

SOLID

#1 2018

GROUND

A MAGAZINE FROM
SANDVIK MINING AND ROCK TECHNOLOGY

Australia:

**Anywhere,
anytime**

Ranger series:

**Rugged and
reliable**

Big Picture:

**Medium
mountains**

Canada: Goldcorp Borden Lake

**“This is like no other
underground environment
I’ve ever worked in”**

SANDVIK

Dear reader,

NOTHING IS MORE important to Sandvik Mining and Rock Technology than our customers. We pride ourselves on building, maintaining and developing a strong relationship with you to improve your safety, productivity and efficiency. Read more about how we're doing just that in this issue – for example:

■ By designing and supplying a multi-stage processing plant and equipment to Boral (Australia), delivered to their Deer Park basalt quarry on time, on budget and with no variations. The plant is already exceeding output projections by 15-20 percent.

■ By partnering with Goldcorp to provide quick-charge battery-powered and tethered electric equipment for the Borden Lake gold project (Canada), under development as the world's first all-electric underground mine. Two Sandvik DD422IE drilling jumbos are currently developing Borden's access ramp, where the customer is already experiencing improved accuracy, consistency and a safer operating workplace.

INNOVATION - Our customer focus is matched by our equally strong focus on innovation. Enter the new Sandvik LH202 narrow-vein loader. Narrower than competing loaders and delivering a three-tonne payload for tunnel widths of two metres and above, it offers unprecedented capacity for this size class, enabling more tonnes to be moved more safely, at lower cost. Continuous improvement is our goal, even on successful products such as our Ranger series of top-hammer drill rigs, where the redesigned Ranger DXi series is now offering significant productivity, usability and sustainability improvements.

TECHNOLOGY - We are at the forefront of the drive towards digitalization, with our automation, fleet management and analytics solutions. With digitalization comes the potential for improved, safer working conditions, together with the demand for a whole range of new skills and the need to observe data privacy legislation.

Digitalization is a new frontier for our industry, one which has a human side to it, too.

We are proud to share this journey with you.



LARS ENGSTRÖM
PRESIDENT, SANDVIK MINING
AND ROCK TECHNOLOGY

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Managing humans and machines.



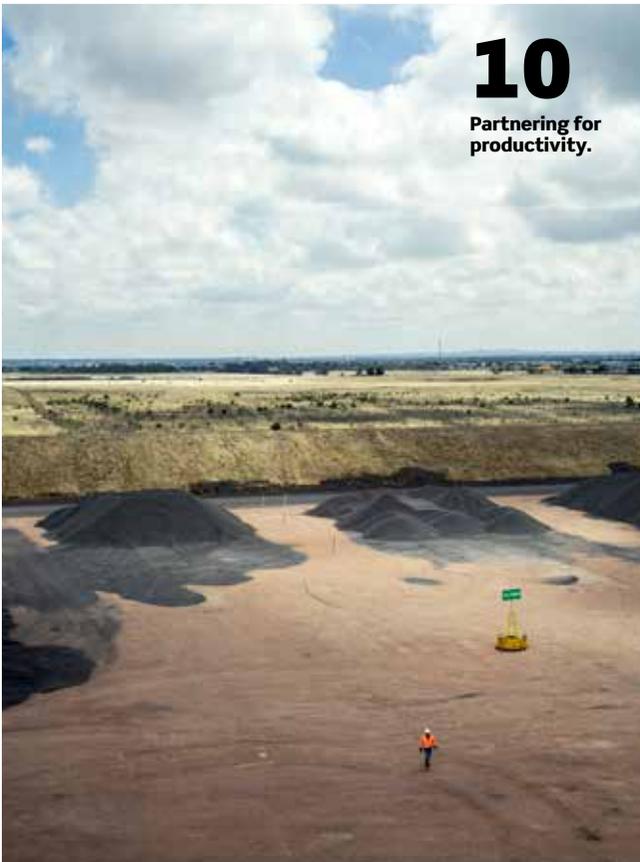
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Not just for jewellery anymore.



