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MINING & QUARRY WORLD

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SQM expects lithium price boost in third quarter

Chilean lithium producer SQM expects prices and sales volumes to rise in the third quarter, executives said recently, after the miner missed estimates for second-quarter net profit.

The world's second-largest lithium producer reported a 59% decline in quarterly profit, with lithium prices down around a third year-on-year.

Net profit of $88.4-million missed analysts' estimates of $143.01-million, according to data compiled by LSEG, while revenue of $1.04-billion was broadly in line with the estimate of $1.064-billion.

Chief Executive Ricardo Ramos in a statement said lithium prices had in some cases hit the lower limits of sales contracts, affecting agreed volumes.

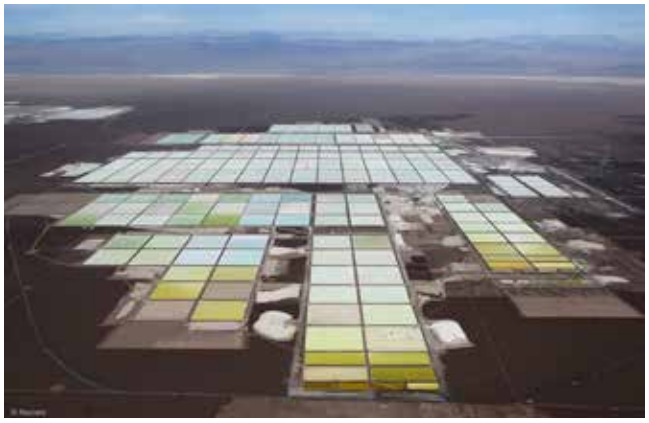
Executives on a call with analysts declined to give further details about how the company had adjusted contracts, citing confidentiality.

They predicted an uptick in sales volumes of at least 10% in the third quarter from the second quarter, and pointed to potential supply reductions in China as a good sign for prices.

"We expect that with the recent price recovery in China, our sales price in Q3 should be higher than in Q2," said Felipe Smith, SQM's commercial vice president for lithium.

He noted that Asia prices outside of China have also been strengthening, although more slowly.

Global prices for lithium, a critical component of electric vehicle batteries, have plunged nearly 90% from a late-2022 peak, leading producers to slash workforces and pull back on



plans.

SQM began laying off 5% of its Chilean workforce in June, and Moody's last month lowered the miner's outlook to "negative" due to lithium revenue uncertainty.

SQM also makes fertilizers and industrial chemicals on Chile's Atacama salt flat, one of the highest concentration lithium deposits in the world.

The company said it is on track to finalize a partnership with Chilean state-run copper miner Codelco as soon as September or October. The deal still requires approval from regulators in China, after other countries signed off.

SQM also said it expects approval for a major revamp of its lithium operations in the first half of 2030 as it works to submit an environmental impact report to authorities next year.

Osisko Development raises $203m to fund Cariboo gold project

Osisko Development recently closed a $203-million private placement to fund its Cariboo gold project in Canada.

The offering comprised 99.1-million units priced at $2.05 each. Of these, 58.6-million units were sold through a brokered deal raising about $120-million, while 40.5-million units were sold in a non-brokered placement generating about $83-million.

Double Zero Capital, a Delaware investment firm, subscribed for about $75-million, representing 15% of Osisko's outstanding common shares following the deal.

Each unit includes one common share and one-half of a warrant, with each full warrant allowing the purchase of an additional share at $2.56 until August 15, 2027. Warrants may be accelerated if the company's share price exceeds the exercise price for 20 consecutive trading days.

Osisko said net proceeds would fund the equity portion of capital for the Cariboo gold project and for general corporate purposes. Combined with a previously announced $450-million project loan from Appian Capital Advisory and other potential financing arrangements, the company expects sufficient funding to complete construction.

The Cariboo project, which is fully permitted and 100%-owned by Osisko, recently underwent an updated feasibility study.

The 2025 feasibility study outlines a low-impact underground operation with average life-of-mine gold production of 190 000 oz/y and a 22.1% after-tax internal rate of return at a base case gold price of $2 400/oz.

The 2025 capital expenditure estimate increased to C$1.41-billion, from the 2023 feasibility study estimate of C$1.12-billion.

The average all-in sustaining cost is projected at $1 157/oz.

Uganda targets higher exports with first large-scale gold mine

Uganda has inaugurated its first large-scale gold mine, a $250-million Chinese-owned project in the country's east that will also refine the bullion to 99.9% purity, according to a statement from the president's office.

The landlocked east African country, which has a variety of minerals including copper, cobalt and iron ore, wants to expand its mining industry and position itself as a major gold producer and exporter.

Last year Uganda raised $3.4-billion from gold exports, according to central bank data, about 37% of the country's total export revenue. The figure includes the re-export of gold brought into the country, with nearly all its domestic production from small-scale artisanal miners.

While its gold export earnings have increased in recent years, it is still far behind Africa's largest bullion producer Ghana, which raised $11.6-billion from shipments of the metal last year.

"In order to wake up in the minerals sector, we must have full value addition for all minerals like gold, lithium, tin among others," President Yoweri Museveni said in a statement issued recently.

The Wagagai Gold Mining Project, owned by Wagagai Mining (U) Limited and covering just over nine square kilometres in Busia district, was inaugurated by Museveni recently.

The plant, which has started operations, is expected to process 5 000 tons of gold ore per day and produce about 1.2 metric tons of refined gold a year, according to the statement. That compares to Uganda's total domestic production of just 0.0042 tons in 2023.

Uganda will use the revenue generated by exporting gold to develop assets such as power stations and the country's railway, Museveni said.

Landlocked Uganda is currently constructing a €2.7-billion ($3.16-billion) standard gauge railway to reduce the cost of transporting its exports and imports via neighbouring Kenya.

Orion raises A$1.93m, with strong South African investor support

Orion Minerals' share purchase plan (SPP), which closed on August 12, has raised A$1.93-million, or about R22.2-million.

Under the SPP, each eligible shareholder was entitled to apply for parcels of new fully paid ordinary shares from a minimum parcel of A$170, or R2 000, up to a maximum of A$30 000, or R355 000, without incurring brokerage or transaction costs.

The SPP attracted strong support from shareholders, particularly those in South Africa, where a total of R20.6-million, or about A$1.79-million, was raised, Orion points out.

The SPP follows the capital raising completed earlier this month by way of placement of 289-million shares to sophisticated and professional investors and agreement to convert outstanding loan amounts owed by Orion to equity through the issue of 233-million shares, for a total aggregate value of about A$5.8-million, or about R67-million.

"As Orion begins accelerating towards production, I wish to thank all shareholders and investors who chose to participate in the placement and SPP, particularly those from South Africa.

"We appreciate the ongoing support of our shareholders and welcome the new investors. We are working hard to secure the necessary financing that will transition Orion to becoming a producer and create value for all stakeholders," says CEO and MD Tony Lennox.

Orion is developing its flagship Prieska copper/zinc mine and Okiep copper project in South Africa's Northern Cape.

Glencore considers $13.5bn Argentine copper investments under RIGI incentives

Commodities major Glencore has applied to bring two of its flagship Argentine copper projects under President Javier Milei's new Incentive Regime for Large Investments (RIGI), seeking to unlock $13.5-billion in development spending over the next decade.

The Baar, Switzerland-based miner said it submitted applications for its 100%-owned El Pachón and Agua Rica projects. Capital investment is expected to reach $9.5-billion for El Pachón (Phase 1) and $4-billion for Agua Rica.

If approved, the RIGI would secure an "attractive and long-term economic and investment framework" along with investor protections.

"President Milei and his administration must be credited for introducing the RIGI. This framework has changed the investment landscape in Argentina, providing a key catalyst to attract major foreign investment to the country," CEO Gary Nagle said in a statement.

"Today's submission marks a significant step towards the development of El Pachón and Agua Rica. It also deepens our longstanding commitment to Argentina, a country to which we have been a proud partner across multiple commodities for over two decades," he added.

The El Pachón deposit in San Juan province holds an estimated 6-billion tonnes of ore grading 0.43% copper, while the Agua Rica deposit in Catamarca province has about 1.2-billion tonnes at 0.47% copper, along with gold, silver and molybdenum. Agua Rica will use existing processing facilities at Alumbrera, 35 km away, as part of the MARA project.

The projects are expected to generate more than 10 000 direct jobs during construction and 2 500 permanent roles once operational, according to the company.

"The RIGI provides a key platform for the development of Argentina's significant natural resource endowment," said Martín Pérez de Solay, CEO of Glencore Argentina. "I am confident that the mining sector can be a major contributor to the Argentinian economy with the El Pachón and Agua Rica projects supporting the country's ambition to become one of the world's leading copper producers."

Northern Star delivers record dividend

Northern Star Resources has announced a record-breaking full-year, underpinned by strong gold prices, disciplined investment and the addition of De Grey Mining's Hemi development project to its portfolio.

For the 2024–25 financial year (FY25), the company posted record underlying free cash flow of $536 million, up 16% year-on-year, alongside underlying earnings before interest, taxation, depreciation and amortisation (EBITDA) of $3.5 billion and underlying net profit after tax of $1.4 billion, or $1.19 per share.

Revenue surged 30% to $6.4 billion, reflecting a 29% increase in the average realised gold price to $3922 per ounce.

Northern Star declared a fully franked final dividend of 30 cents per share, taking the FY25 payout to a record $0.55 per share.

Combined with the completed $300 million on-market share buy-back, the company has returned more than $840 million to shareholders.

"The company has delivered another record-breaking financial performance on the back of a dedicated team effort in a favourable gold price environment," Northern Star managing director Stuart Tonkin said.

"For FY25, we reported record Group underlying free cashflow of $536 million, or $328 per ounce, which underscores the value of the profitable growth path we have been on for the past four years to deliver sustaining long-term returns for shareholders.

"The FY25 result also demonstrates the strength and value-creation that we are embedding in our business. EBITDA and ROCE (return on capital employed) metrics have shown consistent improvement over the last three years, while our investment grade balance sheet remains strong and in a net cash position."

Looking forward, Northern Star will focus on maximising production from its three operating centres and advancing the newly acquired Hemi development project, with growth projects such as the KCGM mill expansion expected to underpin long-term margins.

"Our focus remains on unlocking the full value of our production centres and advancing the newly acquired Hemi project, which aligns with both our portfolio and purpose to responsibly deliver superior returns for shareholders," Tonkin said.

Short Courses for Engineers in the Bulk Materials Handling Industry

Join experts at the Wolfson Centre for Bulk Solids Handling Technology to learn how to identify and help avoid handling, storage and transportation issues when dealing with powders and bulk materials.

A suite of courses examining the handling, feeding and storage of bulk materials has been developed for process engineers and management, maintenance, health and safety technicians and anyone involved in the processing of powders and bulk materials.

These courses range from basic level to advanced and cover all aspects of this science. Each course is held at the Wolfson Centre premises in Chatham, Kent, UK.

Overview of Particulate Handling Technology:

8 – 10 October 2025; Includes optional practical workshop – An introduction to the storing and handling of bulk materials, equipment selection and design methodologies for safe and reliable plant. Topics covered include hoppers and silos, material characterisation, feeders, discharge aids, dust control, sampling and segregation.

PNEUMATIC CONVEYING COURSES

29 - 31 October 2025; Pneumatic Conveying of Bulk Materials – Basic course; identification of components of pneumatic conveying systems, system selection and design techniques. This course includes an optional practical workshop.

19 – 20 November; Pneumatic Conveying System Design – advanced course; An in-depth exploration of detailed calculations for design of pneumatic pipelines and specifying plant

10 – 11 December 2025; Troubleshooting and Commissioning Pneumatic Conveying Systems; – A 'hand's on' practical course in the pilot plant at the Wolfson Centre premises in Chatham, Kent. It provides a look at the practical challenges of starting up systems on site and making sure they work as the designer intended.

Full details for these and the others courses on offer can be found here

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Lithium market soars as CATL shuts one of world's top mines

Lithium prices and stocks spiked recently after battery giant Contemporary Amperex Technology Co. Ltd. halted operations at a major mine in China, spurring speculation that Beijing might move to suspend other projects as it tackles overcapacity across the economy.

Tianqi Lithium Corp. jumped as much as 19% in Hong Kong, while Ganfeng Lithium Group Co. surged 21% after CATL confirmed it had shut the mine in Jiangxi province. Australian and American miners also rallied. Prices of the battery metal on the Guangzhou Futures Exchange hit the daily limit and held firm throughout the day.

Shares of US producer Albemarle Corp. surged above 15% at 9:33 a.m. in New York, while Piedmont Lithium Inc. jumped by nearly 18%. Lithium Americas Corp. climbed as much as 13% while Chilean producer SQM rose as much as 12% in US trading.

The fate of the CATL mine – the biggest in China's lithium hub of Yichun – had been under close scrutiny for weeks, amid speculation that authorities wouldn't extend its license. The mine accounts for some 6% of global output, according to Bank of America Corp., while other mines in the region account for at least another 5%.

"I think it will mean the lithium price in the near term has very big upside," Matty Zhao, co-head of China equity research at the lender, said in a Bloomberg TV interview.

The most-active lithium carbonate futures contract on Guangzhou's exchange jumped by the daily limit of 8% recently, according to the exchange website. The contract due in November traded at 81,000 yuan a ton,up from the last settlement of 75,000 yuan.

Lithium producers have struggled with a global supply glut exacerbated by demand headwinds for electric vehicles, including President Donald Trump's rollback of incentives for the industry in the US. In China, the so-called anti-involution campaign has fueled speculation about a possible crackdown on a sector that's clearly suffering from oversupply.

CATL, the world's biggest battery producer, confirmed the closure of its Jianxiawo mine recentlyz, saying it's seeking to renew its expired permit without giving more details. The operation will be shut for at least three months, people familiar with the matter told Bloomberg News at the weekend, after its mining license expired on Aug. 9.

The Chinese company said the stoppage would have little impact on its overall operations, and its shares rose as much as 2.8% in Hong Kong.

"For CATL we do not expect any meaningful operational impact to battery production from the Jiangxi mine suspension," said Eugene Hsiao, the head of China equity strategy at Macquarie Capital. "The concern from the mine suspension is less on CATL and more on if the broader lithium supply chain can see tighter capacity, and if this will be coordinated via Chinese government actions."

The "anti-involution" theme has gripped China's financial markets in recent months, with investors trying to pinpoint industries and companies that might benefit from Beijing-led efforts to tackle deflation and overcapacity. It's encompassed sectors from e-commerce to EVs and steelmaking.

"We believe this could be part of the government's anti-involution initiative," Citigroup Inc. analysts said in a note. Closures in Yichun "should help China to re-price its strategic resource in the long-run, and the government can ensure lithium is mined and extracted in a proper and compliant way."

Like many Chinese battery companies, CATL has aggressively expanded investments in minerals from lithium to nickel and cobalt in order to lock in long-term supplies and lower costs. That vertical integration has in turn aided China's push to become the world's leading EV manufacturer.

Spot lithium carbonate prices in China rose by 3% to reach 75,500 yuan a ton, the highest since February, according to Asian Metal Inc. The lithium carbonate prices traded on Liyang Zhonglianjin E-Commerce platform, a popular benchmark for domestic investors, rose by over 10,000 yuan to around 85,500 yuan per ton for November delivery.

Australian miners

Shares of Australian lithium producers also spiked. PLS Ltd., formerly Pilbara Minerals Ltd., jumped as much as 20% in Sydney, while Liontown Resources Ltd. surged as much as 25%. Mineral Resources Ltd. was up as much as 14%.

Traders and industry executives are now watching for other mining curbs around China's Yichun city, which has emerged as a battery-metals hub. A local government department has asked eight miners to submit reserves reports by the end of September, according to notes from brokers and analysts, following an audit that found non-compliance in the registration and approvals process.

"CATL's situation does not change the oversupply structure in the market," said Zhang Weixin, an analyst at China Futures Co. "However, if production disruption is expanded to other mines in Yichun after Sept. 30, the lithium price level could go even higher."

Mexico's PEMEX eyes lithium from oilfield brines

Mexico's state-owned oil company, Petróleos Mexicanos (PEMEX), is exploring lithium extraction from oilfield brines in a bid to diversify its portfolio and advance the country's energy transition.

Chief executive officer Victor Rodríguez said in the unveiling of the company's 2025-2030 Strategic Plan that high concentrations of lithium, comparable to Bolivia's, have been detected in drilling operations across five states.

The company is assessing direct lithium extraction (DLE) technologies to isolate and process the metal into carbonate or hydroxide, essential materials for batteries and clean energy technologies.

As part of the plan, PEMEX may launch a new subsidiary, PEMEX Lithium, to produce so-called "petrolithium," lithium sourced from petroleum brine. The move aligns with President Claudia Sheinbaum's push for energy diversification and resource sovereignty.

Sheinbaum has framed the company's expansion into lithium as a deliberate shift away from dependence on oil production, refining, and fuel sales, opening new revenue streams in the process.

The initiative could pave the way for collaboration with the national lithium company, LitioMx, mirroring global trends in which oil majors invest in lithium to future-proof their operations.

