is essential. This involves removing barriers for underrepresented groups, such as women and minorities, to fully utilise available talent.

The future of mining is driven by technological advancements. However, the success of this evolution depends on the workforce's ability to adapt. Actions such as implementing training programs, establishing industry-academia partnerships, and participating in forums like Mining Indaba are vital for building a skilled and diverse workforce.

Considering the ongoing transformations within the mining industry, what is the current and future state of skills in the minerals industry?

This is a central question for many industry professionals. Research on this topic, notably highlighted in **The Digital Mining Report: The Future of Work, the Changing Skills Landscape for Miners**, offers key insights.

A better understanding of the future skills required by the mining workforce will enable industry stakeholders to strategically plan their human resources and maintain their competitive edge in global markets.

Further analysis from this report reveals the following impacts on the workforce across the mining value chain:

- **Robotics and Automation:** The increased adoption of drones, autonomous vehicles, and remote-controlled systems will enhance exploration and mining operations. This is predicted to reshape traditional roles like drill operators, surveyors, and field geologists, while increasing the need for remote vehicle operators and geologists with advanced skills in modern data and digital technologies.

- **Data and Digital Literacy:** There will be a growing demand for data and digital literacy across all stages of the mining value chain. As human-machine interaction becomes more common, these skills will be crucial for redesigning most occupations, improving decision-making, and optimising daily tasks.

- **Remote Operations and Integrated Centres:** Cloud computing, information sharing, and big data are transforming work by enabling integrated operating centres. This trend will accelerate, allowing more work to be done remotely and flexibly, leading to improved work health and safety and enhanced workplace conditions by reducing on-site hazards.
- **Resilient Skills:** Industry and academic sources agree that skills requiring higher levels of task creative intelligence, social intelligence, and perception and manipulation will be less susceptible to the impacts of technology and automation. The report identifies the following future skills as increasingly important and resistant to technological impact:

    - Change Management
    - Collaboration
    - Complex Stakeholder Engagement
    - Creativity
    - Data Analysis
    - Data and Digital Literacy
    - Design Thinking
    - Stakeholder Analysis
    - Strategic Planning

A **Technology Impacts Index** applied to mining occupations indicates that technology will primarily **enhance** (42%) and **redesign** (35%) jobs, with a smaller proportion (23%) potentially being **automated**. The 'end-to-end' mining stage is expected to see the most occupation enhancement through technology, while 'mining operations' will experience the greatest redesign of roles (Table 5).

EY's report compiles this data into an industry **Skills Map**, illustrating the evolving skills landscape. This map categorises industry occupations into 'enhanced', 'redesigned', and 'automated' scenarios based on technological impacts. It also provides a detailed breakdown of occupations, including their constituent skills, skill type, required education level, and a percentage indicating likely future demand.

The Digital Mining Report suggests that demand for all industry **Skill Types** will increase overall (as illustrated in the figure below), although some skills within the 'Technical' category may experience decreasing or slow growth.

Specifically, **System, Basic, and Social Skills** are projected to have the highest future demand. Conversely, certain technical skills, such as Vehicle Operations and Materials Extraction, are expected to have the least net growth in demand.

Technologies such as automation, artificial intelligence (AI), and digital mines are key words – they're shaping the very foundation of how mining operations are conducted. These advancements promise increased efficiency, improved safety, and higher productivity. However, they also bring challenges that can't be ignored, especially when it comes to preparing the workforce to keep up with these rapid changes.

THE TECHNOLOGICAL EVOLUTION IN MINING

From autonomous haul trucks to AI-driven exploration tools, innovations in mining technology are redefining the industry. Automation reduces the physical demands of labour by replacing manual tasks with machine-driven processes. AI enhances decision-making by analysing complex data sets to predict equipment failures, optimise routes, and even identify promising ore deposits. Meanwhile, digital mines powered by IoT (Internet of Things) and real-time monitoring allow for more precise control over operations.

These technologies deliver clear advantages, including increased profitability, reduced environmental impact, and improved safety in hazardous environments. But, this isn't just about replacing human workers with machines – it's about reimagining roles and skills within the sector.

THE NEED FOR A FUTURE-READY WORKFORCE

While the pace of technological advancement is exhilarating, it has exposed a critical issue – many workers are unprepared for the complexities of next-generation

mining. The skills gap is real, and without deliberate action, it could hinder the industry's growth.

A survey by industry experts revealed that nearly 65% of mining professionals believe their teams aren't fully equipped to handle new systems and technologies. This underscores one key question: *Are we doing enough to prepare our people for the future of mining?*

The solutions lie in proactive education and training strategies designed to arm employees – current and future – with the skills they need to thrive.

BRIDGING THE SKILLS GAP

Addressing the workforce challenge requires collaboration between mining companies, educational institutions, and training providers. Programs that combine academic learning with real-world applications are proving to be game changers. Here are examples of initiatives paving the way for a well-equipped workforce:

1. **Rio Tinto Autonomous Systems Training** Rio Tinto, one of the early adopters of automation, has developed a training program to upskill operators in managing their autonomous truck fleets. This ensures a seamless transition for workers as technology reshapes roles.

2. **Partnerships Between Industry and Academia** Institutions such as the University of Queensland have partnered with mining companies to create tailored programs that address industry demands, from technical training in handling equipment to team leadership skills.

3. **Government-Backed Apprenticeships** Countries like Canada and Australia have introduced apprenticeship schemes specific to the mining sector, emphasising hands-on experience with emerging technologies.

These initiatives are not just filling existing gaps – they're creating a stronger foundation for lifelong learning in the industry.

MINING INDABA'S ROLE IN WORKFORCE DEVELOPMENT

Events like *Investing in African Mining Indaba* are crucial in driving the conversation on workforce transformation. Bringing together experts, educators, policymakers, and industry leaders, these gatherings encourage solutions tailored to the sector's pressing challenges.

Mining Indaba has hosted panels on topics such as "Future-Ready Talents" and "Leadership in a Digital Era." These discussions emphasise actionable strategies such as collaborative recruitment pipelines and integrating soft skills like critical thinking and adaptability into technical training.

THE ROAD AHEAD

Preparing the workforce for tomorrow's mining isn't just a nice-to-have – it's essential for sustaining growth and innovation. By investing in education, skill-building, and leadership development, mining companies can ensure they have the talent needed to tackle future challenges.

But there's more to workforce transformation than technology. A future-ready workforce must also be diverse, inclusive, and engaged. Mining needs to remove barriers to entry for underrepresented groups, such as women and minorities, to truly tap into the vast potential available.

The future of mining is bright. Automation, AI, and digitalisation are reshaping the industry for the better. But the heart of this evolution will always be its people. Are we ready to support their growth as much as we value technological advancement? That's the challenge – and the opportunity – that the mining industry faces today.

Whether you're hosting innovative training programs, forging partnerships with schools, or attending events, your role is vital. Together, we can build a resilient and capable workforce that will lead the mining industry into its next great era.

Rock drilling: essential tools and innovations

Rock drilling is fundamental to mining, construction, and infrastructure projects, enabling access to subsurface resources and the creation of necessary boreholes. The efficiency, safety, and cost-effectiveness of these operations hinge on the quality and suitability of the rock drilling tools employed. This article delves into the diverse types of rock drilling tools, their specific applications, and the latest advancements shaping the industry.

UNDERSTANDING ROCK DRILLING TOOLS

These specialised tools are engineered to penetrate hard rock formations across various sectors, including mining, tunnelling, construction, and oil and gas exploration. Due to the demanding nature of rock drilling, these tools must exhibit exceptional durability, power, and efficiency to withstand intense friction and pressure.

TYPES OF ROCK DRILLING TOOLS

1. **Drill Bits:** The primary cutting element, available in various configurations to suit different rock types and drilling objectives.

    - **Button Bits:** Ideal for hard and abrasive rocks, featuring tungsten carbide buttons for effective crushing. Common in mining and water well drilling.
    - **Tri-Cone Bits:** Used for soft to medium-hard formations, employing three rotating cones with teeth to crush rock. Predominant in oil and gas applications.
    - **PDC (Polycrystalline Diamond Compact) Bits:** Employ synthetic diamonds for exceptional hardness, suitable for very hard rock in oil and gas and exploration.
    - **Drag Bits:** Designed for softer rock, scraping the surface rather than heavy cutting, often used in rotary drilling.

2. **Rock Drill Hammers (Pneumatic Drills):** Utilise compressed air to power a piston that impacts the drill bit, fracturing rock.

    - **Jackhammers:** Handheld pneumatic drills for breaking hard surfaces like concrete and rock, common in construction.
    - **Crawler Drills:** Mounted on crawler vehicles for large-scale operations in mining and tunnelling, designed for extreme durability and deep drilling.

3. **Down-the-Hole (DTH) Hammers:** Positioned at the bottom of the drill string, providing efficient drilling in hard rock.

    - **Mechanism:** Compressed air drives the hammer, striking the rock at the borehole bottom, combined with bit rotation for rock fragmentation.