Screening stuns Swedes

More than a year ago, NCC Industry in Södra Sandby, Sweden, implemented Sandvik WX6500 screening media for a full-scale test. Although the company always had a preference for rubber screening, it had not found a long-term solution until it agreed to test the Sandvik product.

NCC Industry tested Sandvik WX6500 with aggressive raw materials, and technicians were surprised when they first inspected the test installation. Even after the screening media had seen heavy use, they found the wear was so light that they could still see the structural markings from the manufacturing process.

More than 285,000 tonnes have now been fed to the Sandvik WX6500 panels, compared with around 30,000 tonnes that would have been achievable with wire mesh, and the panels are still going strong.



Automation simplified

The industry-leading AutoMine product family is gaining a new member in AutoMine Tele-Remote for underground loaders. This new solution provides an easy way to start exploring the potential of automation in Sandvik equipment, and provides functionality for the smart teleoperation and monitoring of a single unit from a remote location.

The product, as with the rest of the AutoMine family, is designed to improve operator safety. Rather than working in potentially high-risk environments, the operators can use the equipment reliably and efficiently from a remote location. AutoMine Tele-Remote is specifically designed to be easy to implement and operate, allowing everyone to experience the benefits of advanced automation.



Groundbreaking business

Sandvik has won a supply agreement with SUEK, the leading coal producer in Russia and one of the world's largest coal companies. The deal includes eight Sandvik MB670-1 bolter miners designed for longwall mining.

The deal was agreed after SUEK was impressed with the Sandvik units it had in place

already, as its three Sandvik MR340s and four Sandvik MB670s set several cutting records over the past couple of years.

Along with the equipment, Sandvik and SUEK will work closely together to ensure all operators are fully trained, and that parts stock is readily available to minimize potential downtime.



Sandvik will deliver eight Sandvik MB670-1 bolter miners to Russian coal producer SUEK.

Award-winning improvement

Sandvik has worked together with Hindustan Zinc Limited to improve loader bucket life at Agucha mines, introducing innovative design features that have also boosted loader productivity. The joint initiative won the top award among more than 60 case studies from the Quality Circle Forum of India.

The Sandvik GET solution at Agucha mines includes a Shark blue pointer system, and a complete bucket wear package with heel shrouds and profile bars. These improvements, combined with maintenance and monitoring, have extended bucket life from 800 hours to 4,000 hours, helping Agucha mines save SEK 1.2 million across its 13-loader fleet.

Potash partnership

The chemical fertilizer industry is extremely important, and Thailand has billions of tonnes of potash deposits that are yet to be mined. The country has imported chemical fertilizer from overseas in the past, but that is beginning to change.

Thai Kali Company Limited was established with the objective to explore and operate underground potash mines. It started working in September 2016 using a Sandvik MR620 and a Sandvik LS171NP. The partnership is working well, and the company has excavated more than 700 metres of tunnel so far.

Analytics drive process improvements

▶ Sandvik has introduced OptiMine Analytics, a new performance-enhancing data analytics solution that transforms data into process improvements via insights and actionable dashboards embedded into operation management systems.

OptiMine Analytics improves planning through data-driven simulations and then continuously optimizes production cycles with real-time data.

Additionally, insights into operator actions improve safety by identifying areas for training proactively.

OptiMine Analytics is the result of a close collaboration between Sandvik and IBM, whose industry-leading analytics platform and predictive modelling expertise will help OptiMine customers access years of insights on mining optimization and turn it into actionable improvements.



OptiMine Analytics' data-driven simulations improve production cycles.

THE QUOTE

“Sandvik is the only equipment provider that can offer the full suite of equipment in an automated setting that we require.”

John Welborn, managing director and CEO of Resolute Mining LTD

Sustainable suppression

▶ The new Eclipse fire suppression range further cements Sandvik's commitment to the environment, health and safety (EHS). The range is liquid-based and activates automatically, and it has proven to be up to 30 percent more effective than dry powder systems on super-heated surfaces. There are two options in the range - Eclipse Sustain and Eclipse Extreme.