Mexico holds an estimated 1.7 million tonnes of lithium reserves. While smaller than other Latin American producers, the country has 82 known deposits across 18 states, with the largest concentrations in Sonora, Puebla, and Oaxaca. Experts say that with targeted investment and development, Mexico could emerge as a significant player in the global lithium market.

Analysts warn that PEMEX faces steep challenges in the sector, including its lack of experience in non-energy mining, the technical hurdles of clay-based lithium extraction, and the need to meet sustainability standards.

The government is positive and views PEMEX's participation as a natural extension of its role in the shifting global energy landscape, with potential partnerships on the horizon with universities, innovation centres, and public enterprises abroad.

Dante: A 'strategic, long-life' critical minerals asset

Terra Metals has identified commercial quantities of titanium, vanadium, and copper at its Dante critical minerals project in Western Australia.

The company's maiden mineral resource estimate (MRE) shows high concentrations of the three metals across the 148-million-tonne (Mt) resource, amounting to 22Mt of titanium dioxide, 800,000t of vanadium oxide, and 270,000t of copper.

A high-grade indicated resource of 38Mt within the MRE features 18.4% titanium dioxide, 0.73% vanadium oxide, and 0.23% copper.

The project area also features concentrate grades across gold and platinum.

Terra Metals will commence phase three drilling shortly, targeting resource growth and potential new discoveries across multiple reef corridors.

Terra Metals chief executive officer and managing director Thomas Line said the maiden MRE had exceeded all expectations.

"Our maiden MRE confirms Dante as a globally significant critical metals discovery," he said, "and to achieve it within just 12 months, at a very low discovery cost per tonne of resource, is an exceptional result.

"The quality of the mineral system – its scale, near-surface continuity, metallurgical performance and growth potential – positions Dante as a strategic, long-life critical metal asset on a global scale.

"With phase three drilling about to commence, and the mineral system remaining wide open, we see a clear path to rapid, low-cost resource growth and potential further discoveries across this vast, under-explored province."

BHP to explore large-scale CCUS hubs

BHP is teaming up with the world's largest steelmakers to conduct a pre-feasibility study (PFS) into carbon capture, utilisation and storage (CCUS) opportunities in Asia.

ArcelorMittal Nippon Steel India, JSW Steel, Hyundai Steel, Chevron and Mitsui & Co. have joined BHP in launching Asia's first independent, industry-led PFS into large-scale CCUS hubs.

Hatch has been appointed project management officer in collaboration with the Global CCS Institute, McDaniel and Pace CCS.

The study will explore technical, commercial and regulatory pathways for capturing and either repurposing or storing carbon dioxide from hard-to-abate sectors such as steelmaking.

"BHP is committed to supporting our steelmaking customers on their journey to decarbonise the industry," BHP vice president marketing sustainability Ben Ellis said.

"With more than one billion tonnes of production a year in Asia coming from blast furnace capacity that is relatively early in its production life, it's important for industry to progress technologies to decarbonise existing steelmaking assets while new commercial pathways to decarbonise steelmaking are developed over time.

"By leveraging shared knowledge and resources with our partners, we are investing in support for innovative solutions like the potential of CCUS that we see as an essential part of decarbonising hard-to-abate sectors such as steelmaking."

Each consortium member will be involved in at least one proposed hub, with the goal of aggregating captured CO_2 into large enough volumes to optimise costs, unlock utilisation solutions and share risks across multiple industries.

The consortium's study will look at ways to solve scale challenges by aggregating captured carbon into sufficiently large quantities to optimise the unit cost of capture, transportation, and storage.

It will also provide sufficient scale for economic utilisation solutions and unlock novel solutions for multiple hard-to-abate industries at once, to enable regional decarbonisation efforts to be accelerated, and/or ensure cost and risk is appropriately shared among interested parties.

Canada invests in Northcliff's New Brunswick tungsten project

The Canadian government has awarded Northcliff Resources a C$8.21-million grant to advance its Sisson tungsten/molybdenum project in New Brunswick.

The funds, provided by Natural Resources Canada through the Global Partnerships Initiative, will support an updated feasibility study and basic engineering work.

The Sisson project, located near tidewater in southeastern Canada, is aimed at supplying critical minerals for industries such as communications technology, aerospace, defense and clean technology.

The investment builds on $15-million (about C$20.7-million) in Defense Production Act Title III funding awarded to Northcliff in May by the US Department of Defence.

"Canada is a global leader in mining, including the responsibly sourced critical minerals that power our economy for clean energy, digital technologies, and national defence," said Canada's Energy and Natural Resources Minister, Tim Hodgson. "This federal investment demonstrates Canada's commitment to increasing Canadian mineral production to strengthen domestic supply chains, create Canadian jobs, and make the most of our natural resources, in New Brunswick and across the country."

Northcliff chairperson, president and CEO Andrew Ing said the coordinated funding demonstrated the strategic importance of the project. "Bi-lateral investments by the Canadian and US governments are being made to ensure that the minerals are available to support newly developing technologies, as well as maintain security of supply and North American industrial competitiveness," he said.

Northcliff has spent about C$70-million on studies, environmental approvals and other development work since completing a positive feasibility study in 2013. The company is now focused on advancing the project to a construction decision, with detailed project planning, financing and offtake talks under way.

In the 2013 feasibility study, development of the Sisson project was proposed as an openpit mine with conventional processing facilities, supplemented by value-added downstream and on-site processing of tungsten concentrates in an ammonium paratungstate plant.

Vertex commences underground mining at Reward

Underground production has officially kicked off at Vertex Minerals' Reward gold mine in New South Wales, with the first blasting on the Lady Belmore Reef being undertaken recently.

The milestone positions Vertex to start processing high-grade stope ore from Reward in the coming weeks. The material will accompany the low-grade gold stockpile feed to the gravity processing plant until all mining fronts at Reward are enabled.

"As previously announced, the start-up mine schedule includes mining 2075 tonnes at 17.8 (grams per tonne of gold) from a developed airleg stope block," Vertex said.

"The planned stope width is the same as the interpretation of the mineralisation. Given the stope will take some time to extract, additionally, the Vertex geology and mining team have brought forward a very high-grade long hole stope to commence mining in August 2025.

"The high-grade long hole stope is to be mined with a long hole stope method, using the Epiroc production rig."

Reward's underground mining operation has a JORC resource of 225,000 ounces at 16.7 grams per tonne. Vertex aims to have at least four mining fronts at Reward while maintaining a continuous feed to the nearby processing plant, which will involve various mining methods.

Recent milestones at Reward include the underground 11-kilovolt-amperes to 1000-volt transformer substation being installed, access drives to Reward's two starter stopes being cleaned for drilling to commence, and decline 3 on the mica vein being fully dewatered to provide further feed to the gravity plant.

Equinox Gold sells non-core Nevada assets to Minera Alamos for $115m

Equinox Gold has agreed to sell its 100% interest in the Pan mine, Gold Rock project, and Illipah project in Nevada to Minera Alamos in a $115-million transaction.

The deal includes $90-million in cash and $25-million in Minera Alamos shares, representing up to 9.99% pro forma ownership.

CEO Darren Hall said that the sale "reflects our commitment to portfolio optimisation and disciplined capital allocation".

"This transaction simplifies our business and allows the team to focus our efforts and capital on core operations and key development opportunities, positioning Equinox Gold to drive greater shareholder returns," Hall stated.

"The $90-million in cash proceeds will strengthen our balance sheet, and the significant equity ownership will provide continued exposure to the upside within the Nevada assets, as well as to Minera Alamos' existing high-quality portfolio."

The transaction is expected to close in the fourth quarter of 2025, pending regulatory and stock exchange approvals and other customary conditions.

The Nevada assets are considered noncore by Equinox.

Lindian gets approval for rare earths expansion

Lindian Resources has won approval for a significant expansion of its licenced mining area for the Kangankunde rare earths project in Malawi.

The Australian company's application to expand its target zone was approved by the Mining and Minerals Regulatory Authority in Malawi. It has agreed to a more than 100% increase in the licence area, from 900 hectares to 2500 hectares.

The expanded footprint will support an increase in production as the project moves into its second stage. The project's stage one target was the production of 15,300 tonnes of monazite concentrate per annum. This will increase to up to 100,000 tonnes per annum in stage two.

Much of the planned production is subject to a right of first refusal deal with Iluka Resources. If Iluka provides debt funding for at least 50% of the stage two expansion costs, it will have access to a maximum of 25,000 tonnes of additional concentrate per year for 15 years.

Lindian Resources executive chair Robert Martin said the company was confident of finding buyers for the remaining production output.

"The upgrade of our stage two expansion area from an exploration licence to a mining licence allows Lindian to work in parallel on our larger stage two expansion whilst using the learnings from our stage one production facility," he said.

"The company continues to field additional inbound enquiries and is currently working on multiple pathways for further strategic offtake and funding agreements."

Rio commits $276 million to expand Amrun operations

Rio Tinto has approved a $US180 million ($276 million) investment to develop the Norman Creek area at its Amrun bauxite operations in Queensland.

Construction is already underway on key infrastructure including a 19km haul road, camp accommodation and a communications tower.

The development will enable mining in the Norman Creek region, which contains around half of Amrun's 978 million tonnes of declared ore reserves. First production is expected in 2027, with full construction completion targeted for 2028.

Rio Tinto pacific operations aluminium managing director Armando Torres said the project was essential to supporting jobs and local communities over the long term.

"Norman Creek is another important step in securing the long-term future of our Weipa operations, and the benefits that mining brings to communities in the region, Queensland, and the nation," Torres said.

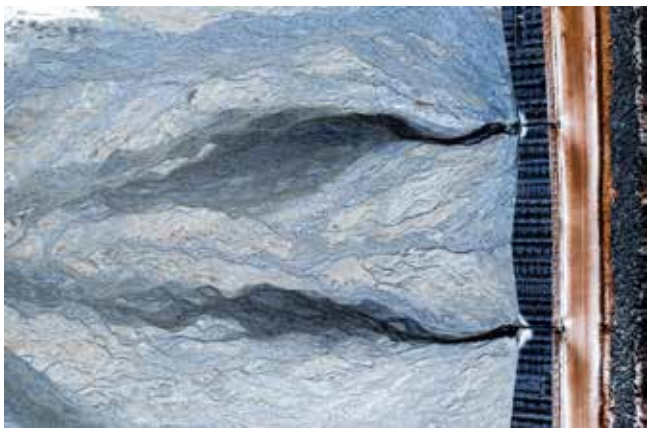
"It will maintain jobs in the region through to at least the middle of this century, ensuring continuity for our people and the Weipa community.

"The decision to approve Norman Creek reflects the quality of Western Cape York's world-class bauxite deposits, combined with the strong operational improvements our people are making at Amrun that are bolstering our confidence to invest for the long-term."

The announcement follows Rio Tinto's recent commencement of early works and a final feasibility study on the proposed Kangwinan project, which would further expand production capacity at Amrun by up to 20 million tonnes a year, in addition to the current 23 million tonnes.

Named at the request of the Traditional Owners, the Wik Waya people, Kangwinan is designed to replace output from the aging Andoom and Gove mines, both expected to close by the end of the decade. First production from Kangwinan could begin as early as 2029.

The Norman Creek investment will be classified as replacement capital and is already included in Rio Tinto's broader capital expenditure guidance.



Rio Tinto updates tailings information

Rio Tinto has published new information on 14 of its global tailings facilities, along with its progress toward aligning with the Global Industry Standard on Tailings Management (GISTM).

The GISTM is directed at mining operators and applies to tailings facilities, whether they already exist or are set to be built.

A set of 15 principles, the GISTM includes 77 individual requirements for tailings facilities. Operators conduct self-assessments against the requirements before a third party audits the company's conformance. The results are then published publicly.

Created in August 2020 following the Samarco and Brumadinho dam disasters in 2015 and 2019, respectively, the GISTM makes it clear that extreme consequences to people and the environment from catastrophic tailings facility failures are unacceptable.

Under GISTM classifications, Rio Tinto's 14 facilities have been rated as very high or extreme, based on the potential consequences in the event of a failure. New information on a further 84 tailings facilities has also been rated low, high or significant.

The information is accessible via Rio Tinto's interactive map covering its of tailings facilities.

"Managing tailings responsibly is essential for keeping people, communities and the environment safe from harm and is fundamental to maintaining our social licence," Rio Tinto chief technical officer Mark Davies said.

"We are proud to share our management practices transparently and to partner with local communities, our industry peers and regulators to drive transformative improvements in tailings management."

According to Rio Tinto's website, it operates a diverse range of tailings facilities at various stages of the tailings facility lifecycle.

This includes tailings contained within engineered earthen embankments and tailings deposited into previously mined open-pits. Some consist of embankments constructed in a single phase whereas other have been raised several times over their life to increase storage capacity.

"Rio Tinto has committed to implementing the GISTM at all our tailings facilities and we have been working hard over the past five years to bring these into conformance," Davies said.

"We have made significant progress and have detailed plans in place to complete the few outstanding items."

Why Colorado Springs wants to delay closing its last coal plant

About a dozen miles south of Colorado Springs, a smokestack rises from a cluster of boxy beige buildings, flanked by a giant mound of coal and a web of metal power lines.

Built in 1980, the Ray D. Nixon Power Plant is the city's last remaining coal-fired power facility. Its combination of gas- and coal-powered generators have the capacity to produce more than 260 megawatts of electricity.

Colorado Springs Utilities had planned to close it at the end of 2029. Now, Travas Deal, the CEO of the city-owned utility, warns that transitioning away from the coal plant could inflate bills and put the grid at risk.

"What we're looking at is an option to utilise Nixon to help maintain reliability and to keep cost points as low as possible as we look for a longer-term decarbonisation strategy," Deal told CPR News.

Delaying the power plant's planned closure comes at a critical moment for Colorado's climate ambitions.

To meet state emission targets, Gov. Jared Polis' administration has banked on utilities following state laws and shifting away from coal-fired power plants. That plan, however, now faces economic headwinds due to the rising cost of solar and wind, plus a Trump administration determined to protect fossil fuels.

Colorado Springs Utilities officials say those circumstances require it to reassess plans to close the power plant.

Over the last few months, Deal approached state regulators for permission to keep the facility open longer than currently planned and initiated meetings to share concerns with the U.S. Environmental Protection Agency. The federal agency cited those conversations extensively in its draft decision to reject parts of a state air quality plan, which would have codified Ray Nixon's 2029 retirement date into federal law.

Environmental groups are now worried that the utility's efforts could undermine the state's energy transition. All six coal-fired power plant facilities across Colorado are currently scheduled to close by 2031.

"It is very concerning to have one of the major utilities in the state backtracking on commitments they've made when those commitments are an essential part of meeting state climate goals," said Matt Gerhart, an attorney for the Sierra Club.

How Ray Nixon became Colorado Springs' last coal plant

In 2020, the board governing Colorado Springs Utilities voted to accelerate the closures of the Ray Nixon and the Martin Drake coal power plants.

It was a decision partly driven by the passage of a framework meant to kickstart an energy transition. Colorado's Climate Action Plan, enacted in 2019, requires public utilities to reduce their greenhouse gas emissions by 80% of 2005 levels by 2030. The planned closure of the Ray D. Nixon Power Plant was a key component of CSU's strategy to meet those mandated reductions.

The utility demolished Martin Drake in 2023. Deal oversaw the closure after earning a promotion to serve as CEO a few months earlier. While he previously helped manage a coal-fired power plant in Indiana, Deal said he isn't biased in favor of coal.

"I shut down Drake 10 years ahead of schedule, if that tells you anything," he said. "What I do is try to do what's right for the company at the time."

Deal, however, pushed back against any assertion that coal plants are a major source of air pollution, saying, "Interstate 25 here creates a lot more pollution than a coal plant." And while he thinks coal "doesn't have a long-term future," he also said the energy source has been unfairly "villainised."

Deal also argued that current zero-carbon electricity sources – like wind, solar and grid-scale batteries – can't yet replace the 24/7 baseload energy offered by a coal plant. Colorado Springs Utilities is currently evaluating nuclear as a future energy source.

One of the primary concerns driving CSU's push to keep the Ray D. Nixon Power Plant operating is the rising cost of renewables. The utility recently considered proposals to build a vast amount of new wind and solar energy, but concluded they would be too expensive in February 2025.

According to Deal, the high price tag stems from a combination of factors: a congested supply chain, heightened demand across the energy industry, raw material shortages, tariffs and recent policy changes by the Trump administration.

Energy providers across Colorado, including Xcel Energy, have also expressed reservations about grid reliability and maintaining rates as utilities decarbonise.

Meanwhile, environmental advocates argue that CSU's decision not to acquire renewables is short-sighted and could end up hurting ratepayers.

"If CSU keeps waiting to replace Nixon, the cost of replacement resources may go up, especially if CSU waits too long to take advantage of the shortened timeline for wind and solar tax credits," Gerhart said.

Polis considers keeping the power plant open longer than planned

At a press conference last Thursday, Gov. Jared Polis, when asked about the proposed delay, said closing the power plant remains cost-effective in the long run, but he understands the utility also must weigh the risks of moving too quickly.