- **Applications:** Used for blast holes in mining, foundation drilling in construction, and water well drilling.

4. **Drill Rods:** Connect the drill bit to the rig, transmitting rotational and hammering force. Available in various lengths and materials (e.g., steel alloys) to withstand high torque and pressure.

5. **Rotary Drills:** Employ rotational force to grind through rock, often combined with percussion. Used in oil drilling, water wells, and exploration.

    - **Operation:** High-speed rotation and pressure fracture rock formations.
    - **Applications:** Suitable for deep, wide boreholes in oil and gas and large-scale mining.

KEY CONSIDERATIONS FOR TOOL SELECTION

- **Durability:** Essential for withstanding harsh conditions.
- **Efficiency:** Minimises operational costs and enhances productivity.
- **Versatility:** Ability to handle diverse rock types.
- **Cost-Effectiveness:** Long-term value, including reduced downtime and maintenance.
- **Safety:** Design features that mitigate risks to operators and the environment.

INNOVATIONS IN ROCK DRILLING

- **Automated Drilling Systems:** Leverage robotics and AI for real-time monitoring and optimisation.
- **Smart Sensors and Monitoring:** Provide data on performance, temperature, and wear for informed decision-making.
- **Hybrid Power Drills:** Reduce emissions and energy consumption through combined electric and diesel power.
- **Wear-Resistant Materials:** Advanced composites enhance tool lifespan and reduce replacement frequency.

ROCK BOLTING: THE UNSUNG HERO OF MODERN MINING

In the demanding world of mining engineering, safety and efficiency are paramount. Rock bolting, a technique that has evolved from a simple concept to a cornerstone of modern practice, plays a vital role in achieving both. This method, involving the insertion and grouting of steel bars into pre-drilled rock, effectively reinforces unstable rock masses, preventing potentially catastrophic collapses.

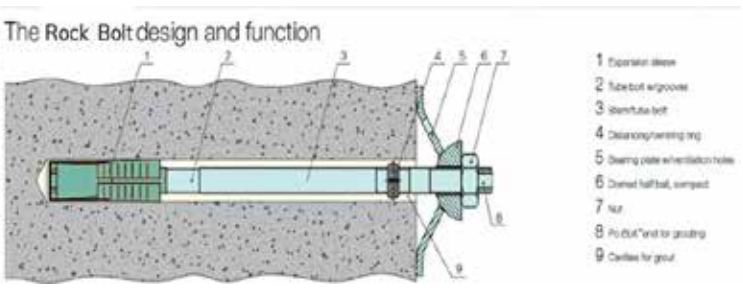
A HISTORICAL FOUNDATION

The story of rock bolting begins in the mid-19th century, driven by the need for safer, more reliable support as mining operations delved deeper. Initially, timber was the primary support, but its limitations became apparent. The first recorded use of bolts for rock reinforcement occurred in a North Wales slate quarry in 1872. This early application paved the way for further innovation, with German coal mines

adopting the technique for ground reinforcement by 1918. Over time, advancements in materials and installation techniques transformed rock bolting into the robust system we know today.

MODERN MINING'S ESSENTIAL TOOL

Today, rock bolting is ubiquitous in underground mining, across methods like room and pillar, cut and fill, and sublevel stoping. It ensures the stability of tunnels, shafts, and other crucial excavations, significantly influencing mine design and safety protocols.



THE UNDENIABLE ADVANTAGES:

1. **Enhanced Stability:** Rock bolting provides "active" support, engaging the rock mass to create a reinforced structure. This method effectively controls deformation, outperforming traditional frame supports, especially in challenging geological conditions.

2. **Increased Efficiency:** Compared to frame support, rock bolting requires fewer and lighter materials, reducing transportation and labour. Its simple installation allows for close integration with excavation, enabling rapid progress and mechanised operations.

3. **Economic Benefits:** The reduced material costs, lower maintenance requirements, and optimised roadway cross-sections result in significant economic savings.

TYPES OF ROCK BOLTS AND APPLICATIONS:

- **Mechanical Bolts:** Rely on expansion shells for anchorage.
- **Resin Bolts:** Utilise resin cartridges for bonding.
- **Grouted Bolts:** Employ cement grout for secure anchoring.
- These bolts are used in a wide array of applications, from stabilising tunnel roofs to reinforcing high walls.

SAFETY AND ENVIRONMENTAL CONSIDERATIONS:

Safety standards, such as proper bolt spacing, tensioning, and grouting procedures, are critical for effective rock bolting. Environmental factors, including the long-term durability of materials and the potential for ground water contamination, are also considered in modern applications.

CONCLUSION

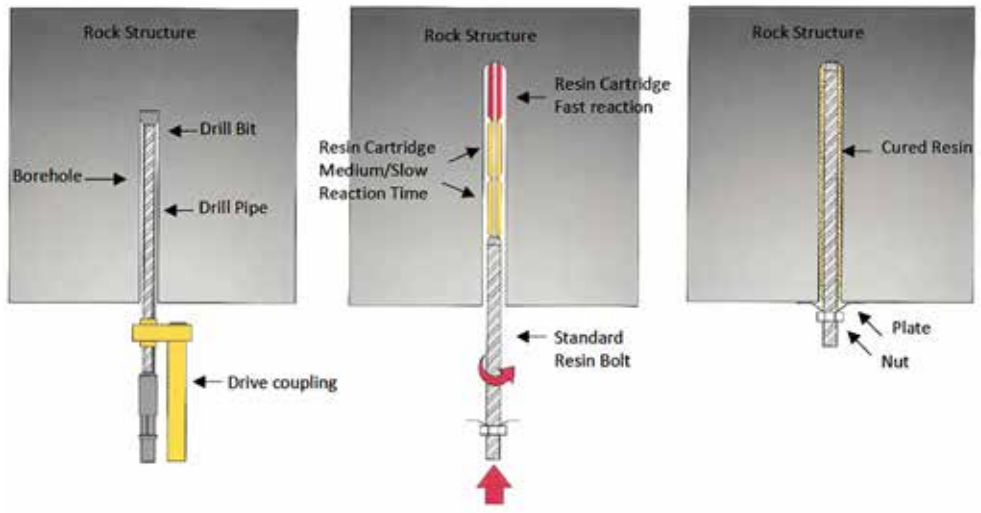
Rock drilling tools are indispensable for resource extraction and infrastructure development. The industry is continually advancing, with innovations driving enhanced efficiency, safety, and sustainability. As technology progresses, we can anticipate further improvements in drilling operations, ensuring more effective and environmentally responsible practices.

THE FUTURE OF ROCK BOLTING

As mining operations continue to expand, rock bolting's role will only intensify. Ongoing research focuses on developing more durable materials, advanced monitoring systems, and automated installation techniques. By embracing innovation, the mining industry can ensure the safe and sustainable extraction of resources.

ENHANCED ROCK REINFORCEMENT WITH RESIN-BASED BOLTING SYSTEMS

Deep underground mining and tunnelling operations face



significant safety challenges due to the inherent instability of rock strata. Effective rock reinforcement is crucial to protect workers and equipment. In this article we look at a variety of rock reinforcement methods.

Cable bolting, using long, grouted reinforcement tools, is a standard technique for stabilising rock masses above tunnel profiles. Traditionally, resin cartridges have been employed for rock reinforcement, but recent advancements have introduced pumpable resin systems, offering notable advantages.

PUMPABLE RESIN SYSTEMS: A MODERN APPROACH

Pumpable resins are gaining popularity due to their ability to combine the rapid curing time of traditional resins with the effective load distribution of cementitious grouts. Unlike cementitious grouts, which require 12-24 hours to cure, pumpable resins solidify within minutes, minimising downtime. This quick curing time is particularly beneficial in challenging ground conditions, where rapid reinforcement is essential.

Advantages:

- **Rapid Installation:** When used with self-drilling bolts, pumpable resins can achieve reinforcement in under three minutes, significantly accelerating mining cycles.
- **Enhanced Stability:** The fluid nature of pumpable resins allows them to penetrate even small cracks, ensuring thorough ground consolidation and robust long-term stability.
- **Versatility:** Pumpable resins are compatible with various bolting systems, including hollow bolts, cable bolts, and self-drilling anchors, making them adaptable to diverse geological conditions.
- **Overhead applications:** The fluid behaviour of the resin, that solidifies when still, allows for overhead instillation without the need for extra sealing.

Considerations:

- **Equipment and Training**: Implementing pumpable resin systems may require new equipment or retrofitting existing machinery, along with specialised operator training.

RESIN CARTRIDGES: A PROVEN SOLUTION

Resin cartridges, consisting of two components separated by a thin plastic film, offer a reliable and straightforward method for rock reinforcement. When a bolt is rotated within the borehole, the components mix, initiating a rapid curing process that creates a strong bond between the bolt and the surrounding rock.

Advantages:

- **Simple and Fast Installation:** Cartridges require minimal equipment and can be installed quickly, even in challenging positions.
- **Reliable Bonding:** The precise chemical composition of the cartridges ensures a strong mechanical interlock between the bolt and the rock.
- **Adaptability:** Resin cartridges can be used in various ground conditions, provided the borehole remains stable.