Eclipse Sustain is the world's first fluorine-free fire suppression liquid formulated for mobile equipment, and this foam concentrate is designed to be environmentally sustainable, as well as being safer to handle.

Eclipse Extreme is engineered to suppress hydrocarbon fuel and oil fires in temperatures ranging from -40 Celsius to +60 Celsius, helping to ensure safety in even the harshest conditions.



Jet Park flying high

▶ Sandvik has been present in the South African market for nearly 70 years, and this commitment continues with the investment in a new local manufacturing facility that will develop Sandvik products and solutions tailored to this part of the world.

The latest local manufacturing facility will initially produce a new Sandvik LH115L low-profile loader, designed specifically to meet the demands of local customers and perform in the harshest underground conditions. It's the first Sandvik product to be manufactured locally, using only local suppliers, employees and locally sourced components.



Solutions for a digital future

▶ As the mining and construction industries continue to embrace digitalization, Sandvik needs to constantly optimize its own offering to customers around the world. The launch of My Sandvik digital service solutions is part of an improved digital offering.

This new solution consists of My Sandvik Insight and My Sandvik Productivity.

Insight provides customers with a full overview of their fleet, including its location, and access to information that identifies potential servicing needs.

Productivity gives customers up-to-date productivity reports for set periods of time, as well as drawing attention to potential malfunctions. This solution can also provide machine-specific analysis to enable performance comparisons.

My Sandvik digital service solutions are now available worldwide, 24 hours a day, seven days a week, and offer the potential to increase operational safety and efficiency.

Founded in 1993 and headquartered in Toronto, Canada, Kinross Gold is a senior gold mining company with a diverse portfolio. With mines and projects in the United States, Brazil, Chile, Ghana, Mauritania and Russia, Kinross employs approximately 9,300 people worldwide.

Q & A

AROUND THE WORLD IN 30 YEARS



IN SEPTEMBER 2010, Kinross acquired the Chirano mine in Ghana. The mine is situated on the Bibiani gold belt, and the company expects to exploit 11 gold deposits spread along a 10-kilometre strike length.

The site had open pit mines, but today the focus is underground. *Solid Ground* spoke with Richard McMahon, who has worked in the mining industry for more than 30 years.

Q WHAT ATTRACTED YOU TO MINING?

When I was a young guy, mining was the thing to get into. That's where the money was. There was also the opportunity to travel. After working in Ontario, I had the chance to go to Kyrgyzstan, and after that I had the travel bug. Mining has taken me to Vietnam, Mongolia, Baffin Island and Northwest Territories in Canada. Now it's brought me here, to Ghana.

Q WHAT'S YOUR ROLE AT CHIRANO?

I'm the underground mobile maintenance superintendent. My whole career has been in maintenance, and although I've worked some in milling and some open pit, I'd say 80 percent of my career has been spent underground. I think it's important to find what you enjoy doing and what you're good at, and always strive to improve, which is why I've almost always worked in underground mines.

Q WHAT'S THE CURRENT OUTLOOK FOR CHIRANO?

We've come a long way performance-wise. They had an open pit here for years

that recently closed, so we're completely focused on the underground mine now.

We're constantly exploring, and the life of the mine is two or three years at this point, so hopefully we'll find some more that will allow us to continue. The environment and people here are great.

Q HOW HAS SANDVIK HELPED IMPROVE OPERATIONS?

When we took over, the equipment needed some tender, loving care, and we needed to do some rebuilding. I got in touch with Sandvik to see how they could help, and they've done a couple of units for us now. It's been working out, and we formed a bond that way.

They ramped production up here, and as the equipment was old, the breakdowns and maintenance were taking longer and longer. Sandvik came in and applied themselves to our jumbos, and we saw the benefits immediately. Our availability and uptime are on the rise now, and that's because of the relationship with Sandvik. ■

RICHARD MCMAHON

TITLE: Underground mobile maintenance superintendent

HOBBIES: Jogging (completed second half-marathon in 2017 in Toronto), rollerblading, fishing, hunting and riding

FAMILY: Married 30 years; one daughter who's married

BACKGROUND: Raised in a small community in northern Ontario

A royal reopening

Some of the most famous, or at least widely exposed, jewellery is worn by the British monarchy. One thing that isn't as well known is the fact that the gold behind three generations of wedding bands, as well as various possessions of Edward VIII, all came from the same place – Clogau St David's mine, near Bontddu in Wales.