"Generally speaking, of course, coal is the most costly form of energy on the grid," Polis said. "I think they're [CSU] just trying to figure out the date that makes sense to close down their higher-cost coal power plant. And of course, the more renewable energy we have online sooner, that's lower cost, then the sooner that can occur."

Deal confirmed CSU approached the EPA about keeping the Ray D. Nixon Power Plant open past 2029. He also said those conversations weren't an attempt to go over the heads of state authorities, but rather a necessary step to eventually arrive at a workable solution.

While state law remains in place, Gov. Polis signaled he was open to reconsidering the current retirement date.

"Whether it's 2033, 2034, we want to do something that makes sense," Gov. Polis said.

Fortescue secures $3 billion loan in landmark China deal

Fortescue has secured a Renminbi-denominated (RMB) $14.2 billion ($3 billion) syndicated term loan, marking the first RMB facility of its kind by an Australian company.

The deal, backed by leading Chinese, Australian and international lenders, is a significant step in Fortescue's capital strategy and highlights its strong, long-standing ties with China.

Proceeds from the five-year unsecured facility will support general corporate purposes and Fortescue's decarbonisation goals, including partnerships with Chinese suppliers and technology leaders.

Fortescue executive chair Andrew Forrest said the loan represents more than just financial backing.

"It's a signal of what is possible when partners are aligned in ambition," Forrest said. "As the United States steps back from investing in what will be the world's greatest industry, China and Fortescue are advancing the green technology needed to lead the global green industrial revolution.

"China continues to lead the world in industrial scale and innovation. Fortescue shares that ambition and drive. This landmark RMB financing strengthens our long-standing partnerships with Chinese institutions and opens new frontiers for collaboration."

Fortescue group chief financial officer Apple Paget said this financing deepens its engagement with existing financial partners and further expands the company's banking syndicate to institutions with Renminbi lending capabilities.

"The exceptional demand through the syndication process is recognition of Fortescue's strong credit profile, track record for operating excellence and disciplined capital allocation," Paget said.

"It marks another milestone in execution of our capital management strategy, diversifying funding sources, enhancing flexibility and lowering our cost of capital, including achieving Fortescue's lowest ever cost of debt. It reinforces our position as responsible custodians of capital."

The facility was arranged by Bank of China and Industrial and Commercial Bank of China (Sydney branches), with a 12-month availability period and repayments starting 18 months after close.

BHP and Lundin will request Argentina incentives

BHP and Lundin plan to soon apply for a new Argentine investment incentives scheme for their Vicuna copper project, but other miners fear they may get left out before the program's cut-off date a year from now, executives said at a mining conference.

Argentina's Large Investment Incentive Regime, or RIGI, which went into effect in October under President Javier Milei, offers lengthy tax breaks and access to international dispute courts for investments exceeding $200-million. It will be in place through July 2026 with a possible one-year extension.

Mining companies celebrated the measure as much-needed assurance to move ahead with copper projects in a volatile economy with restrictive capital controls, giving the sector its first big boost in decades.

Jose Morea, who leads BHP and Lundin's Vicuna project, said the two companies plan to announce the project's expected investment early next year.

Speaking recently at the Argentina Copper 2025 conference in San Juan province, where most of Argentina's copper projects are concentrated, Morea said Vicuna would file an application in the "short term" for some of the investment to receive benefits under RIGI.

But other copper projects are in the early exploration stages, such as Aldebaran Resources' Altar, and are not ready to start heavy spending that could qualify for RIGI. Altar aims to present a preliminary economic assessment in September, said Javier Roberto, the head of Altar in Argentina.

"How do we manage projects that are a bit behind and face a closing RIGI window – even assuming the national executive grants an extension and we reach June 2027?" Roberto said.

Only two mining projects have received RIGI benefits so far, both in lithium. Only one copper project, McEwen Mining's Los Azules, has applied for the program.

Executives pointed to the uncertainty around Argentina's glacier preservation law as another potential investment obstacle because they said much of the legislation is open to interpretation.

"We need a decree that tells us exactly what's allowed, what's not, and what must be preserved," Roberto said.

Snowline's Valley project shaping up as Canada's next major gold mine

Exploration and development company Snowline Gold's Valley project in the Yukon Territory is emerging as a globally significant gold deposit, with the potential to become one of Canada's largest openpit operations – and one of the lowest-cost, CEO Calum Morrison said.

Speaking at the Diggers and Dealers Mining Forum in Kalgoorlie, Australia, Morrison showcased the company's flagship eight-million-ounce Valley deposit, highlighting its robust economics, high grade, and unusually low strip ratio of one-to-one. A preliminary economic assessment (PEA) released in June outlined a project capable of producing 544 000 oz/y of gold at an all-in sustaining cost of $569/oz in its first five years. Over a 20-year mine life, production will average at 341 000 oz/y.

Morrison said the Valley deposit was "a globally relevant, potentially tier-one project", delivering strong economics from surface.

"This is what delivers most of our project economics," he said, referring to the 3.3-million-ounce starter pit at 2.35 g/t.

At a base-case gold price of $2 150/oz, the PEA outlined an after-tax net present value of C$3.5-billion, but Morrison said upside is significant. At spot prices, the NPV exceeds C$7-billion, with an internal rate of return (IRR) above 40%.

"This is an all-weather project. Even at $1 650/oz, Valley still generates robust economics with a C$1.6-billion NPV and 17% IRR," he noted.

Snowline is now investigating whether it can double Valley's mill throughput from 25 000 t/d to 50 000 t/d, which could sustain a 500 000 oz/y production profile.

Fast-tracking development

While not yet shovel-ready, Snowline aims to significantly compress its development schedule. The project is located 75 km from a government-maintained road and 30 km from a heavy-equipment trail used by other mining projects in the area. Snowline has assumed full infrastructure costs in its PEA but is actively exploring cost-sharing or government support.

"This is a meaningful project for the Yukon – potentially representing 32% of GDP [gross domestic product]," Morrison said. "With a population of just 50 000, this mine can move the needle."

The company's deep relationships with local First Nations and government stakeholders give it confidence that it can accelerate permitting and development.

"We do think we are the best group to advance this project at this stage," Morrison said. "We have got a purpose-built team addressing not only the opportunities, but the risks we see in the project. We have a year-round presence in the Yukon. "

Growing interest

Valley has attracted comparisons to major tier-one discoveries, including Australia's De Grey Mining's Hemi project. While not listed on the ASX, Snowline has drawn increasing Australian attention and currently holds a C$1.5-billion market capitalisation on the TSX-V.

"We've been called the 'next De Grey' in some circles," Morrison said. "I'll let you decide on that, but there are clear comparisons in terms of scale and potential. We are a bigger starter pit, higher grade mineralisation and a lower strip ratio."

"There is M&A potential here, sure. But we believe a significant value gap still exists versus our global peers – and we are focused on unlocking that for our shareholders," he added.

While Valley remains the centrepiece, Snowline controls a 360 000 ha land package in the region and is allocating about 40% of its drilling budget this year to exploration beyond Valley.

Snowline has over C$50-million in treasury, giving it the flexibility to fund both development and exploration in parallel.

Port Hedland cleared for $4bn downstream iron ore plant

Port Hedland is set to host a $4 billion hot briquetted iron (HBI) plant after Western Australia's Environmental Protection Authority approved the Port Hedland iron (PHI) project.

The facility, backed by South Korean steel-maker POSCO, will process Pilbara iron ore into HBI and iron ore pellets within the Boodarie Strategic Industrial Area, nearly 10km south-west of Port Hedland.

The PHI project includes a pellet plant and an HBI plant, consuming 3-3.5 m tonnes of iron ore annually. Around 2 m tonnes of HBI will be produced each year, with the remainder exported as pellets.

Supporting infrastructure includes hydrogen production and storage, a nitrogen plant, handling and storage facilities, power transmission, carbon capture and administrative and workshop buildings.

Port Hedland mayor Peter Carter said the project would diversify the local economy.

"We've always been an iron ore port and we'll continue to be an iron ore port," he told the ABC. "But (now with) a company like POSCO coming to town and having a green (iron) mill in our town, it will attract so many other people … It's a big drawcard for other industry to come to play."

Hot briquetted iron is a higher-value product and could more than double Australia's iron ore export revenue, according to the Superpower Institute.

The PHI project also aims to be powered by renewable energy by 2050, aligning with broader decarbonisation goals.

With approval from the WA Environmental Protection Authority secured, next steps include gaining approval from the area's Native Title holders.

West African Resources targets 500 000 oz/y by 2029

Gold miner West African Resources is aiming to become a sustainable 500 000 oz/y producer by 2029, underpinned by strong operational performance from its Sanbrado and Kiaka operations in Burkina Faso.

CEO Richard Hyde said that while the company would ultimately consider opportunities across the "west coast of Africa to the west coast of Australia", its focus for the next 12 to 18 months would be optimising its existing assets and paying down debt.

"We really need to focus on bedding down the projects, make as much money as we can, and pay down debt," he told delegates on the last day of the Diggers and Dealers mining conference in Kalgoorlie.

"We have got about $250-million in debt, which is not a lot considering the size of the company now, but the opportunity is to get Kiaka hitting its straps and drill out the targets we have already got — not complicate the business with new development projects."

West African recently poured first gold at the Kiaka project, its second operating mine, which is ramping up to nameplate production of about 250 000 oz/y. With Sanbrado contributing about 300 000 oz/y at peak, Hyde said the company was on track to hit nearly 570 000 oz in 2029, before settling into a long-term sustainable rate of 500 000 oz/y.

A new ten-year production outlook released on Wednesday supports this goal, projecting 4.8-million ounces produced over the next decade, with several years exceeding the half-million-ounce mark. The plan is based just 3% on resources and reserves, which Hyde said leaves significant upside potential.

"We have assumed fairly conservative metrics," he said.

"With targeted drilling at M1 South, the M5 South underground, and extensions at M5 North, plus the addition of secondary crushing capacity at both Sanbrado and Kiaka, we believe we can maintain high throughput rates."

West African is undertaking 200 000 m of drilling over the next two years using its own fleet of drill rigs. Hyde highlighted the company's exploration success at M1 South, noting recent results of 44 m at 25.4 g/t, 44.5 m at 17.1 g/t, 38.5 m at 17.4 g/t and 21.5 m at 24 g/t.

"It is a very attractive ore body. When you are underground, you can actually see it."

The company has also brought forward underground planning at M5 South and the Toega deposit, which is being integrated into the life-of-mine plan.

Despite operating in a challenging jurisdiction – with Burkina Faso experiencing two coups since 2021 – West African has delivered its second project, Kiaka, under budget and ahead of schedule. The mine is currently operating at about 50% throughput. The company is waiting for the connection to grid power, expected in the September quarter.

"There is enormous potential once we get to full throughput."

West African has contributed more than $350-million to the Burkina Faso economy since 2020 and remains committed to operating as a majority-indigenous employer, with 93% of its nearly 3 000-strong workforce drawn from the local population.

"We believe we are the best mine builders in the world," Hyde said. "We have consistently met or beaten guidance, and we have done it while investing heavily in local communities, safety and training."

Hyde also noted that West African is unhedged, with 6.5-million ounces in reserves and 12.2-million ounces in resources. "At today's gold price, with our margins, you can do the maths," Hyde quipped.

"We are in a strong position to grow production, reduce debt, and deliver value."

US adds copper, silver and potash to draft list of critical minerals

The US government has proposed adding copper, silver and potash to its list of critical minerals for the first time.

The Department of the Interior released a draft 2025 list of 54 minerals deemed critical to the US economy and national security. The update, developed by the US Geological Survey (USGS), includes six new additions: copper, silver, potash, silicon, rhenium and lead. Arsenic and tellurium were recommended for removal.

The Interior Department also signalled it may consider adding metallurgical coal and uranium, which are both considered "fuels" and currently excluded from the list, to the final version when it is published in 30 days.

The draft list will shape federal strategy, investment and permitting decisions around domestic mining, recycling and processing.

"President Trump has made clear that strengthening America's economic and national security means securing the resources that fuel our way of life," said Interior Secretary Doug Burgum. "This draft list of critical minerals provides a clear, science-based roadmap to reduce our dependence on foreign adversaries, expand domestic production and unleash American innovation."

The list is updated every three years under the Energy Act of 2020. It began with a 2017 executive order that directed agencies to evaluate vulnerabilities in US mineral supply chains.

"The draft 2025 list and methodology reflect USGS advances in forecasting potential mineral supply chain disruptions, as called for in the Energy Act of 2020," said USGS acting director Sarah Ryker. "Minerals-based industries contributed over $4-trillion to the US economy in 2024, and with this methodology we can pinpoint which industries may feel the greatest impacts of supply disruptions and understand where strategic domestic investments or international trade relationships may help mitigate risk."

The new model tested more than 1 200 disruption scenarios for 84 minerals across 402 industries. The analysis highlighted samarium, rhodium, lutetium, terbium and dysprosium among the commodities posing the greatest economic risks.

While probability-weighted impacts amount to a fraction of US GDP, the report warns that a sudden disruption of a single mineral could reverberate through entire sectors, such as semiconductor manufacturing or defence.

National Mining Association (NMA) president and CEO Rich Nolan applauded the USGS for updating its critical minerals list with a number of minerals that he said were "essential to everything from rebuilding and modernising the nation's infrastructure to supporting our national security and providing the irreplaceable inputs to advance our technological leadership".

However, Nolan noted that the NMA believed all minerals were critical. "Many so-called critical minerals are only found because they are either co-located with or are produced in the processing of other minerals. And the rapid pace of innovation means the minerals used in today's technologies may be different than those needed tomorrow. Given those realities, any policies applied to a critical mineral listing should be applicable to all US mined materials."

West African's profit rises 133% y/y on the higher gold price

Unhedged gold mining company West African Resources has lifted its net profit after tax for the six months ended June 30 by 133% year-on-year to A$214.63-million, on the back of a 39% year-on-year increase in revenue to A$477.32-million.

The ASX-listed company produced 95 644 oz of gold from its Sanbrado mine, in Burkina Faso, during the six months under review. This was lower than the 107 644 oz of gold produced in the first half of 2024.

As a result, the company sold fewer ounces of gold – 98 178 oz – compared with the 101 954 oz sold in the prior comparable period.

Gold revenue from Sanbrado was, nevertheless 39% higher year-on-year on the back of a 44% year-on-year increase in the average gold price, in Australian dollars, to A$4 809/oz.

In US dollar terms, the average sales price was $3 049/oz for the six months under review.

All-in sustaining costs were, meanwhile, also 12% higher year-on-year at $1 374/oz.

West African ended the six-month period with a A$279-million cash balance and A$49-million in unsold gold bullion

CONVEYOR BELTS – the longer the life, the lower the cost

Conveyors play an integral role in mining and quarrying, where reliability is paramount because time really is money. The conveyor belts used on them are also a significant overhead and therefore a prime target for the bean counters. The conveyor belt market is hugely competitive, as evidenced by the often huge variations in the price of belts of supposedly the identical specification. However, regardless of the price, it is the reliability and ultimate longevity that actually dictates their true cost. So, are you getting the best value for money?

"PRICE IS WHAT YOU PAY. COST IS WHAT YOU SPEND"

The selling price is usually the biggest influence on the purchasing decisions we make. In business it is usually budgetary constraints that take priority. However, buying something because it is 'competitively priced' but then proves to be unreliable or needs replacing after a very short period can be very costly.

To calculate the true cost of vitally important components such as a conveyer belts, it is essential not to look at the price in isolation but to include as many other directly connected costs as possible. The 'above the line' price that you pay is just the tip of the iceberg because it is the less obvious 'below the line' costs are what is actually spent. Managers who are directly responsible for conveyors will almost certainly know the cost in terms of lost output when there is a stoppage. If they do not, then they should! However, the key question is whether or not the cost of that lost output is being measured and recorded and used to help make buying decisions.

NOT ALL CONVEYOR BELTS ARE CREATED EQUAL.

Even though they may both claim to meet a certain specification and international quality standards, there are frequently huge differences between the durability and longevity of the belt when fitted and running. There are numerous, well-documented reasons for these huge differences, but they are not necessarily obvious at the selection stage.

Time is money – stopping for repairs costs time and money.

On the scrap heap after only 600 hours. There can be a very big difference between one conveyor belt and another.

Ironically, one of the best warning signs are the prices being offered. It is not uncommon to see belts being offered by traders, suppliers and sourcing companies that are half the price (or less) than those being offered by quality-brand manufacturers.

As with almost any product, price ultimately determines the quality of performance, the need for ongoing repairs and the length of useable life. In the case of so-called 'economy' conveyor belts, all the evidence points to the big name quality brands having a significantly lower 'whole life cost' because they provide up to 400% longer operational life compared and considerably less downtime thanks to far fewer unplanned stoppages for repairs. Unfortunately for those who manage the day-to-day running of conveyors, it is extremely rare for those who ultimately make the purchasing decisions to understand the technical differences associated with the performance and longevity of a conveyor belt. Consequently, price is the number one buying criteria. To be fair, purchasing managers cannot be an expert on every product they are required to source. Trying to convince them and the company accountants that you want to use more reliable but seemingly 'higher priced', premier quality belts can be difficult. Fortunately, it becomes much easier if you 'speak their language' by presenting an argument based on factual, whole-life cost calculations.