Disadvantages:

- **Installation Challenges in Unstable Ground:** Loose ground can cause boreholes to collapse, hindering cartridge installation.
- **Sensitivity to Borehole Dimensions:** Precise borehole dimensions are crucial, as variations can affect the amount of resin required for effective reinforcement.

CONCLUSION

Both pumpable resin systems and resin cartridges offer significant advantages over traditional reinforcement methods, providing rapid and reliable rock stabilisation. Pumpable resins excel in speed and adaptability, while resin cartridges offer simplicity and proven performance. Choosing the appropriate system depends on the specific geological conditions and operational requirements of the mining or tunnelling project. Utilising these resin-based bolting systems is vital for enhancing safety and efficiency in deep underground operations, where ground stability is paramount.

Tyres, moulding the future of mining

Off-the-road (OTR) tyres constitute a significant portion of mining operational expenses, with typical operations incurring costs annually. The disposal of worn and damaged tyres poses a major sustainability challenge for the industry. In terms of cost, tyres are second only to fuel, representing multi-million USD expenditures for an average mine each year. Furthermore, tyre performance and availability directly impact equipment uptime and, consequently, the ability of haul fleets to meet production targets.

Optimal OTR tyre lifespan hinges on selecting the right type, which involves matching rubber compounds and geometric specifications to specific road conditions dictated by medium and long-term mining plans and production goals. While a single tyre type for the entire fleet offers dispatch flexibility, accommodating the most demanding route conditions across all trucks increases overall tyre consumption.

This highlights a compelling opportunity to optimise both tyre selection and haul fleet scheduling. These decisions can significantly reduce tyre consumption, lower operational costs, and ensure adherence to production plans. Given that tyre type can influence haul cycle times, the allocation of trucks to different routes should also be considered.

Driven by supply chain innovation and a strong desire for sustainability, the mining industry is now focusing on the use of off-the-road (OTR) tyres as a key area for enhancing its environmental performance.

Modern mining machinery faces demanding tasks, hauling massive weights, and operating in harsh conditions for long durations. While crucial, tyres can often be overlooked. Today's OTR tyres, however, represent a pinnacle of engineering, incorporating advanced compounds, innovative designs, and high-tech manufacturing.

The global OTR tyre market, valued in the billions and projected for further growth, presents a significant opportunity. Nevertheless, the mining sector still grapples with challenges concerning tyre lifespans and premature end-of-life disposal.

In Australia, over 130,000 tonnes of tyres are discarded annually, with Chile nearing 180,000 tonnes. Globally, the management of end-of-life tyres is a critical concern, leading mining companies to increasingly prioritise sustainability – a goal that fundamentally begins with maximising the lifespan of each tyre. ***Gordon Barratt*** *of Mining & Quarry World takes a detailed look at the life cycle and how technology is changing to improve the longevity of a mining tyre.*

To enhance the safety of individuals working with mining's largest tyres, collaborative research and development of improved tools, practices, and systems are essential. The mining industry is well aware of the inherent risks involved in servicing these massive tyres. Their significant weight and size, coupled with operational temperatures and pressures, demand extreme caution and precision in even routine tasks. While safety measures in tyre servicing have advanced over the past two to three decades, the rapid evolution of truck designs and sizes, alongside escalating production demands, is pushing equipment and tools to their limits. This, combined with a shortage of skilled personnel, can place tyre technicians under increasing pressure, leading to a higher incidence of service-related safety events.

WHY TYRE SAFETY MATTERS IN MINING

Large mining vehicle tyres are crucial for stability, traction, and preventing accidents. Their constant pressure and flexing, combined with the friction of movement, generate heat that degrades them. Tyre failure can lead to significant problems, and using oxygen-containing air creates a serious explosion risk from ruptures or lightning.

The growing trend of using nitrogen in passenger car tyres for pressure retention and fuel efficiency is now extending to mining. Beyond these benefits, nitrogen significantly enhances safety by drastically reducing the risk of explosions.

NITROGEN VS. AIR INFLATION

While mining tyres typically use atmospheric air (roughly 78% nitrogen, 21% oxygen, and some water vapor), nitrogen inflation involves a mixture of at least 95% nitrogen. This offers advantages like slower pressure loss and reduced corrosion of metal parts due to less water vapor. Consequently, worker and operator safety improve. Deflated tyres wear out faster. Although both gases permeate tyre walls, nitrogen escapes four times slower than oxygen and over 100 times slower than water vapor. In harsh conditions, nitrogen helps maintain safer pressure levels for longer, potentially extending tyre lifespan by around 10%.

Beyond safety, tyre failures cause work disruptions and significant downtime in mining operations. Overheating, often due to heavy loads on rough terrain and exacerbated by hot, dry conditions, is a primary cause.

Nitrogen helps maintain optimal tire pressure, reducing flexing and friction. Its slower leakage rate also sustains fuel efficiency; the EPA estimates a 0.3% mileage decrease per psi drop across all tyres.

A recent study revealed a 3.8% fuel efficiency increase with nitrogen in long-haul trucks. The sheer size and pressure of mining vehicle tyres already pose a safety risk, amplified when filled with oxygen near flammable materials. Tyre fires are especially dangerous underground, a risk significantly lowered by using nitrogen. Furthermore, in operations with combustibles, nitrogen inflation greatly diminishes the danger of lightning-induced explosions.

Although nitrogen-filled tyres offer significant safety and efficiency advantages for mining operations, implementing a nitrogen inflation system presents logistical hurdles. The primary challenge lies in the cost and emissions associated with transporting nitrogen over the vast distances often required to reach remote mine sites. A more sustainable solution would be on-site nitrogen generation, a possibility currently under investigation by some companies.

Generating nitrogen directly at mining sites, particularly sun-exposed locations, could offer an additional benefit,

as nitrogen is frequently utilised in various extraction and processing stages. For instance, it is commonly employed at coalfaces to suppress methane and reduce the risk of spontaneous combustion. On-site nitrogen generation at the coalface would be particularly advantageous, allowing operators to move the generator alongside other auxiliary equipment, thereby minimising the need for extensive underground pipelines.

Supporting efforts to use mining tyres until they reach the 100% wear limit is an area where the supply chain can help. Consistent and quality tyre inspections are a “must” for the industry enabling early identification of issues, thus enabling a longer tyre life and more uptime. Some companies offer AI / maintenance planning packages as a means to improving the longevity of a tyre. Research into tyres and associated technologies has recently highlighted that an estimated 90% of OTR tyres experience premature failure. This is often linked to a company focus on maximising productivity, sometimes at the expense of tyre longevity – a view the mining sector would likely challenge, although it holds some historical relevance.

The mining industry is now actively taking significant steps to address this premature tyre wastage. Mining companies are adopting strategies for better management of tyre lifecycles, and the supply chain is encouraging more mindful use supported by new maintenance technologies. Furthermore, innovations in materials and manufacturing processes aimed at creating more sustainable tyres demonstrate the sector's strong drive for change.

Ultimately, achieving greater sustainability hinges on how tyres are used in daily operations.

However, the battle to be more sustainable starts with how tyres are used day-to-day. “The wear of tyres depends on a variety of factors such as driver skills, weather conditions, equipment maintenance and road conditions. Recent studies highlighted a mine in north Chile where 48 front end loader tyres and 223 mining truck tyres (with an estimated value of $5.1m) were discarded between 2019 and 2021. “Of these, between 80% and 90% were discarded prematurely due to operational damage, without reaching 100% of their service life,” they add.

Haul roads: Finding the path to improving performance?

MICHELIN'S INNOVATIONS FOR MINING OPERATIONS

At MINExpo 2024, Michelin unveiled two key advancements: the Michelin XDR4 Speed Energy™ Tyre and the Michelin Better Haul Road monitoring system.

The XDR4 Speed Energy™ Tyre features an optimised, flexible tread and a novel energy-efficient rubber compound. This design aims to reduce fuel consumption and CO_2 emissions by minimising heat generation, thereby directing more energy to the truck's propulsion.

Recognising the critical role of haul roads in mine safety and productivity, Michelin introduced Better Haul Road. This mobile and web-based software provides real-time monitoring and analytics of haul road conditions. It enables mining crews to digitally document and assess potential issues, prioritise actions, and share information across teams.

Christel Dubus, CMO for Michelin Mining Services, highlighted the system's proactive approach, stating, "This ensures that any issues are quickly resolved, minimising downtime and maintaining the flow of operations, while considering opportunities to reduce fuel and energy consumption." He also emphasised the system's role in extending the longevity and reliability of haul roads.

Industry “experts” corroborated the importance of haul road maintenance, noting that "Maintaining clean and well-conditioned roads contributes to reducing [tyre] tread damage and avoiding load imbalances." They also stressed the significance of proper tyre pressure, stating that "controlling tyre pressure is crucial for maximising tyre lifespan, which represents a significant opportunity to enhance both economic efficiency and environmental responsibility."