The mine was shut down in 1998 as production had slowed to unsustainable levels, but now Alba Mineral Resources has announced it will explore the site once again, in the hope of bringing it back into production. The company sees high potential for finding unworked veins, so perhaps North Wales could once again provide the gold for the next royal wedding.



Gold-standard batteries

For the first time ever, researchers from the University of Tokyo have been studying how gold ions move in liquid. This allows the scientists to better understand behaviours of liquids at the atomic level, which should result in a thorough analysis covering what components are needed to design less volatile, more energy-efficient batteries.

With this improved understanding, as well as an ever-increasing demand for battery power, a more reliable future for the devices that have become essential in daily life is looking positive.



Canadian centenarian

Some mines live longer than others, and the Dome underground mine in Timmins, Ontario, lived longer than most. The operator Porcupine Gold Mines, a subsidiary of Goldcorp, finally closed down the underground mine after 107 years of operation.

The discovery of the gold-rich Dome site was

made all the way back in 1909, with production starting in 1910. Goldcorp confirmed that more than 67 million ounces of gold have been mined since then, and mine life had been extended as recently as July 2016. The surface operations will continue into the future, adding to the rich legacy of the Dome.

CLEER thinking

An initiative that goes by the acronym CLEER (clean, low-energy, effective, engaged and remediated) has been shortlisted by Canada's federal government as a potential project that could benefit from a piece of a 950 million US dollar fund. The overall goal is to boost job creation and the Canadian economy. The initiative focuses on significant environmental benefits, with a target of a 50 percent reduction in carbon footprints by 2027. It is hoped that this project will mean minerals and metals can be sustainably sourced, and that the methods can be used as a template for projects all over the world





Medical futurist

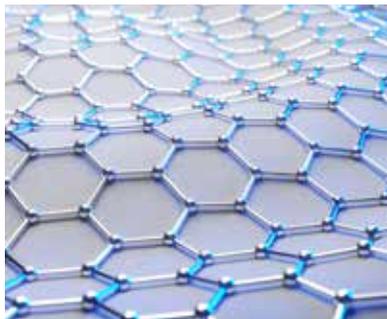
▶ Wear and tear injuries are common in the construction industry because of the amount of lifting involved, as well as the loads placed on workers' joints. Researchers from the University of Waterloo in Ontario, Canada, are finding ways to use artificial intelligence to help reduce these long-term injuries.

AI can gain insight into how the workers are moving and lifting, and this in turn can be analyzed and fed back to employees. Actionable advice can then be given on how to improve technique, reduce loads and lessen the risk of wear and tear injuries in the long term.

Thin innovation

▶ Graphene is one of the most interesting materials in the world today. Just one atom thick, but also the strongest material ever tested, the two-dimensional material is constantly being tested for practical uses.

A team of researchers at Ames Laboratory, part of the US Department of Energy, has made a discovery relating to how graphene reacts with copper, which allows them to deliberately pattern the formations. This in turn could enable the team to harness magnetic and electronic properties to their full potential.



Smart protection

▶ Microsoft's mixed-reality headset HoloLens is more than a gadget to change the way people can see the world around them. It's now certified as protective eyewear, and Microsoft plans to launch a HoloLens hardhat accessory in the near future.

Bringing this technology to construction or mine sites could help improve employee safety, as the headset itself can identify hazardous areas and notify the user. In the future, the device could also monitor levels of fatigue, helping workers to recognize when they need to take a break to avoid accidents.



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The weight, in carats, of a diamond recently discovered by Meya Mining in Sierra Leone, thought to be the fifth-largest ever from the region. It's known as the Meya Prosperity Diamond.



Animal magnetism

▶ In the middle of the 1800s huge numbers of people made their way to California in the hope of discovering untold riches. It was the California Gold Rush, and more than 300,000 prospectors made the journey to dig for the precious metal.