CALCULATING 'WHOLE LIFE' COST

The principal of 'whole life cost', also referred to as 'total cost of ownership (TCO) is simply the cost of the conveyor belt itself plus the cost of removing the old belt and the installation (including splicing) of the replacement plus the cost of the downtime. The final part of the cost calculations are the labour and material costs incurred in repairing the belt (including the splice repairs) during its lifetime plus the estimated costs of the production lost while those running repairs were carried out. These calculations are easier to make if conveyor maintenance and repair is contracted out to a vulcanizing company. However, if these functions are performed 'in house' then it is important that accurate maintenance records are kept.

TIME OR TONNAGE?

Having added together the various elements of cost, the final step is simply to divide the total. This can either be done by either the length of time that the belt has been operational or, if known, the total weight of material conveyed during its lifetime. On conveyors that are usually running non-stop during the day then time is usually the best measure. However, if the conveyor only operates intermittently then using tonnage as the basis for the calculation may prove more accurate. You can, of course, calculate using both time *and* tonnage.

The price ultimately determines the quality and longevity.

Having calculated the lifetime cost of a belt you are replacing, the question then becomes one of comparison. There is little or no point in making the calculation unless you have something to compare it against. This, of course, can mean trialing a higher grade of belt or a different type of belt entirely, perhaps both. Maintaining individual life data can also be a huge help, as happened in one case I came across recently. The on-site conveyor managers were perfectly happy with the premier European brand belts they had been using. Unfortunately, senior management insisted that they buy a "much cheaper" belt of the 'same' specification but made in India. The result was that the Indian import belt lasted less than four weeks, some 95% less the quality brand.

Good quality European-made belts can provide up to four or five times longer operational lifetime.

Cheaper in the long run – quality belts help maximise productivity.

PREDICTING THE LIFESPAN

Understandably, manufacturers of conveyor belts, regardless of their reputation for quality, can never guarantee how long a belt will last before needing to be replaced because there are simply too many influencing factors. Do not let this put you off. There is inevitably some degree of risk in any business decision but if you choose a tried and trusted manufacturer with a reputation for quality then the rewards can be considerable. As the old saying goes, *"If you never try something different then you will always get what you already have"*.

In my experience, the best approach is to select a conveyor that has the highest frequency of belt repairs and replacements. The next step is to discuss the application and your requirements with an experienced representative or application engineer representing each potential new supplier. If the conveyor you have chosen is particularly problematic then it is often a good idea to make absolutely sure that the specification of the belt is correct for that particular conveyor by using a belt calculation program. If necessary, have the process overseen by a professional conveyor belt engineer.

For conveyors where damage caused by trapped foreign objects can be a problem, the most cost-effective solution is to fit a belt that has been specifically engineered to resist such damage. Specialist belts such as Fenner Dunlop's X Series range will provide much longer lifetimes because that is exactly what they are designed to do.

STANDING THE TEST OF TIME

Never accept that belts cannot last many times longer than is currently being achieved. Thanks to huge technological advances, the cost-effectiveness of modern-day conveyor belts should be measured over several years rather than just a year or two. Worryingly, we are seeing more and more examples of belts that only last a few months and, as in the example I gave earlier, only a matter of weeks.

This actually strengthens the case for selecting belts based on 'whole life' calculations rather than simply the buying price. There will always be a natural desire to reduce expenditure but conveyor belts that provide a longer operational life invariably prove much cheaper in the long run.

Leslie David

ABOUT THE AUTHOR

After spending 23 years in logistics management, Leslie David has specialised in conveyor belting for over 19 years. During that time, he has become the most published author on conveyor belt technology in the world.

A modern perspective on a traditional method

Room and pillar mining, a foundational technique in underground mineral extraction, continues to be a significant method globally, particularly for horizontally deposited minerals like coal, potash, and limestone. This method involves carving out a grid of "rooms" into the ore body while leaving behind "pillars" of the mineral to support the mine roof. While the fundamental principle has been in use for centuries, the industry is witnessing a technological revolution that is reshaping its efficiency, safety, and environmental impact. *Mining & Quarry World gives a brief insight into this type of mining method.*

Room and pillar mining is one of the oldest and most enduring underground mining techniques. It involves excavating a series of orthogonal openings in a mineral deposit, leaving behind rectangular or square pillars to support the overburden. These pillars act as natural structural supports, preventing collapse and maintaining stability.

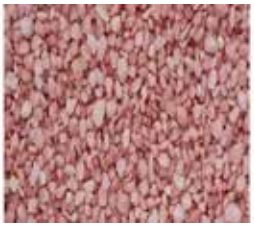
This method is best suited for tabular or bedded ore bodies that are thin to moderately thick and dip from flat to about 40°. When executed systematically, the layout resembles a city grid, with rooms intersected by "streets" of untouched ore.

IDEAL APPLICATIONS

Room and pillar mining is commonly used for:

- Coal
- Potash
- Salt (sodium chloride)
- Trona

Coal



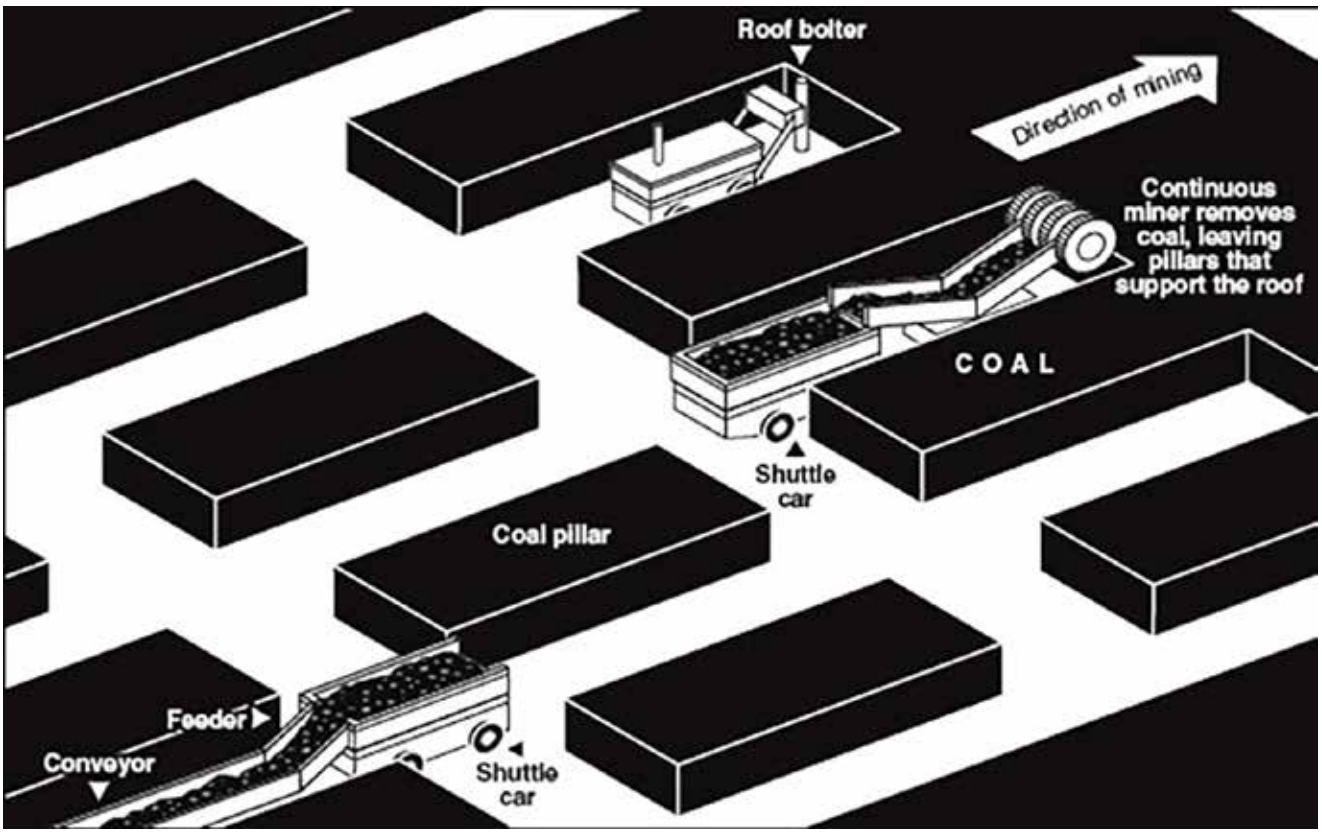
Potash

Salt

Trona

Limestone

ROOM AND PILLAR MINING METHOD



- Limestone
- Horizontal metallic deposits

Despite advances in surface mining, this technique remains widely used due to its effectiveness and adaptability.

HISTORICAL CONTEXT & MODERN USE

Dating back to medieval Europe, room and pillar mining has stood the test of time. It's especially effective for sedimentary, flat-lying deposits formed in layers. A vertical shaft leads to the productive area, where most mining activity occurs. This area is laid out in a grid to stabilise the overburden – the rock and material above the mined zone.

To prevent collapse, large pillars are left in place. While a uniform layout is ideal, ore bodies rarely form in perfect grids, requiring careful planning and exploration to determine where rooms and pillars should be placed.

Key Stages of Room and Pillar Mining

1. Exploration
   - Identify suitable deposits (coal, iron, uranium, salt, gypsum, oil shale).
   - Assess productivity and safety.
   - Determine if room and pillar is the optimal method.

2. Ownership
   - Ownership is assigned at the exploration stage.
   - The owner is responsible for exploration costs and safety assessments.

3. Design
   - Thorough geological analysis is essential.
   - Rooms and pillars should be evenly sized to:
   - Ensure proper airflow
   - Distribute roof weight evenly
   - Support continuous mining operations
   - Simplify the cut sequence

There are two pillar types: Barrier Pillars : Wider, sturdier; prevent total collapse and Panel Pillars: Smaller; flank productive panels

4. Mining
   - Material is extracted via vertical shafts.
   - Traditional blasting has given way to continuous mining, which grinds and removes ore more efficiently.
   - Success depends on evenly distributed ore and precise planning.

5. Retreat Mining
   - Involves removing remaining pillars, causing controlled collapse. Extremely risky and controversial due to:
   - Worker safety concerns
   - Geological instability
   - Environmental impact

6. Maintenance & Repurposing
   - Abandoned mines pose collapse risks.
   - Maintenance is costly but necessary.
   - Some regions repurpose mines for storage or commercial use.
   - Collaboration between companies and local authorities is vital for post-mining plans.

RISKS AND CHALLENGES

The Evolution of a Method: From Conventional to Continuous and Beyond

Historically, room and pillar mining relied on a conventional cycle of cutting, drilling, blasting, and hauling. While still

RISKS AND CHALLENGES

Risk	Description
Overburden Collapse	Prevented by evenly distributed pillars
Poor Airflow	Caused by uneven room shapes; endangers workers
Retreat Hazards	Removing pillars can destabilise the surface and threaten ecosystems
Maintenance Neglect	Old mines may collapse if not properly maintained

in use, this has been largely supplemented by continuous mining, which employs mechanical miners to cut and load the ore in a single operation. This evolution has significantly increased productivity.

Modern operations are now embracing a new wave of advancements that are pushing the boundaries of what is possible in underground mining:

- **Automation and Robotics:** The use of automated and remote-controlled loaders, haulage systems, and even robotic equipment is on the rise. These technologies allow for continuous operation, leading to increased productivity and, crucially, enhanced worker safety by removing personnel from potentially hazardous areas. In fact, studies suggest that automation and remote operation can reduce accidents in mines by up to 70%.

- **Data Analytics and Machine Learning:** Big data is playing an increasingly important role in optimising mine design and operations. By analyzing vast datasets, mining companies can identify trends, predict potential hazards like rock falls, and refine the dimensions of rooms and pillars for maximum stability and resource extraction.]

- **Advanced Sensing and Geo-mechanical Analysis:** Technologies like LiDAR and radar are being used for real-time monitoring of mine conditions. This data, integrated with advanced geo-mechanical analysis and numerical modelling, allows for a more precise understanding of rock mechanics and helps to ensure the long-term stability of the mine.

WEIGHING THE PROS AND CONS

Room and pillar mining offers several distinct advantages. It is a relatively flexible and cost-effective method, particularly for deep deposits where removing large amounts of overburden for surface mining would be uneconomical. The method also allows for good ventilation and can be highly mechanised, leading to high productivity rates.

However, it is not without its drawbacks. A significant portion of the ore must be left behind as pillars, which can result in lower recovery rates, sometimes as low as 40%, compared to other methods like longwall mining. The potential for surface subsidence and the risk of pillar collapse, especially in abandoned mines, are also significant concerns.

ENVIRONMENTAL AND SAFETY CONSIDERATIONS IN THE MODERN ERA

The mining industry faces increasing pressure to operate in an environmentally and socially responsible manner. For room and pillar operations, this means addressing key challenges:

- **Subsidence:** The risk of the ground surface sinking above mined-out areas is a major environmental concern. To mitigate this, some operations employ backfilling, where waste material is used to fill the voids left by mining, thereby controlling roof subsidence and reducing surface deformation.

- **Water and Air Pollution:** Like all mining activities, there is a risk of water contamination from leachate and air pollution from dust. Modern mines employ water treatment facilities and dust suppression techniques to minimise their environmental footprint.

- **Worker Safety:** Ensuring the safety of miners is paramount. Modern safety management in room and pillar mines involves a multi-faceted approach, including rigorous ground control measures, comprehensive training for personnel on safety protocols, and detailed emergency response plans. Regulatory bodies like the Mine Safety and Health Administration (MSHA) in the United States set mandatory safety standards for underground coal mines, covering aspects like roof support and ventilation.

GLOBAL APPLICATIONS AND FUTURE OUTLOOK

Room and pillar mining is utilised worldwide, with notable operations in the United States, Australia, China, and South Africa for coal, as well as for other minerals in countries like Canada (potash) and Brazil (gold). Case studies from various locations, such as the Chingola Mine in Zambia and the Maddhapara Hard Rock Mine in Bangladesh, demonstrate the method's adaptability to different geological conditions.

Looking ahead, the future of room and pillar mining will be shaped by the continued integration of technology. The drive for greater efficiency, improved safety, and better environmental performance will likely lead to even more sophisticated automation, data-driven decision-making, and innovative mine designs. As the global demand for energy and resources continues, this age-old mining method, enhanced by modern technology, is set to remain a vital part of the global mining landscape.

CONCLUDING THOUGHTS

Modern room and pillar mining involves highly precise engineering to determine pillar size, shape, and placement. While early mines were hazardous, today's operations benefit from advanced technology and refined techniques. Despite its age, Room and pillar mining remains one of the most effective and elegant solutions for underground resource extraction.

Fleet management in mining

Managing fleets in the mining industry is a multifaceted challenge, requiring the coordination of diverse heavy machinery—from haul trucks to drilling rigs. Effective fleet management is essential for minimising downtime, boosting productivity, and cutting operational costs. With the rise of artificial intelligence (AI), mining operations now benefit from advanced tools that dramatically enhance fleet performance. This article explores how AI-driven solutions are revolutionising fleet management and driving productivity gains across the mining sector.

Mining & Quarry World take a detailed view of managing fleets within our Industry.

Open-pit mining contributes significantly to global greenhouse gas (GHG) emissions, with the loading and hauling processes being among the largest sources. These emissions cannot be overlooked in the broader context of climate governance. There is an urgent need to develop efficient, green, and climate-smart fleet management strategies to mitigate environmental impact.

This article delves into the emission reduction potential of fleet operations in open-pit mines, identifying key areas for improving quality and efficiency. These insights can help guide the development of practical academic and industrial solutions.

Current research on fleet management in mining focuses on three core areas:

- Shortest Path Optimisation: Enhancing route efficiency to reduce fuel consumption and travel time.
- Truck-Shovel Allocation: Balancing equipment usage to maximise output and minimise idle time.
- Real-Time Truck Scheduling: Leveraging data to dynamically adjust fleet operations for optimal performance.

To better understand the drivers of green fleet management, the article also reviews the latest innovations in climate-smart mining practices from industry.

Despite progress, existing research still falls short in several areas. Promising directions for future exploration include:

- Optimising Equipment Utilisation: Improving how machinery is deployed to reduce waste and energy use.
- Scheduling Clean Energy Trucks: Integrating electric or hybrid vehicles into fleet operations.
- Advanced Waste Management: Minimising environmental impact through smarter disposal and recycling.
- Accurate Carbon Measurement Systems: Developing robust methodologies for tracking and reporting emissions.

The mining industry is responsible for 4-7% of global GHG emissions, with direct production activities accounting for 45-60% of lifecycle emissions. Fleet transportation alone consumes up to 35% of total energy used in mining. Transitioning to low-emission equipment is a key strategy, but widespread adoption faces technical hurdles such

as battery limitations, energy storage, and equipment adaptability.