A separate case study revealed that between 50% and 75% of tyres are prematurely discarded due to excessive tyre pressure.

Furthermore, a study published in *Engineering and Applied Sciences* by the University of Mines and Technology in Ghana identified several factors contributing to OTR tyre failures, including poor road conditions, water presence, operator errors, incorrect inflation, excessive heat generation, and mechanical stress.

The off-the-road (OTR) tyre segment is integral to the efficiency and productivity of the mining industry, particularly within the challenging terrains of Australia. As the industry continues to evolve, several trends and innovations are set to shape the future of OTR tyres in mining operations.

ADVANCEMENTS IN OTR TIRE TECHNOLOGY

Smart technology is revolutionising OTR tyres. Integrated sensors now provide real-time data on temperature, pressure, and tread wear, enabling predictive maintenance and improving safety and efficiency.

Material science innovations are enhancing tyre durability. New compounds and tread designs are engineered to endure harsh mining conditions, extending tyre lifespan and reducing operational costs.

Sustainability is a growing focus in the mining industry. OTR tyre manufacturers are adopting eco-friendly materials and processes to minimise their environmental impact. This includes using recycled materials and developing tread designs that reduce rolling resistance and improve fuel efficiency.

Furthermore, tyre recycling initiatives are gaining traction. The development of efficient recycling technologies will facilitate the repurposing of OTR tyres, reducing waste and fostering circular economies within the mining sector.

The mining industry is increasingly prioritising sustainability. Manufacturers of OTR tyres are exploring eco-friendly materials and processes to reduce their environmental footprint. This includes the use of recycled materials and innovations in tread design to lower rolling resistance and improve fuel efficiency.

THE EVOLVING LANDSCAPE OF OTR TIRES IN MINING

The integration of OTR tyres with fleet management software is transforming mining operations. These systems provide detailed tyre performance data, enabling optimised resource allocation and maintenance scheduling.

As autonomous vehicle adoption increases, OTR tyre designs are being tailored for enhanced precision and reliability, crucial for seamless operation without human intervention.

Artificial intelligence (AI) is being leveraged to analyse data from smart tyres, providing predictive insights for proactive maintenance and minimising downtime.

IoT technology enables remote tyre condition monitoring, facilitating rapid responses to potential issues and mitigating risks in remote mining locations.

Collaborations between tyre manufacturers, mining companies, and regulatory bodies are vital for driving innovation, fostering knowledge exchange, and accelerating the development of next-generation OTR tyres.

The industry must adapt to stricter safety and environmental regulations. These regulatory frameworks will significantly influence future OTR tyre advancements.

The future of OTR tyres in mining is marked by significant transformation. Technological advancements, sustainability initiatives, and improved operational practices are driving this evolution.

Adapting to these trends will enhance performance, improve efficiency, and ensure compliance with evolving environmental and safety standards, securing a progressive future for mining operations, particularly in regions like Australia.

Orica celebrates over 10,000 blasts with the WebGen™ wireless initiating system

Orica is proud to announce that its groundbreaking WebGen™ technology has reached a significant milestone, achieving 10,000 blasts globally and firing 200,000 WebGen™ 200 primers. This milestone reflects the rapid adoption and success of WebGen™ in the mining industry.

WebGen™ is the world's first truly wireless initiating system, communicating through rock, air, and water to initiate blasts reliably and safely. This groundbreaking technology eliminates the need for down-lines and surface connecting wires, significantly enhancing safety by removing people from hazardous areas. WebGen uses low- frequency magnetic waves to communicate with each primer, ensuring precise and controlled blasting operations.

Dr. Rodney Williams, Vice President Initiating Systems, commented on the recent milestone: “This achievement highlights the widespread adoption of WebGen technology, enabling our customers to implement new mining methods and achieve real-world benefits.”

The journey of WebGen™ technology has been marked by innovation and rapid adoption. It all began with WebGen™ 100, which entered alpha trials in February 2015. This pioneering product saw its first commercial blasts at a gold mine in Canada in July 2017. Over the years, WebGen™ 100 made its mark in the industry, achieving a milestone of 100,000 units fired by May 2022. Its final deployment has just commenced at a zinc mine in Europe, with blasting to be completed this month, marking the end of an era as it is phased out.

Building on the foundation laid by its predecessor, WebGen™ 200 experienced swift market acceptance. Its first alpha blasts were fired at a mine in Canada in May 2021, leading to its first commercial firing at a gold mine in Canada in October 2022. By April 2024, WebGen™ 200 had already reached 100,000 units fired.

The WebGen™ 200 range, including WebGen™ 200 Surface, WebGen™ 200 Surface Pro, WebGen™ 200 Underground Pro, and WebGen™ 200 Dev, has set a new standard in the mining industry. Each variant is designed to meet specific operational needs, with WebGen™ 200 Dev being a key enabler of Orica’s journey to automation. Underpinned by WebGen™ wireless initiation system and Epiroc’s Boomer M2C carrier, the Avatel™ system is a complete mechanised development charging solution that offers full control over blast energy from design through to execution. The system enhances safety by allowing operators to charge explosives remotely from an enclosed cabin, reducing exposure to hazardous areas.

WebGen™ has seen significant usage across various regions, including North America, LATAM, AusPac, Asia, and EMEA, with notable growth in LATAM, the Western Australia Goldfields region and Indonesian operations. "WebGen’s success is a testament to the dedication and innovation of our team and customers,” said Rodney. “We look forward to continuing this journey and achieving even greater milestones together with our customers."

WEBGEN™ REAL WORLD BENEFITS - KEY CASE STUDIES

WebGen™ wireless technology uses low-frequency magnetic induction signals to communicate with primers in blastholes, enhancing safety by preventing accidental detonations from lightning strikes and eliminating interactions with surface connectors. This system has been implemented at over 75 sites across six continents and 13 countries, streamlining the blasting process and allowing for more efficient and precise blast designs.

The success of WebGen™ technology is exemplified by several key case studies:

- Musselwhite Gold Mine, Canada: The implementation of WebGen™ technology at this site led to a 15% increase in ore recovery and a 10% reduction in blasting costs.

The mine also reported improved safety conditions due to the wireless initiation system.

- New Afton Copper and Gold Mine, Canada: WebGen™ enabled safer undercutting in block caving operations, reducing slot drive development by eight meters per drive. This resulted in estimated development cost savings of more than $1 million CAD across 18 undercut drives.

- Kemi Zinc Mine, Europe: The adoption of WebGen™ technology facilitated the transition to more advanced mining methods, leading to a 92% increase in ore recovery and an 80% increase in the total mined volume of the stope. The mine also achieved a notable reduction in waste mined.

- Boddington Gold Mine, Australia: WebGen™ technology provided enhanced mine schedule flexibility, allowing for more efficient resource allocation and improved overall productivity.

- Sierrita Copper Mine, USA: The use of WebGen™ technology at this site resulted in significant operational improvements, including increased precision in blasting and reduced environmental impact.

- Kinross Paracatu Gold Mine, Brazil: WebGen™ technology contributed to the mine's social responsibility initiatives by reducing the environmental footprint and enhancing community relations through safer and more efficient blasting practices.

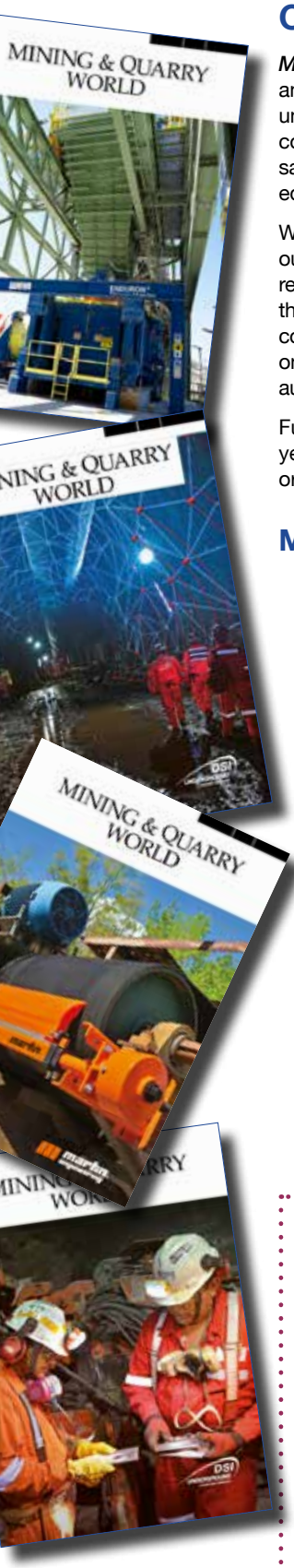
- Grasberg Copper and Gold Mine, Indonesia: WebGen™ 200 enabled more precise blasting operations, resulting in a 20% increase in productivity and a significant reduction in environmental impact. The mine also experienced fewer delays and increased operational efficiency.

- Tara Zinc Mine, Europe: The adoption of WebGen™ technology facilitated the transition to more advanced mining methods, leading to a 25% improvement in overall mine performance. The mine also achieved a notable reduction in downtime and maintenance costs.