A recent article published in the journal *California History* explains that the metal wasn't the only exotic part of life in California in the 19th century, as many of the prospectors imported exotic animals to the area. They were brought over for food, but also allowed the prospectors to

sell clothes and accessories made from the non-native species.

The animal that travelled the farthest was the kangaroo. This animal wasn't brought in to feed the growing population, but instead allowed the owner to charge people to see this rare, strange animal. In an era when the new residents weren't sure if they could make money from gold, charging visitors to observe the rare Australian animal provided an alternative way to make a profit in those turbulent times.

Physical attraction

While looking at gold in terms of its value as an investment, it's easy to forget that one big driver in the demand for gold is as simple as the way it looks. Jewellery markets can have a big impact on gold prices, and the main driver for the jewellery markets is economic growth. As people earn more, gold purchases tend to increase. Some of the biggest economies in the world, such as Germany and the United States, are growing, so demand for gold is likely to grow as well.



The Expert
Gold reliable

In a world of unpredictable commodity prices, investment in risky assets continues to grow. *Solid Ground* looked to the World Gold Council to discover why gold is an attractive investment, and how the future looks for the precious metal.

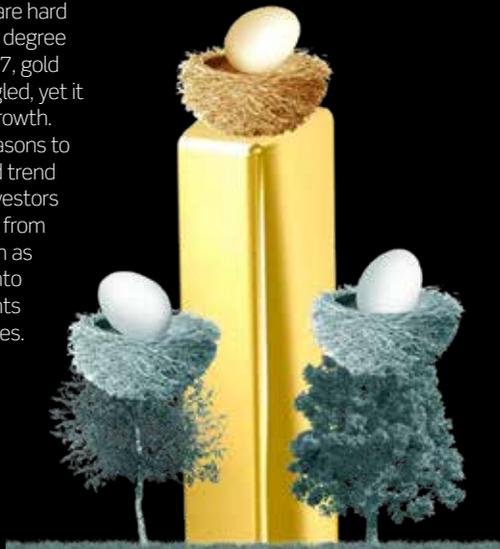


Growing demand

While gold is often seen as an asset to invest in, it's actually a big part of everyday life. Gold can be found in smartphones, medical equipment and dentistry, and it is used by many industries on a regular basis. Last year saw a noticeable increase in global demand for the precious metal, and this trend could continue as emerging technologies like self-driving vehicles become more mainstream.

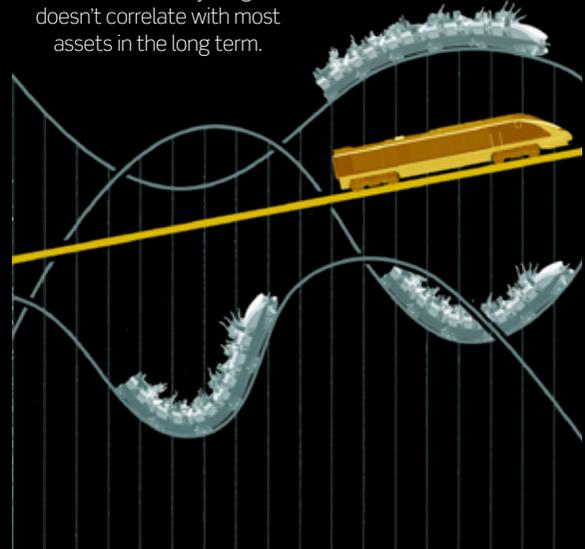
Future proofing

Gold prices and demand in 2018 and beyond are hard to predict with any degree of certainty. In 2017, gold should have struggled, yet it saw double-digit growth. There are many reasons to believe this upward trend will continue, as investors look to move away from volatile assets such as cryptocurrencies into steadier investments with narrower ranges.



Here for the long haul

Risky investments can be attractive, as the rewards tend to be significant. However, these investments also tend to be more volatile. Investing in gold can help offset this volatility, as gold doesn't correlate with most assets in the long term.