In the interim, green, and climate-smart mining practices offer a viable path to reducing ecological impact. By rethinking traditional haulage models and implementing efficient fleet management systems, mining operations can significantly lower energy use and carbon emissions.

An open-pit mine typically involves five stages: drilling, blasting, loading, hauling, and crushing. These operations are capital-intensive, with loading and hauling alone accounting for 16% and 37% of total input costs, respectively – over half of the mine's operating expenses. This underscores the importance of optimising these processes to improve both economic and environmental outcomes.

Efficient fleet management plays a pivotal role in advancing green and climate-smart mining practices. When tailored to the specific conditions of a mine, it can significantly reduce the ecological footprint and promote cleaner mineral production – ultimately enhancing both the profitability and long-term sustainability of mining operations.

THE STRATEGIC ROLE OF FLEET MANAGEMENT IN MINING

Fleet management in mining involves the systematic planning, coordination, and monitoring of vehicles and equipment used across operations. Its core objectives include:

- Maximising equipment utilisation
- Reducing operational costs
- Enhancing safety for personnel and machinery
- Minimising environmental impact

Historically, fleet management has relied on manual oversight and reactive maintenance. Today, artificial intelligence (AI) is transforming this landscape by introducing predictive analytics and automation, dramatically boosting operational efficiency .

AI APPLICATIONS IN MINING FLEET MANAGEMENT

Predictive Maintenance

AI algorithms process sensor data to forecast equipment failures before they happen. By analysing variables like vibration, temperature, and hydraulic pressure, maintenance can be scheduled proactively—reducing downtime and extending machinery lifespan.

Autonomous Fleet Operations

AI enables the use of autonomous vehicles that operate continuously without human input. Equipped with advanced sensors and navigation systems, these vehicles safely and efficiently transport materials within mining sites.

VTS (Vehicle Tracking System)

Refers to a GPS-based technology designed to monitor and manage the real-time movement of mining vehicles. It plays a critical role in enhancing safety, improving operational efficiency, and maximising productivity across mining operations. Vehicle Tracking Systems (VTS) in mining leverage GPS, IoT, and telematics to enable real-time fleet visibility and operational control. The system typically comprises:

- GPS Modules: Installed on mining vehicles to deliver accurate location tracking.
- Telematics & Sensor Integration: Monitor critical parameters such as speed, fuel usage, engine health, and equipment status.
- Cloud-Based Control Platform: Centralised software for remote monitoring, data analytics, and fleet management.
- Robust Communication Networks: Utilise satellite, radio, or cellular networks to ensure seamless real-time data transmission.

These systems empower mining operations to enhance productivity, streamline route planning, enforce preventive maintenance, and improve operator behaviour – ultimately driving safety and improving operational.

TECHNICAL AND LOGISTICAL CHALLENGES IN VEHICLE TRACKING

- Adverse Operational Environments: Extreme temperatures, pervasive dust, and rugged terrain in mining sites necessitate the use of industrial-grade, resilient GPS and telematics equipment.
- Limited Network Infrastructure: Remote mining locations often lack reliable connectivity, requiring costly satellite-based solutions to ensure uninterrupted tracking.
- Substantial Upfront Investment: Implementing a full-scale vehicle tracking system entails significant capital outlay in hardware, software, and personnel training.
- Operator Resistance to Monitoring Technologies: Workforce apprehension toward surveillance technologies highlights the need for structured training and change management to facilitate adoption.

GLOBAL ADOPTION OF SMART FLEET TRACKING IN MINING

Leading mining companies worldwide are harnessing advanced vehicle tracking technologies to streamline operations, reduce costs, and enhance safety. Here are some standout examples:

- Rio Tinto (Australia): Utilises an Automated Haulage System (AHS) with GPS tracking for driverless trucks, resulting in a 13% reduction in fuel costs.
- Anglo American (South Africa): Implemented fleet tracking systems that cut operational delays by 20%.
- Caterpillar's MineStar (USA): Employs real-time tracking and predictive maintenance to reduce vehicle downtime by 35%.
- Coal India Limited (India): Integrated GPS across its fleet, improving fleet utilisation by 25%.

These success stories highlight the growing importance of Vehicle Tracking Systems (VTS) in modern mining operations.

THE RISE OF SMART DIGITAL MINING PLATFORMS

Innovative solutions like Softweb's MiningPro, MiningPro. AI, and Transminex with RPA are leading the charge in digital transformation. These platforms combine:

- Real-time monitoring
- Advanced data analytics
- Logistics optimisation

VEHICLE FUEL SAVINGS AT AN INDONESIAN COAL MINING

A coal mine in Indonesia managed to reduce fuel consumption of haul trucks by 18% thanks to the *Maintenance Management* solution. Before the implementation of the solution, the trucks' average fuel consumption was 373 litres per hour. After close monitoring and corrective actions on fuel injectors and oil filters, fuel consumption was reduced to 305 litres per hour, resulting in savings of approximately US$160,000 per truck per year.

By utilising a real-time monitoring system, Modular Mining's *Performance Assurance* (PA) team identified the

main causes of fuel wastage, such as incorrect injector pressure and oil filter blockage. Thanks to monitoring and proactive measures, the mine was able to improve truck efficiency, reduce the incidence of oil filter blockages that impair engine performance, and extend the life of the mining truck engine.

As a result, truck fuel consumption was significantly reduced from 373 litres per hour to 305 litres per hour, resulting in savings of nearly US$3.4 million per year for the 21 affected trucks. In addition, the mine reduced the incidence of oil filter blockages from 255,000 per week to 0. This solution demonstrates the importance of integrated monitoring and maintenance of mine vehicles to reduce operating costs and improve efficiency in the mining industry.

VEHICLE OPTIMISATION AT GRIB DIAMOND MINING, RUSSIA: UP TO 80% IDLE TIME REDUCTION

The Grib diamond mine in Arkhangelsk, Russia, faced the problem of haul trucks queuing up at inoperative crushers, leading to high idle times and inefficient fuel consumption. This problem occurred due to a lack of communication between crusher operators and the central manager, resulting in trucks often being directed to the crusher even when it was down. By installing a Fleet Management System (FMS), the mine successfully addressed this issue by improving communication and automating truck assignments.

This solution resulted in a significant reduction in truck idle time, from 210 hours per month to just 38 hours per month-a reduction of more than 80% in an eight-month period. The DISPATCH FMS system not only prevents unnecessary truck queues at the crusher but also optimises fleet utilisation by redirecting trucks to other more efficient activities such as waste hauling or parking. This improves the overall efficiency of mine operations, reduces idle time, and maximises the utilisation of the mine truck fleet.

IMPROVED MTBF AND REDUCED UNPLANNED MAINTENANCE AT A PERUVIAN OPEN PIT MINE

A large open pit mine in Peru successfully increased the *Mean Time Between Failure* (MTBF) of its haulage truck fleet by more than 53% and reduced unplanned maintenance by 21% through the implementation of a *Maintenance Management* system and *RemoteCare* service. The system enables real-time monitoring of components, detecting problems before they become major breakdowns. For example, when the *RemoteCare* team detected a drop in coolant pressure on one of the trucks, they took immediate action to prevent engine failure that could have caused major damage.

With remote monitoring and a customised alarm system, the mine managed to prevent serious damage to the truck's engine. One intervention avoided $250,000 worth of engine replacement costs, which when accumulated over a year can save more than $3 million. The technology not only improved maintenance efficiency but also significantly reduced unplanned downtime.

Together, they empower mining companies with deeper operational insights and greater control over fleet performance.

Technologies such as AI and machine learning are increasingly used for predictive analytics, while autonomous vehicles offer safer, more efficient transport solutions. Systems like the Mine Transport Surveillance System (MTSS) further enhance transparency and safety across mining fleets.

CONCLUSION

Fleet management is a cornerstone of modern mining, addressing operational complexities while unlocking substantial gains in efficiency, safety, and sustainability. As the industry continues to evolve, innovative solutions – such as those offered by Jimi IoT – will be essential for staying competitive.

For mining companies looking to future-proof their operations, the time to invest in intelligent fleet management systems is now.

Groundwater Control USA

Mining has been an integral part of human history since ancient times when people first began exploring below ground level looking at what they could find down there. cave ins, explosions, and extreme temperatures are some of the most perilous hazards observed in underground mining. Groundwater contamination alongside ventilation due to mining are just two of the most critical safety aspects in the operation of an underground mine.

Mining & Quarry World takes a look at how the USA are dealing with the issues to water related problems and how. Digital monitoring & AI integration are revolutionising groundwater control in mines.

Numerous underground mines have been developed in the last 10 years or are planned to be developed in the near future in the United States. Most of these mines concentrate on recovery of gold, zinc, and copper. Although many of these mines are located in the arid or semiarid areas of the western United States, water related problems are of great concern at all of the mines. The presence of ground water in a mine has adverse impacts on mine production, ground control, and safety. Strict environmental regulations for the mining industry are being implemented by state and federal regulatory agencies, and the protection of surface and ground water resources is one of the main objectives of the mining regulations. The recent decline in the price of mineral commodities, and strict environmental regulations are leading to the implementation of more sophisticated water control methods during mining operations. The water control methods are aimed at the improvement of mining efficiency and safety, reduction of costs of mining and mine reclamation, and at the limitation of the probable hydrologic consequences of the mining activities. A well designed and implemented water management control system for an underground mine should consider the climatic, hydrologic and hydro-geologic characteristics of the mine area, the mining methods and the depth of the mine, and the potential environmental impacts of the mining operation during and after the completion of the production.

GROUNDWATER CONTROL METHODS

The main objective in the control of water in underground mines is to develop efficient and safe working conditions and to limit the environmental impacts on surface and ground water resources. Ground water control methods can consist of prevention, (the limitation of water inflow into the mines and/or pumping of water prior to entering a mine) or, pumping from the mine. The experience from many mining projects indicates that well-designed and executed mine water control programs can substantially improve mining conditions by increasing the efficiency of rubber-tired vehicles, creating a safer environment by working in dry, instead wet conditions, and, therefore, decrease the cost of operations. Considerable cost savings can be realised in a mine with an adequate water control system. Examples of cost savings include the use of dry hole blasting agents, increased efficiency of mining, and decreasing costs of pumping and water treatment. There are many potential mine water control methods, however, only a few of them are practically and economically applicable for underground mines. The following are the most applicable methods used for water control in USA underground mines:

1. Impermeabilisation at ground surface
2. Ground freezing
3. Grouting
4. Mine drainage.

SELECTION OF WATER CONTROL METHODS

Cost considerations should be a part of any design of mine drainage. The cost study should consider not only the expenses related to drainage, sealing, or grouting, but also the potential expenses for water treatment and discharge, and other environmental consequences. A study of the best method for mine water control should be based on an analysis of local climatic conditions and the development

of a water balance for the mine area. This study should estimate how much water is available for the ground water system recharge, and how much water can be released from storage during the mining operation. The presence of major surface water bodies in the mine area should be analysed, and the potential for hydraulic connection between the source of surface water and the mine should be assessed. The mining method being considered for application and the depth of the mine are important factors in the assessment of potential seepage into the mine from a surface water source. Important factors for the estimation of subsidence effects on hydraulic connection between surface water resources and an underground mine include mining methods, whether the mine is caved or backfilled, and the type and method of backfill placement. Hydro-geologic characteristics of the mine area have a great impact on the selection of water control methods. The presence of major aquifers in the mine overburden, or the existence of a highly conductive water-bearing ore body should be considered. Sudden inrushes of water into an underground mine are often caused by the presence of major geological structures. An investigation of the hydraulic characteristics of major structures, and faults in particular, is necessary for the selection of a water control method. Faults often act as hydraulic conduits in the shear zone along the fault but can also act as hydraulic barriers perpendicular to the fault due to the presence of mylonite and clay particles. Calculation of the probable water inflow into the mine should be a part of any study for mine water control. Analytical methods, as for example the "Large Well" method adapted for the mining application by Russian hydrogeologists (Klimentov *et al*, 1957 and others), are a good first step in the mine inflow assessment. For some mines with relatively simple hydro-geologic conditions, analytical methods may be adequate for the mine water inflow estimates. In more complex hydro geologic conditions, where significant aquifers and major faults are present, or where potential impacts of mine drainage on surface and/or ground water resources is of the concern, the application of numerical computer models should be considered. Simulation of ground water inflow into a mine should indicate from which strata and how much water would be flowing into the mine workings at various stages of the mining activities. Potential environmental impacts of mine drainage on surface streams, including depletion of stream flows, and impacts on adjudicated water rights, are of great concern in the arid climatic conditions of the western United States. The aspects of potential impacts should be considered in the selection of water control methods. Protection of major aquifers which are used by others for water supply is an important consideration in the selection of a water control method. Extensive pumping from a major aquifer can cause substantial drawdown in a large area and impact numerous water users.

This may substantially increase the cost of the mining operation and can be a difficult obstacle in the mine permitting process. The estimated volume of water which will need to be pumped has to balance the development of conditions for efficient and safe mining while limiting impacts on surface and ground water resources. Included in the evaluation of impacts to surface and ground water resources should be an estimation of the potential water quality of discharge from the mine, and the post-mining ground water quality. This type of study would be based on background water quality data, the geology of the deposit, geochemical testing (Humidity Cell, Acid-Base Accounting, and Meteoric Water Mobility Tests) and prediction modelling. Several software packages are available for geochemical modelling including PHREEQE and MINTEQA2 which have been widely accepted by regulatory agencies in the United States.

DIGITAL MONITORING & AI INTEGRATION IN GROUNDWATER CONTROL

STRATEGIES AND CHALLENGES

Groundwater control in mining operations is a crucial aspect of ensuring safety, efficiency, and environmental sustainability. Excessive water infiltration can lead to operational disruptions, equipment damage, and hazardous working conditions. Effective groundwater management is essential to maintaining structural stability and optimising mineral extraction processes.

SOURCES OF GROUNDWATER IN MINES

Mines often encounter groundwater from multiple sources, including:

- Natural aquifers intersecting the excavation area
- Rainfall infiltration through surface layers
- Seepage from nearby water bodies such as rivers and lakes

Managing these water sources requires careful planning and engineering solutions to prevent excessive accumulation.

METHODS OF GROUNDWATER CONTROL

Several techniques are employed to control groundwater in mining operations:

1 **Dewatering Systems**
Dewatering is the process of removing excess water to keep mining areas dry. The common methods include:

- Pumping wells: Installed around the mine to extract groundwater before it enters excavation zones.
- Sump pumping: Collection points within the mine that drain water using submersible pumps.
- Horizontal drains: Pipes installed to direct water away from critical areas.

2. **Grouting and Sealing**
Injection of sealing materials such as cement, polyurethane, or bentonite into fractures and porous rock formations helps prevent water ingress. This method is widely used in tunnelling operations.

3. **Drainage Galleries**
Constructing underground drainage tunnels or galleries allows water to flow away from mining areas naturally, reducing the need for extensive pumping systems.

4. **Artificial Recharge and Barrier Walls**
In some cases, groundwater inflows can be controlled by modifying surrounding hydrological conditions. Methods such as:

- **Artificial recharge**, where excess water is redirected into designated storage zones
- **Barrier walls**, which act as impermeable shields to block water movement into excavation areas

CHALLENGES IN GROUNDWATER MANAGEMENT

Despite advanced control measures, groundwater management in mining presents several challenges:

- **Environmental Impact:** Over-extraction of groundwater can deplete local aquifers and affect surrounding ecosystems.
- **Geological Complexity:** Varying rock formations and water tables require customised solutions for effective water control.
- **Operational Costs:** Dewatering infrastructure, maintenance, and energy consumption contribute to overall mining expenses.

NEW TECHNOLOGIES

Groundwater control in mining is crucial for maintaining safety and efficiency. New technologies are enhancing traditional methods like dewatering and drainage systems. Here are some of the latest innovations:

- **Advanced Dewatering Systems:** Companies are developing efficient groundwater control solutions, including submersible borehole pumps that remove heavily contaminated seepage water.
- **Digital Monitoring & AI Integration:** The mining industry is embracing real-time data capture and trend analysis to optimise water management.
- **Sustainable Water Management:** Innovations such as *in-situ* leaching aim to minimise waste and environmental impact.
- **Peripheral Water Wells:** These helps stabilise mine walls by controlling water seepage, reducing risks in underground mining

LATEST INNOVATIONS

Today Digital monitoring & AI integration are revolutionising groundwater control in mining. Mining companies are now leveraging real-time sensors to monitor water levels, pressure, and contamination. These sensors provide instant feedback, reducing the risk of unexpected flooding. AI-powered predictive analytics then process this data, forecasting groundwater behaviour and optimising pumping schedules – saving energy while preventing water buildup. For instance, firms like Hexagon and Seequent offer hydrogeological modelling software that simulates underground water movement. This helps miners plan effective drainage and dewatering strategies before operations even begin. Meanwhile, smart pumping systems, equipped with automated flow adjustments, ensure water extraction matches dynamic underground conditions, reducing waste and maintenance costs.