- Agnico Eagle's Kittilä Mine, Finland: The implementation of Orica's Avatel system, which integrates WebGen™ wireless initiation technology with Epiroc's Boomer M2C carrier, significantly enhanced safety, and operational efficiency. By allowing operators to charge explosives remotely from an enclosed cabin, the mine reduced exposure to hazardous areas, leading to a 30% improvement in safety metrics and a 15% increase in overall productivity.

WebGen™ has revolutionised not just blasting but mining also and now that customers are realising the value unlocked by not having a physical connection to the blast, they are turning their attention to how they plan mines of the future around the WebGen™ Technology. These partnerships provide us a privileged insight into our customers' needs and guide our development pipeline. Therefore, we will see feature releases and technology enhancements steadily rolled out for years to come.

MINING & QUARRY WORLD



Overview

Mining & Quarry World has expanded to become an international publication covering the surface and underground mining sectors. ***Mining & Quarry World*** will cover a wealth of technical articles, site visits, health and safety related issues alongside financial news, products and equipment in every issue.

We understand your need to get your marketing message out to the intended audience, Mining & Quarry World is regarded as one of the worlds leading publications serving the Mining Industry for equipment suppliers and service companies. With over 180,000 mining professional contacts on our database, this publication truly reaches a worldwide audience.

Further articles of interest will be added throughout the year. Should your company wish to contribute any articles or white papers of interest please note the copy deadlines.

- A Worldwide circulation distributed digitally
- Published six times per year
- All Mining companies and Mining Operations personnel/decision makers receive a free digital copy
- Other recipients include trade associations, educational establishments, libraries, OEMs and service providers
- Printed copies will be distributed on our attendance at all the major mining exhibitions and conferences and can also be printed in a variety of languages
- Besides a wealth of feature and technical articles, site visits and industry news, Mining & Quarry World also covers health & safety, sustainability, technological innovation and financial news, alongside new products & equipment in every issue covering both underground and surface operations

Mining and Quarry World topics to be covered throughout the year 2025

Sustainable Mining Practices: Case studies and innovations in reducing the environmental footprint of mining operations.

Digital Transformation in Mining: The impact of digital technologies, including AI and IoT, on mining efficiency and decision-making.

Renewable Energy Integration: How mining companies are incorporating renewable energy sources to power their operations.

Critical Minerals and Rare Earth Elements: The growing importance of these materials in technology and clean energy sectors.

Community Engagement and Social Responsibility: Best practices for mining companies to engage with and support local communities.

Future of Quarrying: Innovations in quarrying techniques and equipment that enhance productivity and sustainability.

Digital Advertising Rates

Digital product	Total cost	Total cost for all 6 issues	Digital product	Total cost	Total cost for all 6 issues
Front Cover	£2,500	£12,500	**Half page**	£850	£4,250
Back Cover	£2,100	£10,500	**Quarter page**	£500	£2,500
Inside Cover	£2,100	£10,500	**Classified (various sizes)**	£100	£500
Double page centre spread	£2,500	£12,500	**Article placement in Mining and Quarry World**	£1,200p/p	POA for multiple pages
Full page	£1,700	£8,500			

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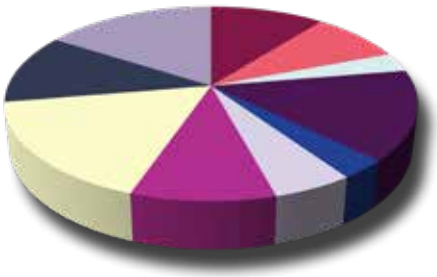
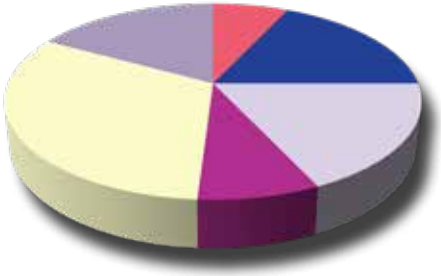
Circulation by commodity



- 12% Coal
- 15% Gold
- 8% Silver
- 3% Uranium
- 9% Aggregates
- 5% Molybdenum
- 3% Diamond
- 6% Nickel
- 14% Iron ore
- 10% Potash
- 15% Copper

Circulation by business sector



- 13% Exploration & drilling companies
- 36% Mining operations
- 2% OEMs & service providers
- 25% Operating companies
- 6% Major aggregate companies
- 18% Processing & materials handling

Others include - smelters, steel processes and PR companies

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MINING & QUARRY WORLD

Proposed subjects for Mining & Quarry World

Every issue of ***Mining & Quarry World*** contains the latest news, new plant and equipment, health, safety and sustainability and digitisation issues affecting the industry. Site visits plus a one on one interview with top executives and engineers within the industry. All year round focused articles from exploration through to production.

February

- Mining Trucks/Automation
- Slurry Pumps
- Underground Drilling and Blasting
- Mining and sustainability case studies and innovations
- Conveying underground
- Digital mining
- Signals and communications
- Hydraulic Breakers
- Blasthole drills
- Reducing your carbon footprint

Copy date: 28th February 2025

April

- Hydraulic mining shovels
- Dewatering pumps
- Rock drilling and rock reinforcement
- Mining automation
- Explosives technology
- Tyre technology
- Workforce transition
- Digital transformations and mining software solutions
- Lubrication
- Rock drilling tools

Copy date: 30th April 2025

June

- Bulk material handling systems
- Sustainable mining practices
- Crushers
- Overland Conveying
- Data and software management tools
- Roof bolting and strata control
- Ventilation systems
- Pneumatic equipment in mining
- Wheel loaders
- Transitioning to an electric mine

Copy date: 30th June 2025

August

- Wheel loaders and dozers
- Grinding mills
- Surface and underground conveying
- Electric rope shovels
- Crushers
- Sustainable mining
- Underground mining trucks
- Ventilation
- Fleet optimisation solutions
- Rock breaking and associated attachments

Copy date: 30th August 2025

October

- Mining automation and information management
- Excavator and dragline attachments
- Underground crushing equipment
- Mineral comminution
- FLP Underground drives
- Scoop trams
- Gas monitoring
- Critical minerals and rare earth elements
- Transitioning mines to a sustainable future
- Fleet optimisation solutions

Copy date: 30th October 2025

December

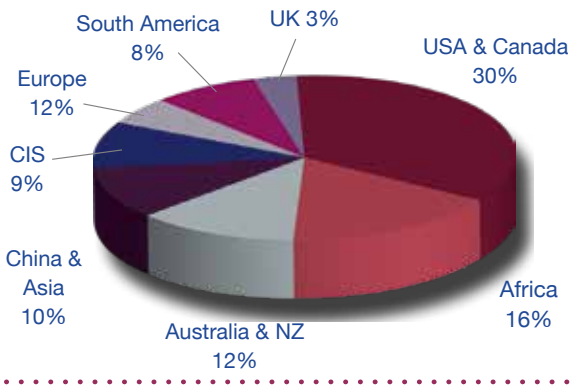
- Hybrid mining machines
- Mine planning and design software
- Autonomous mining and fleet optimisation
- Conveyor dust suppression
- Screening equipment
- Drilling rigs
- Off – highway trucks
- Community engagement and social responsibility
- Tailings Processing equipment

Copy date: 30th December 2025

Further articles of interest will be added throughout the year, if you would like to forward articles for consideration please contact gordon.barratt@tradelinkpub.com

Mining and Quarry World will be attending major exhibitions around the world (as listed on page 4) ensuring your message reaches its intended audience through our bonus copy distribution.

Circulation by geographical area



Innovations in surface mining

Economic development/GDP of any nation and in meeting the day-to-day needs of the population is from the Mining sector only. Our planners and policy makers have had enough contributions to make mining as an integral part of the Indian economics and development model. To support this mission various regulations were also enacted, and efforts were made all these years to produce astronomical quantities of ores-minerals and waste material by surface mining.

Production of ores and minerals (coal and non-coal) safely adopting the new technologies economically in a globally controlled pricing together with is primarily through harmony with all the stakeholders for achieving the goal of sustainable development clubbed with 'innovations in this method of mining'.

SURFACE MINING

Surface Mining in India had been the main method of mining adopted for majority of coal, lignite, iron ore, limestone, dolomite, bauxite, copper, lead and zinc and other minerals. To meet the burgeoning demand of the various minerals, surface mining had contributed to meet the volume. On the other hand, till the late 80's coal which was dominated by underground methods of extraction, had to switchover to large scale development of surface mines.

In the coal and lignite sector, surface mine account for over 80% and 100% of the production respectively. Similarly, in non-fuel sector the major production of iron ore, limestone, dolomite, bauxite, barite only from surface mines and a small proportion of copper, chrome ore, lead and zinc, manganese come from surface mines, leaving a small proportion from underground operations.