PROCESSING EXCELLENCE

■ Building materials company Boral has taken a major step towards being able to “mine anywhere, anytime” at its Deer Park quarry in Melbourne, Australia, thanks to an innovative and modern processing plant solution.

Text: DANIEL DASEY Photo: ADAM LACH



For 50 years, Boral has helped Melbourne's infrastructure grow by supplying a range of construction materials.



LOCATED IN THE SOUTH-EASTERN corner of Australia, the city of Melbourne is one of the fastest-growing urban centres in the developed world. Each year, an additional 150,000 people decide to call this buzzing, multicultural city of 4.5 million home, fuelling demand for new infrastructure, housing and commercial premises.

For the past five decades, building materials company Boral has helped Melbourne to grow by supplying a range of construction materials, such as aggregate for use in concrete and asphalt. So, when Boral realized the processing plant for its largest Melbourne basalt quarry at Deer Park was near the end of its lifespan, the company was eager to find a replacement solution that would be delivered on time and efficiently without affecting output.

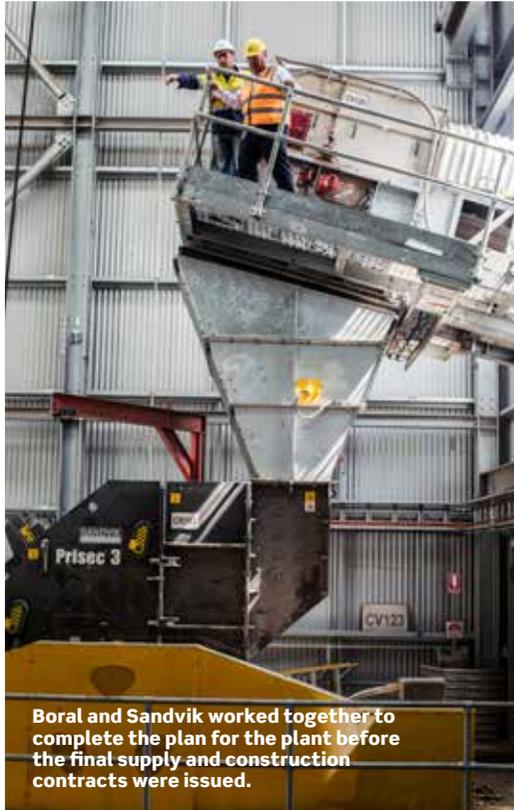
“THE OVERALL MARKET outlook is quite busy, with a number of major projects in the pipeline starting at the end of 2018 and finishing in the early

2020s,” says Luke Brown, Boral’s acting general manager for Southern Region Quarries. “Because Deer Park is in the western suburbs and close to the city, it’s well positioned to contribute to the growing pipeline of infrastructure work in and around Melbourne. So, having a new plant commissioned and ramped up in time for the major road and rail projects has been one of our objectives.”

In 2015, after an extensive tendering process, Boral commissioned Sandvik to design and supply a new aggregate processing facility. Today, the plant is approaching the end of its ramp-up phase and has been completed on time and on budget with no project variations. It is also far exceeding output projections and is helping Boral to move closer to being able to “mine anywhere, anytime” regardless of poor-quality feed and harsh weather.

“We’re achieving the product specification, and the plant is performing as well, if not better, than what we’d asked for,” Brown says. “We have

We have consistently performed 15 to 20 percent above targeted production rates



Boral and Sandvik worked together to complete the plan for the plant before the final supply and construction contracts were issued.

consistently performed 15 to 20 percent above targeted production rates.”

Sandvik designed the multi-stage processing plant and supplied processing equipment including jaw, cone and horizontal crushers, feeders, screens and conveyors as well as walkways and other infrastructure. Partnering with Sandvik, Boral oversaw the construction and subsequent ramp-up phase, which began in June 2017.