Another exciting innovation in groundwater control for mining is sustainable water management.

Mining companies are increasingly adopting in-situ leaching techniques, which involve extracting minerals without traditional excavation. This method minimises waste and reduces the environmental impact of groundwater contamination. Additionally, zero-waste mining strategies aim to recycle and repurpose water used in mining operations, ensuring minimal discharge into surrounding ecosystems.

CASES OF WATER CONTROL METHODS

The water control methods for an underground mine should be selected in the stages of pre-feasibility and feasibility studies. Mine water control can contribute substantial costs to the mining operation, and the environmental consequences for poorly designed water control can be costly for many years after mine closure. The following text presents several cases of well thought out and designed water control methods for a few mines most already in production.

Deep Star Underground Gold Mine in Nevada: This relatively small mine is located on the Carlin Trend in Nevada, near the Post/Betze open pit .Use of water is pumped from surface perimeter wells. Because of the proximity of the Deep Star Mine to the highly water-bearing strata in the open pit area, some hydrogeologists believed that dewatering wells from the surface would be necessary for the underground mine drainage, although available packer test permeability data performed in geotechnical boreholes indicated much lower hydraulic conductivity in the underground mine area. The first deep dewatering well had a low yield and pumping from this well was abandoned. The underground mine is being adequately dewatered by in-mine drainage boreholes and the total mine inflow is less than 10 l/sec (Clode, 1997). Analytical calculations of probable ground water inflow into the mine proved to be more accurate than finite-element computer modelling performed for this mine.

Turquoise Ridge Underground Gold Mine in Nevada: This mine is in the first phase of production. Two shafts were sunk through highly permeable (3x10^-3 cm/sec) basalt up to 180 meters deep, and through moderately permeable (l.5x10^4 cm/sec) hornfel and marble to 350 meters depth and completed in metamorphic sediments with low permeability (5.0x10^-5 cm/sec) at a depth over 700 meters. Shaft sinking was completed under the cover of three dewatering wells, without any significant ground water inflow into the shafts during the sinking (Barker *et al*, 1997). The dewatering wells were up to 700 meters deep and pumped initially up to 86 l/sec. It seems that the surface dewatering wells are not able to lower the water table adequately in the lower permeable strata for the initiation of the ore production on the 900 Level (274 meters). Grouting above the stopes and drilling of angled or vertical boreholes was tested and considered for additional dewatering. Recommendations for mine dewatering, and for the shaft sinking phase of the project in particular, were based on finite-difference (MOD FLOW) computer simulation.

Meikle Underground Gold Mine in Nevada: This mine is in production and the mine drainage was so far accomplished by dewatering wells from the surface. In mine drainage boreholes are considered at a later stage of mining.

West-Leeville Underground Gold Mine in Nevada is now producing, previously it was a proposed mine with a consideration of mine drainage by wells from the surface. Test well was completed and tested for permeability of water bearing strata. Packer permeability tests were performed at the shaft pilot borehole.

Rosebud Underground Gold Mine in Nevada: Ground water inflow calculations for this mine were based on an analytical method ("Large Well" Method), and on a water balance analysis. The potential inrush of ground water where the decline crossed a major fault was accurately predicted and the pilot boreholes drilled ahead of decline drifting were adequate for water control. Mine dewatering is handled by the drilling of drainage/definition boreholes and no major problems have been encountered during mine development and production. In-mine drainage by gravity flow from boreholes is facilitated by pumping of water from several water supply wells in the general mine area, even though these wells are located on the other side of a major structure from the mine.

Kensington Underground Gold Mine in Alaska: This mine is in a development stage and production is likely to be initiated in the near future. Calculations of the probable water inflow into the mine during production were based on a water balance method and on analytical calculations of the potential inflow along major faults. The current mine dewatering program is based on the drilling of drainage/definition boreholes into the hanging wall and into several water-bearing structures. Grouting of fracture zones and several major water-bearing structures was recommended and is being considered.

Lamefoot and K2 Underground Gold Mines in Washington State: These two mines have relatively low ground water inflow, and water control is handled by drilling drainage boreholes and grouting. Grouting of boreholes with a discharge of water of more than 0.06 l/sec per borehole was imposed on the mining company by a federal regulatory agency for environmental protection. Calculations of the inflow of water into these two mines was based on a water balance analysis and on analytical methods.

Crandon Underground Zinc-Copper Mine, in Wisconsin: This mine is in a feasibility study and permitting stage and is located in a state with the strictest environmental law in the United States. Extensive computer modelling has been performed to support the conclusion that mining and mine dewatering would have minimal impact on the local surface and ground water resources. The overburden of this deposit is formed by a regional aquifer in glacial materials. These materials are underlain by low permeable clays and saprolite at the top of the bedrock. The predicted inflow into the mine is only about 37 to 80 l/sec, and the mine drainage would not create any insurmountable difficulties. However, the potential environmental consequence of impacting the glacial aquifer, the streams, lakes, and wetlands, and the need to treat and discharge the water pumped from the mine at a distant location, led to an interesting water control system. The potential reduction of permeability by extensive grouting of the weathered top of the bedrock (which is located within the proposed crown pillar) was proposed and tested. Boreholes drilled from the ground surface to a depth of 80 meters were used for grouting a cement curtain, approximately 10 meters thick, at the top of the bedrock. Results of test grouting, with the use of Portland cement for primary grouting, and with the application of ultrafine cement grout for the secondary grouting, indicated that grouting boreholes at a distance of 3 meters from each other could reduce the original hydraulic conductivity of 2 x 10^-3 em/sec to 9 x l0^-5cm/sec, and could reduce the calculated vertical seepage by up to 95%. It is anticipated that the drilling and grouting from the underground drift will be even more efficient than grouting from the ground surface because of the mostly vertical fracture systems. The verification of the reduced permeability was accomplished by repeated packer permeability testing before and after grouting, and by drilling of several verification boreholes, from which core samples were recovered.

CONCLUSION

Groundwater control remains a fundamental aspect of mining operations, essential for safety and productivity. By implementing efficient dewatering, sealing, and drainage strategies, mining companies can mitigate risks and ensure sustainable resource extraction.

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, tunneling, 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.

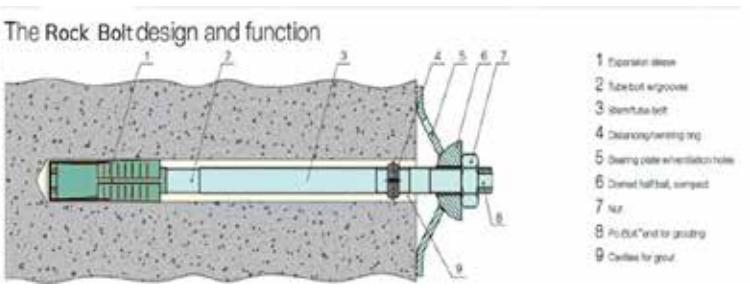
5. **Rotary Drills:** Employ rotational force to grind through rock, often combined with percussion. Used in oil drilling, water wells, and exploration.
   - **Operation:** High-speed rotation and pressure fracture rock formations.
   - **Applications:** Suitable for deep, wide boreholes in oil and gas 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.

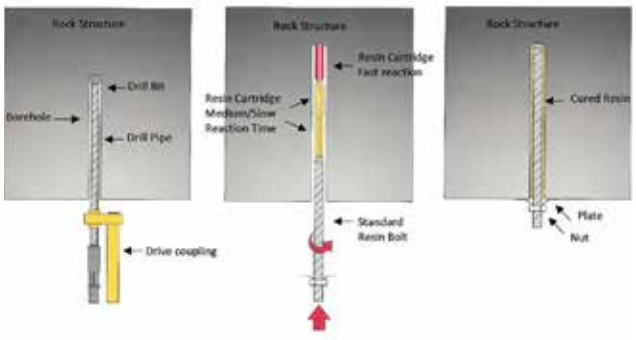
Cable bolting, using long, grouted reinforcement tools, is a standard technique for stabilising rock masses above tunnel profiles. Traditionally, resin cartridges have been employed for rock reinforcement, but recent advancements have introduced pumpable resin systems, offering notable advantages.

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 behavior 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.

Crushing the limits: TAKRAF X-TREME Class Sizers for hard rock applications

Engineered for the toughest conditions, TAKRAF's X-TREME Class Sizers are redefining hard rock crushing. With robust design, advanced wear protection and easy maintenance features, they deliver maximum throughput with minimal downtime – keeping your operation moving.

When it comes to hard rock comminution, every minute counts. Therefore make the most of every second: TAKRAF's X-TREME Class Sizers are purpose-built for extreme duty, setting new standards in performance, reliability and maintainability.

At the heart of this innovation is the TAKRAF WolfRAM Armor, a proprietary tungsten carbide overlay that significantly increases the life of crushing teeth and segments. Paired with precision-engineered tooth configurations optimized for rock intake, these sizers ensure consistent product size and high throughput, even in the most demanding applications.

Maintenance is where TAKRAF's design truly shines. Modular wear components, quick-release crushing segments and an integrated moving unit make it possible to access and replace parts in position – safely and efficiently. The result: reduced downtime and lower operating costs.

With decades of experience in global mining, TAKRAF engineers each sizer to exceed real-world performance requirements. From primary to tertiary sizing, the portfolio offers a tailored solution for every challenge and the harshest environments. The X-TREME Class delivers unmatched reliability.

Whether it's about pushing production limits or optimizing OPEX, TAKRAF's sizer technology keeps you ahead of the curve. Its innovation born from nearly 300 years of industrial tradition, proving, once again: ***Innovation out of tradition – It pays to talk to a specialist!***

Advancements in Mining Mill Technology

Mining mills play a critical role in the mineral processing industry, serving as the primary equipment for reducing the size of ore particles. It provides an overview of the latest advancements in mining mill technology, with a focus on improving efficiency, sustainability, and innovation.

Efficiency in mining mills is paramount, as it directly impacts the overall productivity of mining operations. Recent developments in mill design, such as the adoption of advanced comminution circuits, novel liner materials, and intelligent control systems, have significantly enhanced milling efficiency. These innovations result in higher throughput rates, reduced energy consumption, and improved ore liberation, ultimately leading to increased mineral recovery. *Mining & Quarry World look at some of the most common types of Crushing and Grinding machinery being used today.*

Ball Mills

Ball mills are essential equipment in mineral processing and various other industries, known for their efficiency in grinding and pulverising materials. They are cylindrical devices, typically consisting of a rotating horizontal cylinder partially filled with grinding media, such as steel balls, ceramic balls, or rods. The internal dynamics of ball mills create an environment where the grinding media and the material being processed collide and grind against each other, resulting in the reduction of particle size.

KEY COMPONENTS AND OPERATION:

1. **Cylinder:** The main component of a ball mill is its cylindrical shell. It is usually made of steel or other durable materials and is designed to withstand the rotational forces generated during operation.

2. **Grinding Media:** Inside the cylinder, there is a certain volume of grinding media, which can vary in size and material composition. The choice of grinding media depends on the nature of the material being processed and the desired end product.

3. **Charge:** The combination of the grinding media and the material to be ground is often referred to as the “charge.” Proper control of the charge is essential for effective grinding.

4. **Drive System:** Ball mills are typically powered by a motor connected to a gearbox, which drives the rotation of the mill. Speed control is crucial to optimise the grinding process.

5. **Liners:** To protect the inner surface of the cylinder and enhance the grinding process, liners made of wear-resistant materials are often installed inside the mill. These liners can be made of rubber, metal, or composite materials.

OPERATION:

During operation, the cylinder rotates on its axis, causing the grinding media to cascade and tumble within the mill. As the charge moves, the grinding media collide with the material, effectively crushing and grinding it into smaller particles. The size of the final product depends on factors such as the speed of rotation, the size and composition of the grinding media, and the duration of the milling process.

Ball Mills

APPLICATIONS:

Ball mills are used in various industries, including:

1. **Mineral Processing:** Ball mills are crucial in liberating valuable minerals from ore. They are used to grind ore into fine particles, making it easier to extract and process the desired minerals.

2. **Cement Manufacturing:** In the cement industry, ball mills are used for grinding clinker, which is then mixed with gypsum and other additives to produce cement.

3. **Chemical Processing:** Ball mills are employed in chemical industries to blend, grind, or homogenise materials for various chemical processes.

4. **Pharmaceuticals:** In the pharmaceutical sector, ball mills are used for mixing and grinding ingredients to produce pharmaceutical products.

5. **Paints and Coatings:** Ball mills are used in the production of paints, coatings, and pigments, where precise particle size distribution is essential.

6. **Food Processing:** In the food industry, ball mills are used for particle size reduction and blending of ingredients in the production of food products.

Ball mills are versatile and widely used machines that play a fundamental role in various industrial processes, contributing to the creation of countless products essential in our daily lives. Their design and operation continue to evolve, driven by advancements in materials and technology to enhance their efficiency and reliability.

Rod Mills

Rod mills are industrial machines used primarily for grinding materials. They are similar in design to ball mills but differ in the type of grinding media used. Rod mills use long cylindrical rods made of steel, ceramic, or other materials as the grinding media instead of spherical balls. These mills are commonly used in the mining and mineral processing industries for coarse grinding applications.

KEY COMPONENTS AND OPERATION:

1. **Cylinder:** The main component of a rod mill is a horizontal cylindrical shell made of steel or other durable materials. This cylinder is usually slightly longer than its diameter and rotates on its axis.

2. **Grinding Rods:** Inside the cylinder, there are a series of grinding rods that extend the length of the mill. These rods serve as the grinding media and are made of materials designed to withstand the wear and impact associated with grinding operations.

3. **Charge:** The combination of the grinding rods and the material to be ground is referred to as the “charge.” The charge is fed into the mill through one end, and the grinding action takes place as the rods cascade and tumble within the cylinder.

Rod Mills

4. **Drive System:** Rod mills are typically powered by a motor connected to a gearbox, which drives the rotation of the mill. The speed of rotation can be adjusted to control the grinding process.

OPERATION:

During operation, the cylinder of the rod mill rotates, causing the grinding rods to cascade and tumble within the mill. As the charge moves, the grinding rods come into contact with the material, crushing and grinding it into smaller particles. The size of the final product depends on factors such as the speed of rotation, the size and composition of the grinding rods, and the duration of the milling process.

APPLICATIONS:

Rod mills are commonly used in various industries for coarse grinding applications, including:

1. **Mineral Processing:** Rod mills are used to crush and grind coarse ore particles, particularly in cases where the ore contains a high percentage of rock or other non-valuable materials.

2. **Aggregate Processing:** They are employed in the construction and aggregate industries to break down large rocks and materials into smaller, more manageable sizes for further processing.

3. **Metallurgy:** In metallurgical processes, rod mills are used for grinding raw materials, such as limestone, into fine powder to be used in the production of cement, steel, and other alloys.

4. **Chemical Processing:** Rod mills may be utilised in chemical industries to grind, mix, or homogenise materials for various chemical processes.

5. **Waste Recycling:** In some recycling applications, rod mills are used to reduce the size of waste materials for further processing.

Rod mills are particularly useful when a coarser grind is required or when dealing with materials that are difficult to crush in traditional ball mills. They are essential equipment in many industrial processes, contributing to the production of various materials used in construction, manufacturing, and resource extraction industries.

SAG Mills (Semi-Autogenous Grinding Mills)

SAG mills, or Semi-Autogenous Grinding mills, are large mechanical pieces of equipment commonly used in the mining and mineral processing industries. These mills are a crucial component in the comminution (crushing and grinding) of ore into smaller particles and are known for their efficiency in handling particularly tough and coarse materials.

KEY COMPONENTS AND OPERATION:

1. **Cylinder:** The primary component of a SAG mill is a large, rotating horizontal cylinder. This cylinder is typically made of steel and is usually lined with wear-resistant materials such as rubber or metal to protect it from abrasion.

2. **Grinding Media:** Unlike traditional ball mills, SAG mills use a combination of ore and steel balls as grinding media. The ore itself is used to break up the larger chunks of material, and steel balls are added to assist in further grinding.

3. **Charge:** The combination of ore and steel balls inside

SAG Mills (Semi-Autogenous Grinding Mills)

the mill is referred to as the “charge.” The material is fed into the mill through one end, and the grinding action occurs as the cylinder rotates, causing the charge to cascade and tumble within the mill.

4. **Drive System:** SAG mills are typically powered by a large motor connected to a gearbox, which drives the rotation of the mill. Speed control is crucial to optimise the grinding process.

OPERATION:

During operation, the cylinder of the SAG mill rotates, and the combined action of the tumbling charge and the ore itself causes the material to be crushed and ground into smaller particles. The grinding process is semi-autogenous because it relies on the ore’s natural ability to break apart under the mechanical forces generated by the rotating mill.