The growing thrust on surface mining has been supported by:

- Extensive exploration.
- Detailed planning of the ore body massive investment in the mining machineries and extraction system.
- Investment in research and development to extract higher percentage recovery safely.
- Commissioning of state-of-the-art mineral processing system.
- Plans and programs for maintaining ecological balance (owing to the mining causing degradation/pollution of air, water and land).

- Acceptable R&R policy for the population affected by mining activities

- Developing infrastructure to handle the movement of the final products to the consumer industries and/or the port facilities for exports.

INNOVATIONS IN MINING

Surface Mining activities in India spread from hills to deep forest area to the sea shore operations, over the years had undergone several transformations. This was supported by infusion of investment into mining and processing of the ore, adoption of modern heavy earth moving mining machineries, methods to design mines for disposal of waste and extraction of ore, safe blasting methods, planning & designing of infra for safe movement of HEMM inside the mine premises, adoption of safety gadgets and methods; installation of modern illumination, dust control, slope monitoring, sound level monitoring, computer aided systems for movement of dumpers, monitoring of production etc.

Today, in majority of mining operations Computers and IT had a greater and prominent intervention so as to extract optimally and safely mineral from a mining system. The modern instrumentation techniques also support in our quest for better mining environment all leading to 'sustainable development'.

MINE PLANNING

Ore body evaluation, geo-statistical reserve estimate and modelling have played a vital role in the overall economics of any mine assistance from a large number of computer packages are taken to assist the mine planners and geoscientists in the areas of detailed and more accurate mine planning (both short and long term). In India, we have adopted some of the latest software's and trained our users at the mine level considering the local site conditions at greater detail.

INFRASTRUCTURE PLANNING

Optimum Infrastructure Planning by multiple operators in sharing of land and other recourses. Feasibility of mining common barrier should be looked into. Infrastructure layout should be so planned as it does not block any resource or cause hindrance to the exploitation of the same. The infrastructure should be in line with the Master Planning of the entire area considering mines of different mine operators.

TECHNOLOGY & METHOD OF WORK

For opencast mining, application of large capacity shovel-dumper system, surface miners need to be examined. For shovel dumper system, the equipment configuration needs to be standardised to 3 or 4 modules. The largest size of the dragline deployed in CIL has not changed in past two decades. The prevalent size and technology available across the world should be considered while planning.

MINE EXCAVATION

In the entire mining cycle, excavation of ore and waste play a major role and are the greatest contributor to the safety, ecology and economics. While shovel dumper combination contributes to be the major method of mining in India the efforts are on a sustained basis to introduce the latest version of excavators and dumpers in the system. Our efforts to have large size shovels and dumpers started from mines of NMDC, Tata Steel, SAIL, mines of ACC in the early 70's. It got a sudden jump when Kudremukh came into existence to have an annual excavation volume of 22.5 Million Tonnes in the late 70's.Since then, we have fine-tuned our shovel dumper system, by adopting:

- Higher capacity of the bucket.

- Higher hauling capacity of the dumpers.

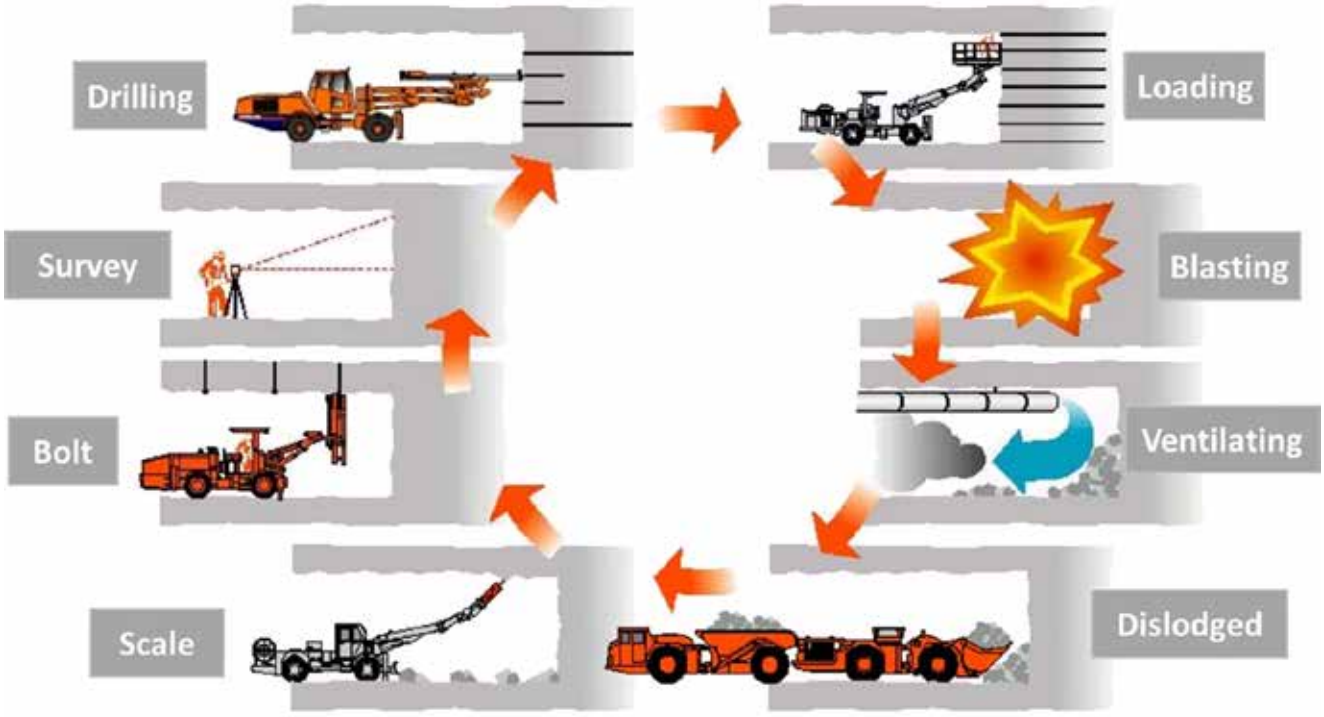


Figure 1: Role of explosives/blasting in Mining.

- Fuel efficient or energy efficient engine power.
- Sturdy and leak proof hydraulic system enabling to maintain designed pressure.
- Full proof braking system.
- Ergonomically designed operator's cabin.
- Modern safety features for making the operation area safe during loading, unloading, hauling, etc.,
- Maintenance methods incorporating reliability techniques.
- Instrumentation to support operator friendly operation.
- Software's and communication system to make the entire operation flawless leading to better availability and utilisation
- Significant improvement in haul road design, haul road stability, haul road lighting and dust control.

DRILLING & BLASTING

Any excavation operation to succeed has to have a well-designed and planned drilling & blasting system in place. **Figure 1** explains the role an influence of blasting on surface mining cycle of operation.

Figure 2: Use of Trencor Surface Miners (having Top-Down Mechanical mechanism of cutting) in a Limestone Mine of Indonesia having average 80 to 140 MPa UCS.

Majority of Indian mines have switched over to the use of Site Mixed Emulsion explosives and ANFO. In the areas of 'initiation' mines are very much concerned for the various problems associated with blast induced ground vibration, frequency of vibration on the stability of natural and manmade structures, fly rocks etc. The proximity of mining benches to human habitation, public roads, historical monuments etc had necessitated use of electronic delay detonators, low density explosives, effective use of stemming plugs and other non-explosive air decks to ensure uniform explosive energy use, designing larger blasts and reduction in blasting frequency etc.

Use of computer aided blast design and explosive selection software's and analysis of post blast fragmentation benefitted miners to go for better ore recovery, design of smooth blasting techniques to ensure stability of the highwall etc. Using software to analyse the blasted material had also ensured better crusher output and reduction in energy consumption in the processing plants. In the areas of blast monitoring and fly rock management Drones, are also helping in the blast design team to a great extent.

BLAST FREE MINING

Majority of limestone mines are facing the serious problem of blasting owing to the proximity of active mining benches to structures. Chittorgarh Fort and Chittorgarh Mines of Birla Corporation in Rajasthan, several captive mines of Cement plants close to state and national highways have faced legal and local ire. To avoid drilling & blasting, efforts have been made to extend the use of 'mechanical cutting' in place of blasting by rippers and surface miners are proposed. The surface mines of Vindhyan limestone and Bauxite mines are now switching over to use surface miners to cut the hard rock mass in the range of 100 to 140 MPa. While Wirtgen surface miners used in coal and softer limestone have proved their economic application, use of surface miners in hard rock cutting is the subject of extensive rock mechanics study.

Use of surface miners of Vermeer make at the Panchpatmali Bauxite Mine of NALCO have been successful. It not only meets the rate of production (as high as 450 to 480 tph) but also meet the economics of overall excavation. In the green field mines where the crushing system is yet to be installed, surface miners prove to be economical. Surface miners also improve the OMS, reduces cost of fuel, generates quality ore in a sized manner in addition to various safety-security and regulatory mechanism involved with the transport-storage and use of explosives. In one hard rock limestone mine of Indonesia, surface miners are widely used to produce over 3 million tonnes of sized ore (**Figure 2**).