According to Kai Kane, Boral project manager for the new plant, a big part of the success of the project has come down to close collaboration with Sandvik and a range of innovative approaches that were implemented on the journey to completion. One key element, for example, was the use of the early contractor involvement approach – an idea that came from Boral. While on many projects, unforeseen changes to the design late

in the process can cause cost blow-outs, Boral and Sandvik worked together to finalize the complete plan for the plant before the final supply and construction contracts were issued. “We spent about six months achieving commercial alignment as well as technical alignment on how to deliver the project,” Kane says. “As a consequence, there were no variations at all during the execution phase, so our costs remained within budget and we also remained within time, as there were no changes required along the way.”

Another innovative element of the approach, this time suggested by Sandvik, was the use during design and construction of 3D models. This way, it was possible to see the plant as a whole as well as the individual stations along the production process. Fabrice Bonneau, Sandvik’s project manager for the design and supply of the plant, says such models provided major advantages over the 2D models traditionally used. “If you look at a 3D model of a screening station, you can see the access, the height of each of the platforms and the shape of the chutes and how this could affect blockages,”



A key improvement that came from the collaboration was a better way of processing poor-quality feeds during bad weather.

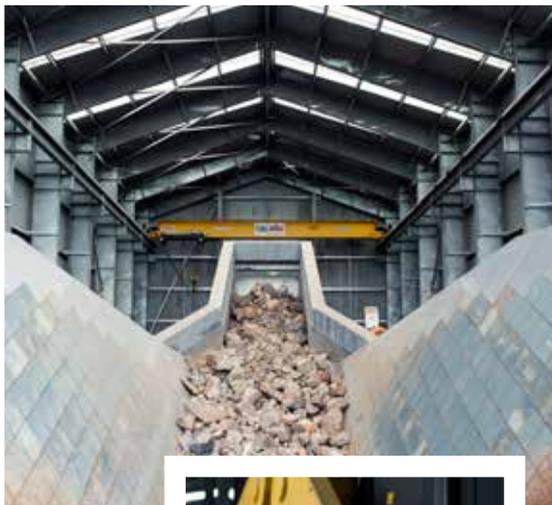


DEER PARK BASALT QUARRY

Boral required a new-for-old replacement of its 25-year-old processing plant at Deer Park in the western suburbs of Melbourne. The new plant was required to scalp, crush and process basalt mined from the nearby quarry to create a range of aggregate grades, road base, ballast and sand. Sandvik was contracted to design and supply the

plant and serve as a technical consultant during the erection and ramp-up phases. After extensive consultation with Boral, Sandvik supplied a range of jaw, cone and horizontal crushers, feeders, screens and conveyors as well as walkways and other infrastructure, most of which was shipped from Europe.

Designed and supplied by Sandvik, Boral's processing plant has performed above targeted production rates.



Management at Deer Park agree: the working conditions are a big improvement at the new plant.



he says. “We were able to have a clear view of what we were designing and share this with Boral for the review of safety, maintainability and accessibility features. It was a step ahead that Sandvik wanted to take.”

KANE SAYS ONE key innovation achieved through Boral’s close collaboration with Sandvik was a more effective way of dealing with the problem of processing poor-quality feeds in inclement weather. The deposit at Deer Park is olivine basalt with a significant amount of clay intraburden between the rock layers. The old plant was unable to process poor-quality deposits in bad weather, leading Boral to selectively mine the quarry and leave tracts of the site untouched.

On Sandvik’s suggestion, Kane says, Boral agreed to the use of special screens that had proved effective in Sandvik-designed processing plants operating in similar conditions in Europe. These have allowed the plant

to approach far closer to its “mine anywhere, anytime” goal. “The solution that we adopted was the use of specific high-capacity screens that can handle extreme clay contents,” he says. “I’m confident that we can now process over 90 percent of the time in all weather and pit conditions. I would like to say 100 percent, but the reality is that there will always be some extreme weather conditions and combinations of clays that will prevent us from achieving that.”

The close collaboration with Sandvik also produced a range of other good ideas, including producing road base as a new product line with the help of a horizontal impactor.