APPLICATIONS:

SAG mills are widely used in the mining and mineral processing industries for a range of applications, including:

1. **Ore Comminution:** SAG mills are used to crush and grind large chunks of ore into smaller particles. They are often used as the primary grinding stage in mineral processing circuits.
2. **Hard and Tough Ores:** SAG mills are particularly effective when dealing with ore types that are hard, abrasive, or contain a high percentage of rock. They can handle materials that might be challenging for other types of mills.
3. **Reducing Energy Consumption:** SAG mills are known for their energy efficiency, making them an attractive choice for operations aiming to reduce energy consumption and operating costs.
4. **Throughput Improvement:** SAG mills can significantly increase processing plant throughput, allowing mining operations to process more ore in a given period.
5. **Liberation of Valuable Minerals:** The grinding action in SAG mills helps liberate valuable minerals from the ore, facilitating their separation and recovery in subsequent processing stages.

SAG mills are a critical part of many mineral processing operations, especially those dealing with large and challenging ore types. Their robust design and ability to handle coarse materials make them an essential tool in the extraction of valuable minerals from the Earth. Advances in SAG mill technology continue to improve efficiency and reliability, contributing to the sustainability and profitability of mining operations.

AG Mills (Autogenous Grinding Mills)

AG mills, short for Autogenous Grinding mills, are large grinding mills used primarily in the mining and mineral processing industries. These mills are unique because they rely on the ore itself to break apart and grind, requiring minimal or no additional grinding media. AG mills are renowned for their efficiency in processing ore with a high percentage of valuable minerals and minimal associated rock.

KEY COMPONENTS AND OPERATION:

1. **Cylinder:** The primary component of an AG mill is a large, rotating horizontal cylinder. This cylinder is typically made of steel and is usually lined with wear-resistant materials to protect it from abrasion.

2. **Ore Feed:** The ore to be processed is fed into the mill through one end. Unlike other grinding mills, AG mills do not typically use additional grinding media such as steel balls or rods.

3. **Charge:** The material inside the AG mill, consisting of the ore itself, is referred to as the "charge." The grinding action takes place as the cylinder rotates, causing the ore to cascade and tumble within the mill.

4. **Drive System:** AG mills are typically powered by a motor connected to a gearbox, which drives the rotation of the mill. Speed control is crucial to optimise the grinding process.

OPERATION:

During operation, the AG mill's rotating cylinder and the natural characteristics of the ore work in tandem to break down and grind the material. The ore itself is abrasive and has the ability to break apart under the mechanical forces generated by the mill's rotation. This autogenous grinding process liberates valuable minerals from the ore, making them available for further processing and recovery.

APPLICATIONS:

AG mills are utilised in various applications within the mining and mineral processing industries, including:

1. **Processing High-Value Ores:** AG mills are particularly effective when dealing with ore types that contain a high percentage of valuable minerals and relatively little waste rock.

2. **Reducing Energy Consumption:** AG mills are known for their energy efficiency, as they do not require the use of additional grinding media, such as steel balls or rods.

3. **Large-Scale Grinding:** These mills are suitable for processing large quantities of ore, making them a cost-effective choice for high-throughput operations.

4. **Coarse Grinding:** AG mills are often used as the primary grinding stage in mineral processing circuits to reduce the size of ore particles before further processing.

5. **Reducing Maintenance:** The absence of grinding media in AG mills reduces wear and tear on the mill's components, potentially leading to lower maintenance costs.

AG mills are essential in the processing of ore with high mineral value and minimal waste. Their unique grinding mechanism and energy efficiency make them a valuable tool in the mining industry. Advances in AG mill technology continue to enhance their performance and applicability in various ore-processing operations.

Stirred Mills

Stirred mills are a category of industrial grinding mills known for their energy efficiency and ability to achieve fine and ultra-fine grinding of a wide range of materials. These mills differ from traditional ball or rod mills in their unique design and grinding mechanism, involving the use of rotating screws or discs to agitate grinding media. Stirred mills are widely used in various industries, including mineral processing, pharmaceuticals, and the production of fine chemicals.

KEY COMPONENTS AND OPERATION:

1. **Stirring Mechanism:** The defining feature of stirred mills is the presence of a stirring mechanism, which can take various forms. Some stirred mills use rotating discs with pegs or pins to agitate the grinding media, while others employ a screw or rotor to create turbulent motion in the grinding chamber.

2. **Grinding Media:** Stirred mills typically use small grinding media, such as ceramic beads or steel balls. The high energy density and efficient mixing within the mill allow for effective grinding with minimal media wear.

3. **Chamber Design:** Stirred mills have a cylindrical grinding chamber with a vertical orientation. The grinding media and material to be ground are introduced into the chamber, where they interact due to the stirring action.

4. **Drive System:** Stirred mills are powered by motors that rotate the stirring mechanism. The speed and direction of rotation can be controlled to optimise the grinding process.

OPERATION:

During operation, the stirring mechanism within the mill creates a highly turbulent and agitated environment in the grinding chamber. This agitation ensures that the grinding media and material are continuously mixed and brought into contact, resulting in efficient particle size reduction. The design of stirred mills allows for high-speed grinding and effective mixing, making them suitable for fine and ultra-fine grinding applications.

APPLICATIONS:

Stirred mills find applications in a variety of industries, including:

1. **Mineral Processing:** Stirred mills are used to achieve

fine and ultra-fine grinding of minerals, including ores, magnetite, and precious metals. They are often employed in regrinding circuits to improve mineral liberation.

2. **Paints and Coatings:** In the production of paints, pigments, and coatings, stirred mills are used to achieve the desired particle size distribution for high-quality finishes.

3. **Pharmaceuticals:** Stirred mills are used in pharmaceutical manufacturing to produce fine powders for drug formulation.
4. **Chemical Processing:** These mills are utilised in the chemical industry for grinding and mixing various chemicals and compounds.

5. **Food Processing:** In the food industry, stirred mills are used to achieve particle size reduction in applications such as spice grinding and cocoa processing.

6. **Nanotechnology:** Stirred mills play a vital role in nanotechnology applications, where achieving precise particle sizes at the nanoscale is essential.

Stirred mills are valued for their ability to efficiently produce fine and ultra-fine particles while consuming less energy compared to traditional grinding mills. Their versatility and precise control over particle size make them a critical tool in industries that require high-quality and finely ground products. Advances in stirred mill technology continue to expand their range of applications and improve their performance.

High-Pressure Grinding Rolls (HPGR)

High-Pressure Grinding Rolls (HPGR), also known as roller presses, are a cutting-edge technology in the mining and mineral processing industry. HPGRs are used for the efficient comminution (crushing and grinding) of various ores and materials, offering advantages such as energy savings, improved product quality, and reduced environmental impact.

KEY COMPONENTS AND OPERATION:

1. **Roller Assembly:** The central component of an HPGR consists of two counter-rotating rolls with specially designed surfaces. These rolls exert high pressure on the material being processed as they move in opposite directions.

2. **Feed Hopper:** The material to be processed is fed into the HPGR through a feed hopper, where it enters the nip region between the rolls.

3. **Drive System:** HPGRs are typically powered by motors and drive systems that precisely control the speed and pressure applied to the rolls.

4. **Hydraulic System:** HPGRs incorporate hydraulic systems to apply and adjust the high pressure between the rolls. This pressure is one of the key factors that facilitate efficient particle size reduction.

OPERATION:

During operation, the material is fed into the HPGR and subjected to high pressure between the counter-rotating rolls. This high pressure causes the material to break apart and undergo plastic deformation, resulting in the formation of microcracks within the particles. The high-pressure action creates more efficient particle breakage compared to conventional grinding methods.

ADVANTAGES:

HPGRs offer several advantages in various applications:

1. **Energy Efficiency:** HPGR technology can significantly reduce energy consumption compared to traditional grinding methods, such as ball mills or SAG mills.

2. **Improved Particle Liberation:** The high-pressure action of HPGRs creates a more exposed surface area within the particles, leading to improved mineral liberation and increased recovery rates.

3. **Reduced Wear and Maintenance:** HPGRs have lower wear rates and reduced maintenance requirements compared to other grinding equipment due to the absence of grinding media.

4. **Product Quality:** HPGRs can produce a more uniform and finer product with fewer over-sized particles, enhancing downstream processing efficiency.

5. **Environmental Benefits:** Lower energy consumption and reduced water usage make HPGRs a more environmentally friendly option compared to traditional grinding methods.

APPLICATIONS:

HPGRs are used in various applications, including:

1. **Ore Processing:** HPGRs are commonly used in mineral processing for the efficient grinding of ores, such as gold, copper, and iron ore.

2. **Cement Production:** In the cement industry, HPGRs are employed for raw material grinding and clinker grinding, reducing the energy consumption in cement manufacturing.

3. **Diamond Liberation:** HPGRs are used to liberate diamonds from kimberlite ore in diamond mining operations.

4. **Coal Processing:** HPGRs are applied in coal processing to improve the liberation of coal particles and reduce the generation of fine coal dust.

5. **Pelletizing:** HPGRs are used in the production of iron ore pellets to enhance pellet quality and reduce energy consumption in pelletizing processes.

High-pressure grinding Rolls have revolutionised the way ores and materials are processed, offering numerous benefits in terms of energy efficiency, product quality, and environmental impact. Their widespread adoption continues to grow as the mining and processing industries seek more sustainable and cost-effective solutions.

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For over 45 years, we have successfully provided pioneering Sizer technology to many industries worldwide. Our tailored mobile, semi-mobile and fixed Sizer stations as well as our latest in-pit innovations, are reliable and efficient answers to reduce the complexity of today's modern mining challenges.

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Achieving Precision in Crushing and Size Reduction Operations

Crushers play a vital role across mining, construction, and aggregate sectors by transforming large rocks, ores, and other raw materials into smaller, more manageable fragments. Depending on the crusher type, this reduction is achieved through compressive force, impact, attrition, or shear. The primary goal of industrial rock crushers is to produce uniformly sized particles, which can then be refined for use in various applications such as road building, construction materials, or as inputs for other industrial processes.

MULTI-STAGE CRUSHING

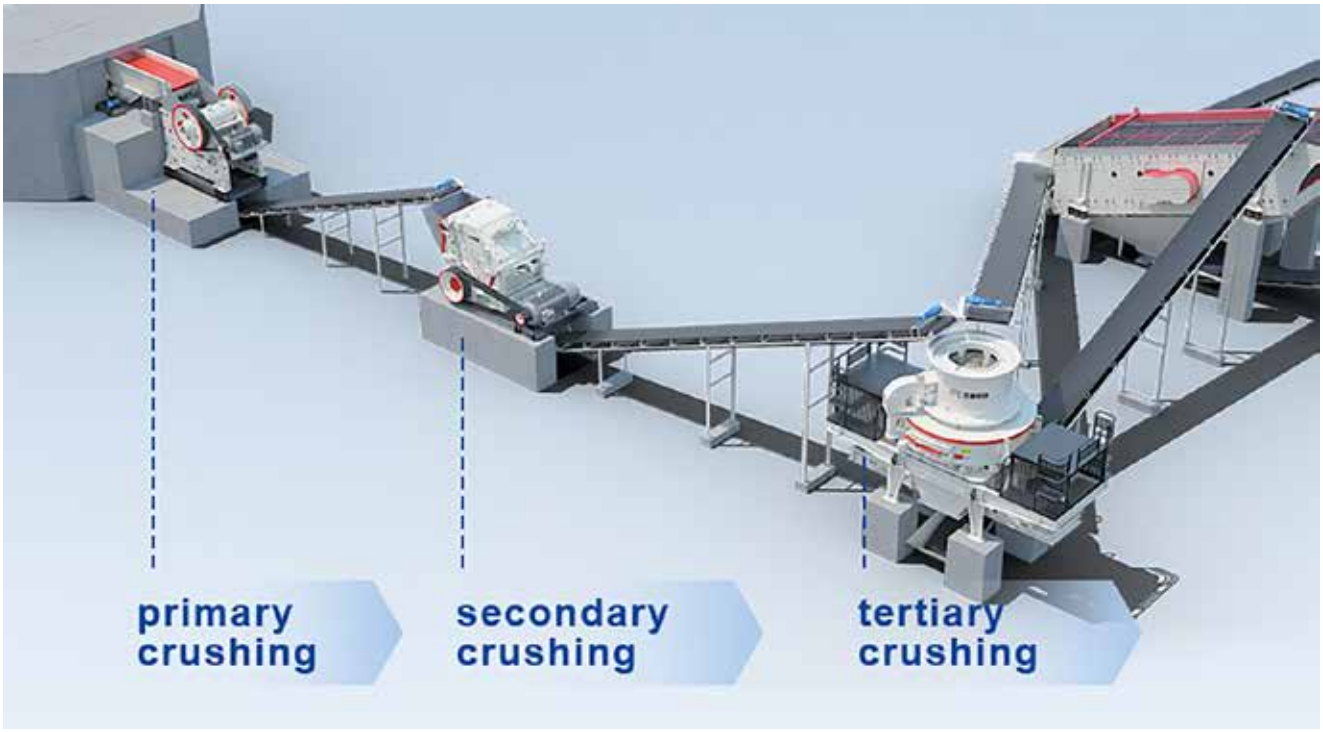
Process Crushing typically unfolds in multiple stages, each employing a specific type of crusher to progressively reduce material size.

- Primary crushing uses large crushers to break down bulk material into smaller chunks.
- Secondary and tertiary crushers then take over, further refining the particle size until the desired granularity is reached.
- Throughout the process, screens are used to separate the crushed material into distinct size categories, ensuring the final output meets precise specifications.

Crushing Methods Explained

COMPRESSION CRUSHING

Compression crushing relies on applying pressure between two surfaces until the material fractures. This technique is

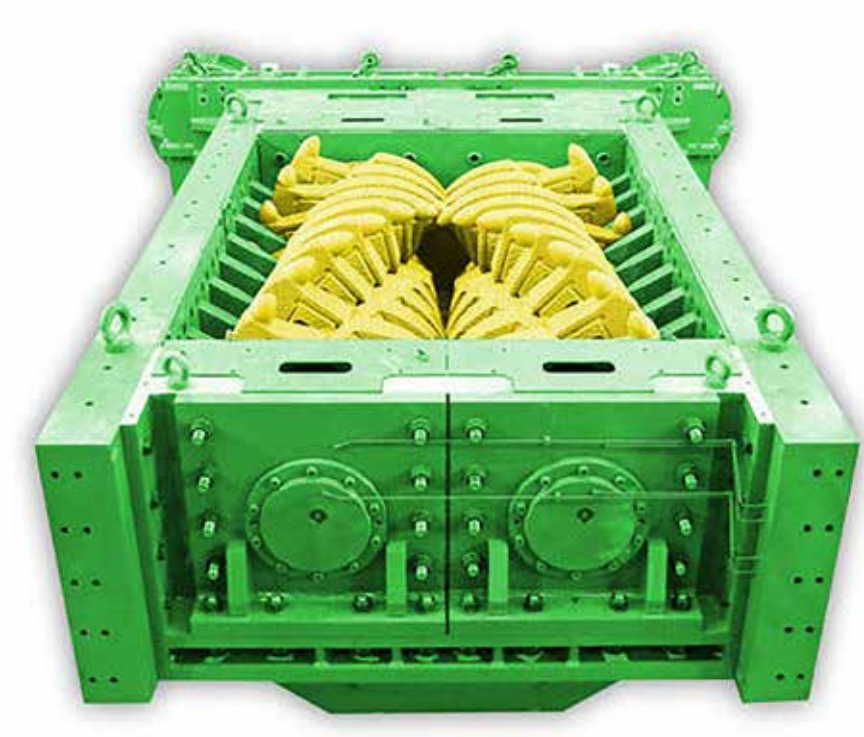


commonly used in jaw crushers and cone crushers:

- In jaw crushers, material is compressed between a stationary jaw and a moving jaw.
- In cone crushers, it is crushed between a rotating mantle and a fixed concave bowl. This method is ideal for hard and abrasive materials, as the material's own compressive strength causes it to break. Impact Crushing Impact crushing involves high-speed collisions between the material and a rapidly rotating component – typically a rotor fitted with hammers or blow bars.

  Found in impact crushers and hammer mills, this method shatters material into smaller fragments.
- Best suited for less abrasive substances like limestone, dolomite, and softer rocks.

  However, when used on highly abrasive materials, the wear on components can be significant due to the intense impact forces. Attrition Crushing Also known as abrasion crushing, this method reduces particle size through grinding and friction, often between rotating surfaces or media.
- Commonly used in ball mills and rod mills, where steel balls or rods grind the material as the mill rotates.
- Ideal for producing ultra-fine particles, especially in mineral processing and ore grinding applications. Shear Crushing Shear crushing applies lateral force to split material along its natural weak planes.
- Typically used in roll crushers, where material is drawn between two counter-rotating rolls.
- Effective for soft or layered materials like coal or clay, which break easily under shear stress.



MMD sizer combs crusher

CRUSHING METHODS: COMPRESSION, IMPACT, ATTRITION, AND SHEAR

Compression Crushing: Compression crushing, also known as compressive force, applies a compressive force to the material between two surfaces until it breaks. This way is frequently applied in jaw crushers and cone crushers. In jaw crushers, the material is squeezed between the fixed jaw and the moving jaw. The material is crushed between a mantle and a concave bowl, both of which are rotating and stationary, respectively. Compression crushing is well suited for hard and abrasive materials because the compressive strength of the material is what causes fractures.