Use of rippers and hydraulic rock breakers are also helping mines where blasting has been banned by the regulators.

THRUST AREAS FOR IMPROVING PRODUCTIVITY THROUGH INNOVATION

Benchmarking of mining operations/ equipment's, optimising size and capacity of the mine, bigger sizes of HEMM in surface mines, cutting down the idle time and breakdown time of machinery by better maintenance and timely procurement of spares, correcting mismatch in excavation and transport equipment capacity, training of

workers for new technology, machinery, and maintenance, large scale use simulators, standardisation of equipment fleet at mine level, Introduction of OITDS for all big mines, proper monitoring at every level, and modern communication and reporting system.

AUTOMATION & APPLICATION OF INFORMATION TECHNOLOGY

Automation is the key to high productivity, production and safety. The information revolution of the country is gradually getting into mining industry and has a significant impact on mine operations.

Information Technology (IT) is cited frequently as one of the most important tools for improving productivity and decision making.

APPLICATION OF IT ENTERPRISE RESOURCE PLANNING (ERP) – SAP

SAP-ERP has been implemented covering the business processes related to Purchase & Stores, Marketing & Despatches, Quality Management, Human Capital management, Finance & Accounts and Costing.

Now it is planned to leverage usage of SAP under following categories: Enlarge scope by implementing all the functionalities available in SAP and which are relevant to most surface mines.

Mining equipment are increasingly fitted with Global positioning systems, sensors and information-processing capabilities to control and manage operations. As advanced equipment becomes more widespread, communications and data networks will enable mine-wide process integration and control capabilities to tie more operations at the mine site together. Ultimately, these networks will supply data to a central control where it will be layered in to provide a range of services and support functions, such as mine planning and equipment-maintenance solutions.

CO_2 EMISSION REDUCTION

Our global commitment to reduce CO_2 emission in all forms of economic activities including Mining, Processing and Handling of ores/minerals has been the firm commitment of the mining companies. In this direction, efforts have been made with the following:

- Use of dual fuel (gaseous fuel) in HEMM engines in place of HSD,
- Use of blast free mining methods to avoid explosive use
- In mines adopting blasting, efforts are made to have effective use of explosive energy in fragmentation. Following the 'Energy Factor' system greatly benefits the blasting engineers to reduce the quantities of explosives.
- Switching over to long distance conveying system including pipe conveyors (JSW Vijaynagar Steel Plant had laid second longest pipe conveyor system to transport all the production from its mines in the Ballari district; JSPL Sharda Mines had also adopted pipe conveyor), cable belt conveyors (ex: NALCO Mines, Baphlimali Utkal Alumina bauxite Mines, Mines of NMDC at Bailadila and Donimali etc), slurry mode of transport

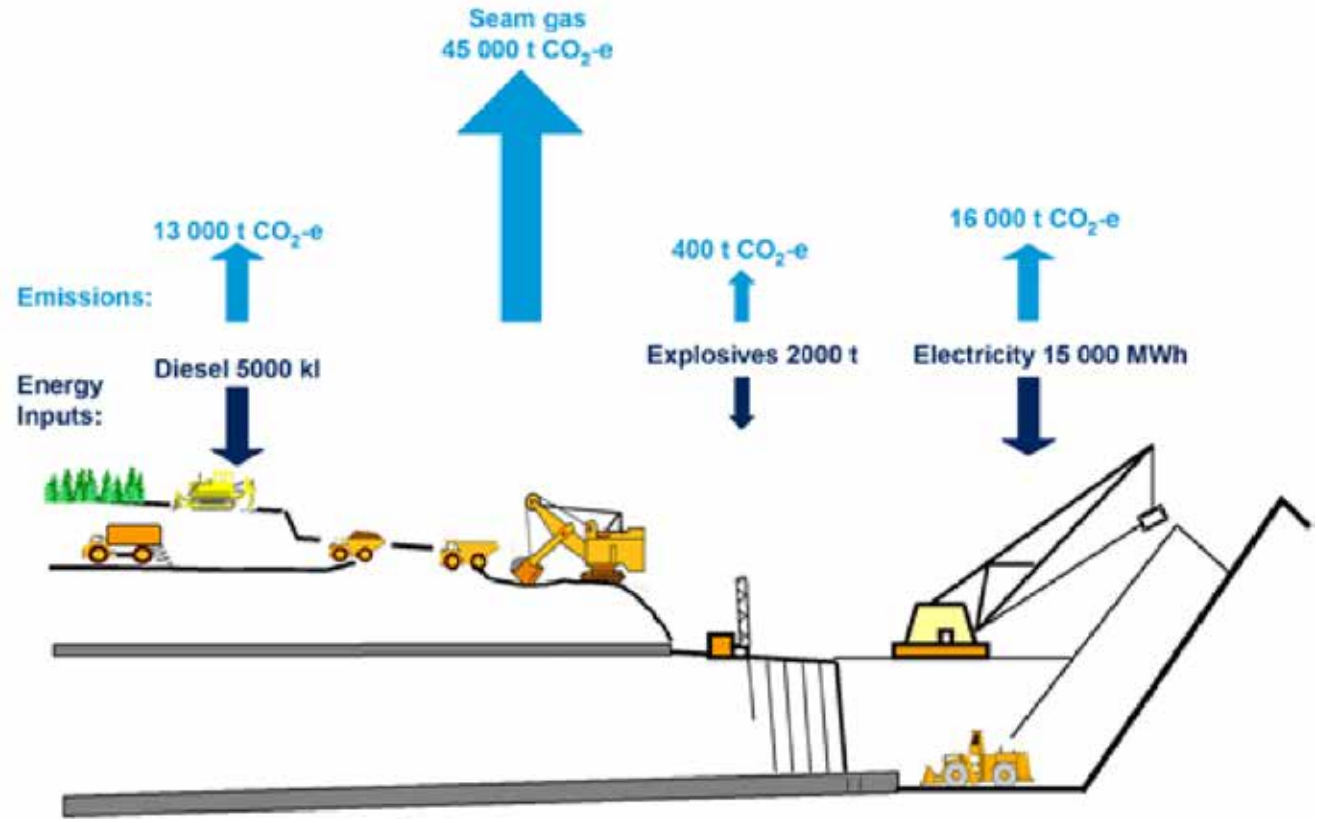


Figure 3: Example of a Coal Mine Energy and Emissions per Million Tonnes of coal ex-pit for a 7:1 stripping ration dragline operation.

of ore to the consumer industry or port facilities (ex: Kudremukh-now defunct, Kirandul to Vizag pipelines of Essar, iron ore fines transport from Barbil sector to Paradip port) etc.

- Use of fuel additives and long-life lube oil to reduce the use of HSD and Lube oil in engines and hydraulic system

- Adopting energy audit at regular frequency to identify wastage of energy and conservation of energy in HEMM, Crushing and Conveying system.

Figure 3 explains the emissions level in case of a surface coal mine having 7:1 stripping ratio. In case of an iron ore or limestone or bauxite mines the level of electrical energy use is enormous when the blasted ore is subjected to processing either in a dry or a wet processing unit. Today, majority of mines are having longer hauling distance and deeper pits (lift) from the processing plants, leading to use of higher HSD consumption vis-à-vis CO_2 emission level.

REDUCE EXPLOSIVE USE TO REDUCE CO_2 IMPRINT

In the mines using explosives for rock fragmentation, any quantity of explosive saved through scientific studies involving – optimisation, explosive energy utilisation etc, considerably reduces in the average liberation of various gases into the atmosphere. As per one study of Maunsell Pty Ltd, Australia, the quantity of gases liberated per tonne of explosives are : CO_2 167.3 kg, CO-16.3 kg, NO2 3.5 kg.

With the use of empty water bottles quantity of explosives primarily SME and ANFO could be reduced after studying the explosive energy content and blast design parameters. The author had introduced this concept in several mines.

OTHER AREAS

Apart from the above-mentioned systems in surface mines, today all-out effort is being made to switch over to eco-friendly techniques. Most mines have identified the mined-out area, old dumps, vacant land area to install Solar Panel system to generate electricity.

Unmanned slope monitoring systems, surveying by use of scanners, various fire detection systems, using paste fill technology for mine reject disposal and storage, etc are gaining more application in Indian mines. Working in 3-D - .University of Technology Sydney (UTS) and its research partners, Downer's Mineral Technologies and the Innovative Manufacturing CDC (IMCRC), have reached an important milestone: one year of advancing their efforts to create a bespoke 3-D printer for the production of mineral separation and mining equipment.

Drones have been launched by Ministry of Mines and IBM in association with mining companies (ex: Tata Steel at Sukinda and Noamundi). In the coming days, drones will help mine management to prepare accurate plans and sections of the mine and neighbouring areas so as to understand the changes in the land use. Use of DGPS is another milestone achieved by the regulators to ensure quick survey of the mine area, movement of ores and minerals etc.

APPLICATION OF AI

Artificial Intelligence has been the buzz word of the modern times. In mining also, it has made an entry. In July 2019, Swedish mining and smelting company Boliden, which is already introducing automation and electrification at its operations, has tested whether artificial intelligence (AI) could optimise its processes. Similarly, Nvidia Drive Constellation – through cloud-based hardware-in-the-loop simulation platform that is testing and validating self-driving technology (autonomous vehicles) in various conditions with Volvo.

In another development, collaboration between Belaz and Zyfra is focussed on AI-based technologies. The companies plan to conduct joint studies of customer needs and an analysis of the global market for digital AI-based products in the mining industry, as a foundation for creating and improving their own developments in this field. Their immediate plans include working on a predictive analytics system for quarry equipment to help predict breakdowns by analysing historical data and carry out predictive maintenance. In parallel, the two companies have mapped out joint steps in the development of industrial safety solutions. In particular, they are planning to test a driver fatigue tracking system using computer vision technologies.

In our country, Zyfra achieved $3 million in contracts with its Indian counterparts in 2018, facilitating industrial manufacturers with AI and Industrial Internet of Things (IIoT)-based solutions as well as autonomous vehicles. They have drawn plans to digitise all the value chain of mining with the use of artificial intelligence in drilling and blasting, and intelligent mine with unmanned vehicles, crushing and enriching minerals. Zyfra had indicated that, AI-based intelligent mine solutions will allow integration of unmanned vehicles like dump trucks, excavators dozers into a single digital control system for the mining and transport complex and ensure that there are no people left behind in dangerous areas and situations. This will ensure increasing of the utilisation of haul dumpers and excavators up to 20-25% and of drilling units by up to 35%, as well as reduce costs for maintenance by 10-15% a year.

CONCLUSION

Today, Indian surface mines are very sensitive and are committed to have innovations with infusion of budget for research and development, energy efficient techniques and energy use etc.

Support from Government of India is essential, for some of the high value innovation like AI, as has been done by Canada's Ontario state. However, with individual association the author could innovate explosive use by using empty plastic bottles in the blasting operations.

Innovations in Surface Mining: By Gyanindra: Additional imagery provided by Tradelink Publications

All references and acknowledgements can be obtained using the link below

(99+) Innovations in Surface Mining

Pantera's comprehensive upgrade

Sandvik Mining and Rock Solutions has launched an update of its Pantera DPi series drill rigs at Bauma 2025 in Munich, Germany.

Considered a premium top-hammer drilling option, the Pantera DPi range has extensive experience in open pit mines, particularly in gold applications using 89mm to 178mm (3.5-inch to 7-inch) hole sizes.

The Pantera DPi has seen more than 2500 units delivered since 2008, with the series continuing to rise in popularity.

The new upgrade offers enhanced productivity and safety benefits, longer service life and higher reliability and availability for extreme weather conditions.

The new RD1700 rock drills which underpin the DPi upgrade prioritise penetration rate and reduce fuel consumption, optimising hammer strikes, feed force and drilling in the process.

An active stabiliser within the RD1700 increases tool life by up to 40% by reducing heat generation by achieving perfect bit-to-rock contact.

The DPi upgrade is in-built with the CT67 rock tools, which enable more effective threading and unthreading, while also boosting penetration.

The Pantera DPi boasts digital functionalities such as the My Sandvik customer portal, which includes consumables logging, access to machine health statistics and drilling data.

Pantera DPi has been also enhanced with upgrades to the CSL lubrication system, boom design, leaf chain feed, engine filters, drill heating system and heavy-duty accumulator.

The drill rigs have levelled up fuel economy with the new C9.3B Tier 3 engine, saving up to five litres per hour, while also boasting a new cabin for lower noise and vibration levels, with thicker front glass and a solar layer to control heat and glare.

Components like the iClean feature can help reduce stress levels by providing automatic sequencing for easy and productive drilling.

Rio Tinto signs aluminium MoU in India

Rio Tinto has signed a memorandum of understanding (MoU) with AMG Metals & Materials, an energy transition solutions provider based in India.

The MoU will see both parties map out the feasibility of developing an integrated low-carbon aluminium project powered by renewable energy in India.

The companies will investigate the possibility of producing 2Mtpa of alumina production and the development of a primary aluminium smelter with up to 1 million tonnes per annum (Mtpa) of capacity, both of which would be powered by wind and solar energy.

Rio Tinto Aluminium chief executive Jérôme Pécresse said the project is a key milestone for the major miner.

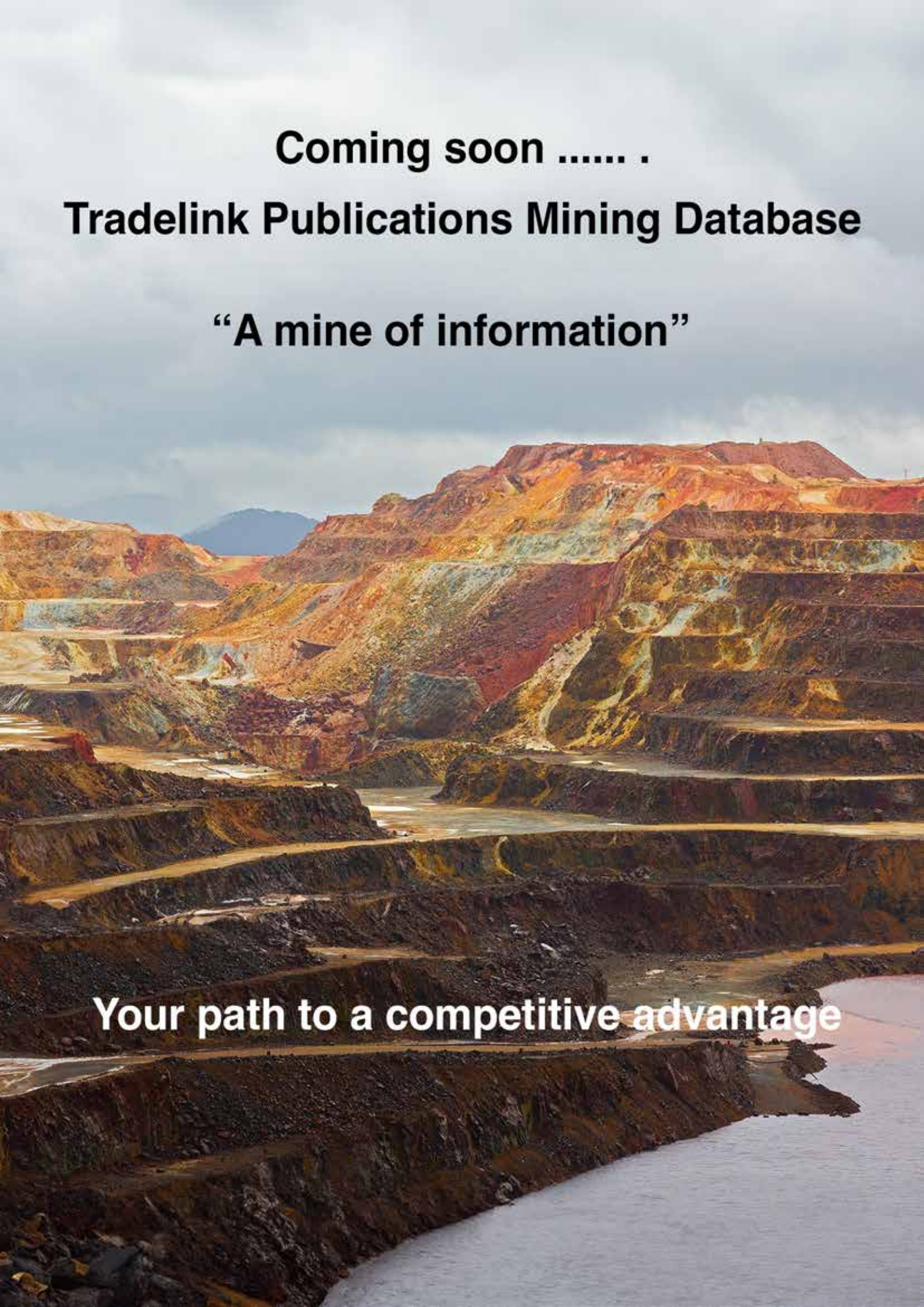
"This study is an important step in our ambition to grow our global, low-carbon aluminium footprint while exploring new project delivery approaches and opportunities in emerging markets," he said.

"Partnering with AMG Metals & Materials enables us to assess how we can develop low-cost responsible aluminium production powered by renewable energy. With its rapid economic growth and strategic position, India is a compelling location for this potential project and aligns with our long-term vision for a globally more diverse and resilient aluminium business."

The study will evaluate a potential first-phase 500,000-tonne-per-annum primary aluminium smelter in India while also assessing smelting technology options.

AMG Metals & Materials, owned by Greenko Group and AM Green, is driven by renewable energy and decarbonisation solutions.

"This MoU could deliver much-needed low-carbon metal at scale to propel decarbonisation initiatives in global supply chains across auto, construction, consumer packaging and many more segments," group president of AMG M&M and Greenko Mahesh Kolli said.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