Impact Crushing: The process called impact crushing involves the repeated striking of the material with a very fast rotating element, for instance, a rotor with the attached hammers or blow bars. Impact crushers and hammer mills work with it. In impact crushers, the material is hit by rotating hammers or blow bars, as a result it breaks up into smaller pieces. This method is preferable in the case of less abrasive materials, such as limestone, dolomite, and soft to medium hard rocks. The high-speed impact forces can wear down the crushing elements rapidly when processing very abrasive materials.

Attrition Crushing: Abrasion crushing is the consequence of material being subjected to the grinding action, often between two rotating surfaces or media. This is the reason there is a decrease in particle size due to abrasion and friction. This method is popularly employed in fine grinding processes such as ball mills or rod mills. In these mills, the material is blended with grinding media, for instance, balls or rods made of steel. The rotation of the mill makes the media grind and wear out the material, thus lowering its size in stages. Attrition crushing is great for the production of

very fine particle sizes, and it is commonly used in mineral processing and mining for grinding ore.

Shear Crushing: Shear crushing takes a shearing force and applies it to the material, which results in the formation of cracks on the weak planes. This method is not frequently used in rock crushing applications but can be found in some specialised equipment, like roll crushers, for example, for softer materials like coal or clay. In roll crushers, the material is pulled between two counter-rotating rolls which exert a shear force on it. The material breaks and reduces in size due to this force. This kind of crushing works better for materials that have a layered or flat structure because the shear forces can easily split the material along the weak planes.

What are the Different Types of Crushers?

PRIMARY CRUSHERS

The primary crushing stage is the first stage of the crushing process. This is where the bulk of the rocks or ore are crushed to make them manageable in the next crushing stages. The primary aim of the primary crushing is to produce a product that can be moved easily by conveyors or feeders to the next step of the crushing. Primary crushers are built to process large and abrasive feed materials. They can handle feed sizes of up to 1500 mm, but it depends on the type and size of the crusher.

Jaw crushers and gyratory crushers are the two most common kinds of primary crushers. These crushers apply compressive forces to the material, but they can be different in their design and the way they operate.

JAW CRUSHERS

Jaw crushers are the most common primary crushers used in the mining and construction industry. They are represented by a fixed jaw and a moving jaw that form a V-shaped crushing chamber. The moving jaw moves back and forth and presses the material against the fixed jaw, that in turn causes it to break down into smaller pieces. Jaw crushers are known for their simplicity, reliability, and the ability to manage large and abrasive materials. They take in feed sizes as large as 1,500 mm and the finished product size ranges from 50 mm to 300 mm depending on the settings of the crusher and the material properties.

There are two main types of jaw crushers: simple-toggle and double-toggle. A single-toggle jaw crusher is simpler in design and is widely used because of its low cost and ease of maintenance. On the one hand, the double-toggle jaw crushers have a more complicated mechanism that creates a more uniform product size and a more efficient crushing. On the other hand, they are often more expensive and require higher maintenance than single-toggle ones.

Jaw crushers are ideal for primary crushing and can handle large, hard materials like granite and basalt.

GYRATORY CRUSHERS

Gyratory crushers are also another primary crusher type which is usually used in large scale mining operations. They are equipped with a vertical conical crushing chamber with a rotating mantle that moves inside a stationary concave surface. The mantle is rotating, and the material is getting compressed against the concave surface thereby it breaks and becomes smaller. Gyratory crushers are valued for their high capacity, continuous operation, and ability to process feeds up to 1500 mm in diameter.

Unlike jaw crushers, gyratory crushers generally have higher reduction ratios. Consequently, they can produce smaller output sizes in a single pass. Moreover, they have a higher production capacity and can do more material per hour. Nevertheless, gyratory crushers are usually more expensive, need more intricate foundation and have higher operating and maintenance costs as compared to jaw crushers. The decision of a jaw crusher or a gyratory crusher is based on, for instance, the required output size, production capacity, and the available budget.

Gyratory crushers, often compared to jaw crushers, excel in processing very hard materials like granite and ores.

SECONDARY CRUSHERS

The secondary crushing step follows the primary crushing step. The purpose of this machine is to decrease the size of the material coming from the primary crusher. The objective of the secondary crushing is to get a product of a more homogenous size and shape. This is the reason it is especially suitable for further processing or use in different fields. Secondary crushers crush materials in the size range of 50 mm to 300 mm, which is determined by the type and size of the crusher. They produce output sizes from 6mm to 100mm.

Secondary crushers can be divided into three main types: cone crushers, roller crushers, and impact crushers. All types of crushers have their own distinctive design, working principles, and applications.

CONE CRUSHERS

Cone crushers are usually applied in the secondary and tertiary crushing. They also play a role in reducing the size of the material coming from the primary crusher. They include a rotating mantle which moves within a stationary concave bowl. It does this by squeezing and squeezing the material as it goes through the device. Cone crushers are often used because they are capable of producing a product with a more uniform and cubical shape as opposed to jaw crushers. This is what makes them suitable for the industry where particle shape is of utmost importance, such as in the production of concrete aggregates.

Weir Minerals Cone Crusher

There are various cone crushers, such as standard cone crushers, short head cone crushers and fine cone crushers. A standard cone crusher has a taller crushing chamber and is used for providing larger output sizes, usually ranging between 25 mm and 100 mm. A short-head cone crusher has a short crushing chamber, and it is designed for the production of finer output sizes, generally between 6 mm and 25 mm. A fine cone crusher, also known as a tertiary cone crusher, is used for the production of They are manufactured to produce very fine output sizes, mostly below 6 mm, particularly for medium-hard to hard materials such as limestone and dolomite.

ROLLER CRUSHERS

Roll crushers are another type of secondary stage crushers. They use two or more rotating cylinders for compressing and breaking down the material. The cylinders can be smooth or toothed, based on the different application and type of material. Roller crushers are usually applied for soft materials, for example, coal, clay, or soft rocks. They can give a finer end product as compared to other types of crushers. They are also recognised for their low energy usage and fairly low wear on the crushing surfaces.

There are two main types of roller crushers: single-roll crushers and double-roll crushers. Single-roll crushers are equipped with a rotating cylinder which squeezes the material against a fixed plate or screen. The double-roll crushers, in contrast, are equipped with two rotating cylinders that compress the material between them. The double-roll crushers can be further divided into the smooth-roll crushers that have the smooth cylinder surfaces and toothed-roll crushers that have toothed or corrugated surfaces to provide the better grip and crushing action.

Roll crushers are best for reducing softer, friable materials like coal, salt, or limestone.

IMPACT CRUSHERS

Impact crushers are the secondary crushers or the tertiary crushers that use high speed impact forces to break the materials. They are a set of rotors with hammers or blow bars mounted on them that crush the material as it enters the crushing chamber. This phenomenon results in the material to be cracked and fragmented into smaller pieces. The impact crushers are applicable for less abrasive materials such as limestone, dolomite, and soft to medium – hard rocks. They can generate a more cubical and uniform product shape which compression crushers do not have.

There are two main types of impact crushers: horizontal shaft impactors (HSI) and vertical shaft impactors (VSI). HSI crushers utilise a horizontal rotor that throws the material on stationary anvils or curtains, which results in the material breaking upon impact. VSI crushers, unlike the traditional crushers, have a vertical rotor which accelerates the material and throws it against a stationary anvil ring or a cloud of material itself. Hence, the shape of the product is more cubical and uniform. VSI crushers are commonly used in the last stage of the crushing process in order to enhance the particle shape and eliminate deformed or elongated particles.

HAMMER CRUSHER: A VERSATILE SOLUTION FOR MULTIPLE MATERIALS

Hammer crushers are widely used in the mining, cement, coal, metallurgy, construction, and other industries for primary and secondary crushing. They are equipped with a rotor with multiple hammers, which apply high speed impact to break down materials, and are a reliable and efficient solution for materials such as coal, gypsum, limestone, and soft ores. The hammer crusher is designed to crush the materials into smaller pieces by the hammer of the hammer crusher.

Single stage and multi stage are the two main types of hammer crushers. Single stage hammer crushers are simpler in design and are widely used for applications where a coarse product size is acceptable. These crushers are cheap and require little maintenance. However, multi stage hammer crushers offer more control over the final product size and shape, which is important when a finer, more consistent output is required. But they are more complex and expensive.

Hammer crushers are used for breaking down softer materials such as coal, clay, limestone, etc. with high moisture content. They are efficient for large scale operations due to their high throughput capacity and low energy consumption. In particular, these machines are very useful when large quantities of material need to be processed quickly and efficiently.

TERTIARY AND QUATERNARY CRUSHERS

Tertiary and quaternary crushers are employed in the last stages of the crushing process. They produce very fine products, often below 6 mm. These crushers are normally used in applications where the size reduction and shape of the particles are of high concern. There are some examples, like the production of manufactured sand, industrial minerals, or fine aggregates for specific concrete mixes.

There are several common types of tertiary and quaternary crushers:

- **Fine Cone Crushers:** These are cone crushers with a very short crushing chamber and a specific design. They are manufactured to produce fine output sizes in the range of 0.078 inch to 0.236 inch.
- **Vertical Shaft Impactors (VSI):** VSI crushers are employed in tertiary and quaternary stages. They contribute to particle shape and yield uniform, cubical products.
- **High-Pressure Grinding Rolls (HPGR):** In the HPGR crushers two counter-rotating rollers with a small gap between them are used. They squeeze and crush the stuff. They are very good at fine grinding and are often used in the mining industry for the grinding of ore.
- **Autogenous and Semi-Autogenous Mills (AG/SAG):** AG and SAG mills are large, rotary drums that use the material itself as the grinding medium. They can be used in the final stages of the crushing operation to produce fine uniform particles.

The selection of tertiary and quaternary crushers depends on various parameters. These are the specialised application, material properties, and the output size and shape which

are required. In other cases, a mixture of different crusher types may be used to produce the best results.

Factors to consider when choosing the right crusher for your application

The right choice of crusher type is a critical element in your application to achieve high efficiency and low cost of operation.

MATERIAL PROPERTIES:

1. **Hardness:** The hardness of a material determines the crushing force needed and the type of crusher that is suitable. Crushing of the harder materials may require the use of the compression crushers, while the softer materials can be processed by the impact or roller crushers.

2. **Abrasiveness:** Hardly abrasive elements might lead to excessive wear on crushing surfaces, which will impact the choice of crusher and the use of wear-resistant parts.

3. **Moisture Content:** The moisture content of the material can influence the crushing process and determine the type of crusher. Some crushers, such as jaw crushers, can handle higher moisture content as well as impact crushers.

4. **Stickiness:** Sticky material can have a negative impact on the crusher by causing blockages and build-up, which will directly influence the selection of the crusher and the need for special features or accessories.

FEED SIZE AND OUTPUT SIZE:

1. **Maximum Feed Size:** The size of the largest particles in the feed materials determines the necessary inlet opening and the appropriate crusher type. Primarily, the primary crushers are made to crush bigger feed sizes compared to the secondary and tertiary crushers.

2. **Desired Output Size:** The crushing equipment and the number of crushing stages are determined by the output size range. Some crushers, for instance, cone crushers, can produce finer product sizes than others, such as jaw crushers.

3. **Size Reduction Ratio:** The relationship between the feed size and the desired output size determines the type of crusher and the number of crushing stages needed to fulfil the required size.

PRODUCTION CAPACITY:

1. **Throughput:** The necessary production capacity, measured in tons per hour, defines the size and type of crusher. If the output is higher, then the crusher may need to be bigger or there may be a need for a couple of crushing units.

2. **Crushing Circuit Configuration:** The design of the overall crushing circuit layout, the number of crushing stages, the arrangement of crushers, screens and conveyors, influences the choice of crushers and the production capacity.

PRODUCT SHAPE AND GRADATION:

1. **Particle Shape:** The type of shape that the particles should manifest, e.g. cubical or angular, is one of the factors that are considered when the crusher is selected. Cubical particles are the primary products of cone and compression crushers, while impact crushers usually generate the angular particles.

2. **Gradation Requirements:** The type of crusher required for the final product and the possibility of other screening or classification equipment are largely dependent on the particle size distribution that is required.

OPERATIONAL CONSIDERATIONS:

1. **Maintenance and Wear Parts:** The issues of maintenance, wear parts availability, and the wear life of the main components are the main things that should be considered in the choice of a crusher.

2. **Energy Consumption:** The calculation of the energy efficiency of the crusher and its associated operational costs such as electricity and fuel consumption shall be carried out.

3. **Noise and Dust Emissions:** The level of noise and dust produced by the crusher is something that should be considered, and this is really important in ecologically sensitive locations or urban settings.

CAPITAL AND OPERATING COSTS:

1. **Initial Investment:** The capital cost of crusher is the most important factor to consider before the project budget is prepared. It includes the purchase cost, installation cost, and commissioning expenses.

2. **Operating Costs:** The recurrent costs such as electricity consumption, replacing parts and maintenance are important during the crusher's life cycle.

FOOTPRINT AND LAYOUT:

1. **Available Space:** A feasibility study should be conducted to check the crusher's dimensions, working area requirements and compare them to the available space at the installation site.

2. **Integration with Existing Equipment:** The crusher's integration with the feeders, screens, and the conveyors, within the plant layout considered, is also another factor which need to be considered to ensure a smooth operation.

Once you understand these factors, visit the Best Crusher Manufacturers for Your Mining Project to find the best manufacturer. Conclusion It is essential that you understand these crushers and their respective uses as this knowledge will help you to identify the appropriate equipment for your crushing needs. Becoming aware of the factors as the physical characteristics of the material, feed size, output size, production capacity, product shape and gradation, capital and operating costs, and plant layout will help you in the choice of a crusher which is suitable for your specific purpose.

Fortescue posts $5.2 billion profit

Fortescue has reported a net profit after tax (NPAT) of $US3.4 billion ($5.2 billion) for the 2024-25 financial year (FY25), shipping a record amount of iron ore as the company continues to consolidate strong relations with China.

The iron ore major shipped a record 198.4 million tonnes (Mt) in the year to June 30, supported by strong supply chain performance and lower hematite C1 costs of $US17.99 per wet metric tonne. Underlying EBITDA came in at $US7.9 billion with a margin of 51%.

"As the industry's lowest-cost producer, we've delivered another strong set of results – record shipments, disciplined cost performance, solid earnings and a continued focus on safety," Fortescue metals and operations chief executive officer Dino Otranto said.

"In line with our commitment to deliver returns to shareholders, the Board has declared a fully franked final dividend of $0.60 per share, bringing total dividends declared for FY25 to $1.10 per share, representing a 65% payout of net profit after tax."

The company joined the Australian Prime Minister and other major iron ore miners in a visit to China in July to strengthen trade relations with the country.

"The Australian Prime Minister's recent visit to China, which I was honoured to join, highlighted the value of collaboration between governments and industry," he said. "It was a strong signal for strengthening relationships in key markets – something underscored by our recent RMB (Renminbi) term loan facility which was made possible through Fortescue's long-standing partnerships with Chinese institutions."

Looking ahead, Fortescue growth and energy chief executive officer Gus Pichot said the company was balancing operational excellence with future growth.

"Green energy and green hydrogen remain key to our future, including our green iron strategy," he said. "Construction of our Green Metal project in the Pilbara is underway and the pilot plant will soon begin producing green iron using green hydrogen."

Fortescue is targeting FY26 shipments of 195-205Mt, with continued investment in decarbonisation and new growth projects.

Redcastle secures district-scale gold portfolio

Redcastle Resources has signed up mining services provider BML Ventures to help it fast-track gold production from its Queen Alexandra and Redcastle Reef deposits in Western Australia.

Under the joint venture arrangement, BML will fund all work up until first revenues. Its team will also manage mining approvals, day-to-day mining, haulage and toll treatment arrangements across both project sites.

Redcastle will provide site access and tenure management, including work on Native Title, heritage surveys, and environmental approvals.

Surplus gold sale proceeds will be split evenly between the two joint venture partners, after cost recovery from BML.

Redcastle said the joint venture represented a risk-managed development strategy that would move the project from its pre-final investment decision stage through to commencement of mining, all within a 12-month timeframe.

The company also announced it had entered into a deal to acquire the highly-prospective TBone Belt package of tenements, which directly adjoin Redcastle's existing tenements and will expand its Eastern Goldfields footprint to 85km2.

Its portfolio will now include four granted mining leases, five mining lease applications, 51 prospecting licences and three pending prospecting licences.

The TBone Belt package is being sold by a consortium of vendors. Redcastle has agreed to pay a maximum cash amount of $1.7 million as well as a two% gross revenue royalty.

Redcastle chairman Ray Shaw said 2025 was shaping up to be a breakout year for the company.

"The joint venture with BML provides a disciplined, capital-efficient pathway for first gold production, while the TBone acquisition delivers a unique opportunity to apply first mover systematic exploration across 48 concessions previously held by six separate entities," he said.

"(These are) adjacent to the tenements where our technical team have already demonstrated success with the Queen Alexandra and Redcastle Reef projects."

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