“Meanwhile, in the overall plant, we have adopted a modular hand railing system that’s saved all site welding and allowed us to progress to site construction in a far safer manner than previously,” Kane says. “And we have also installed two centralized dust collection units in the screening and



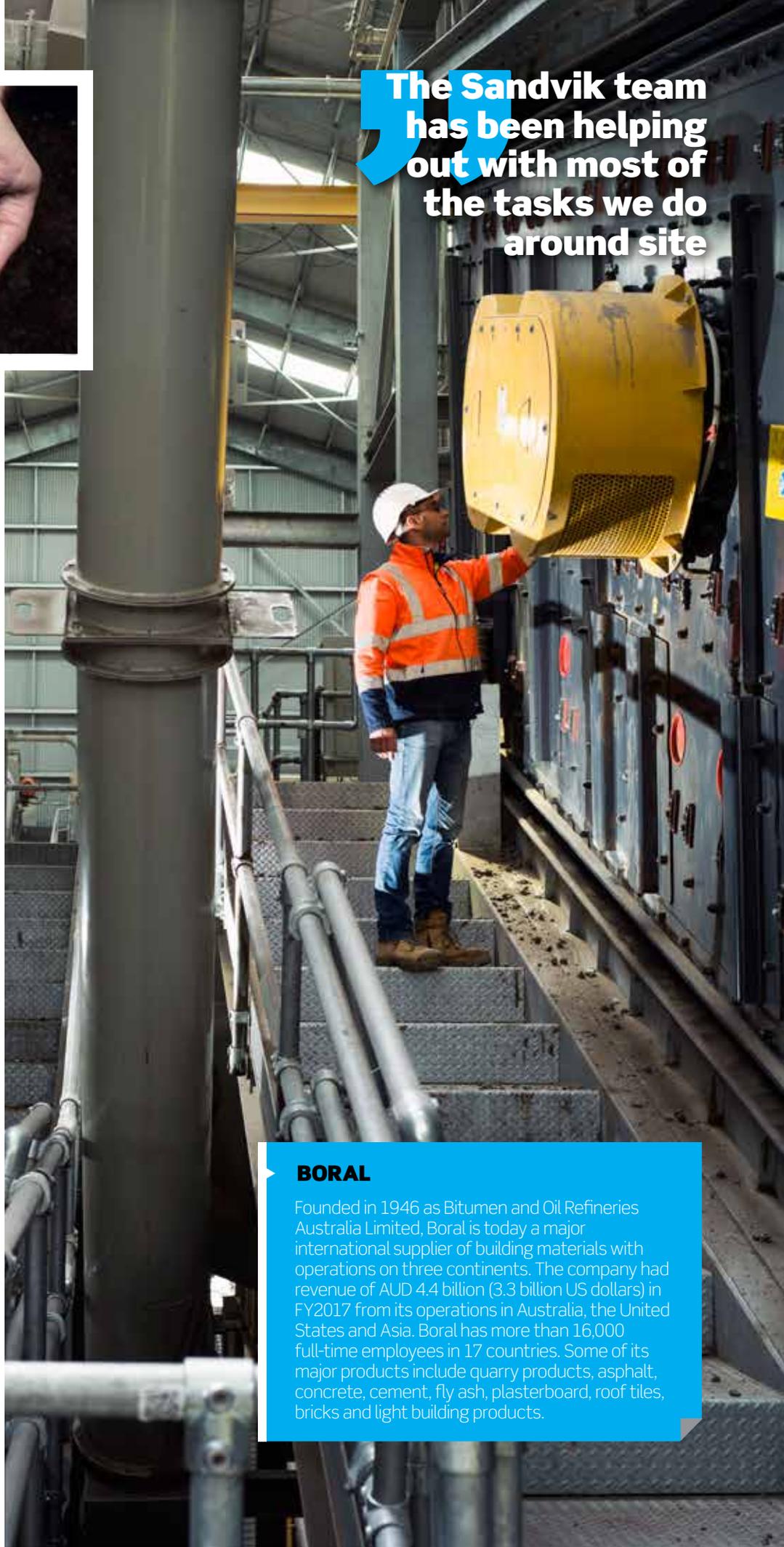
crushing buildings, which have given us hygiene levels that are the highest at any of Boral's quarries."

ACCORDING TO JAKE Laine, maintenance team leader at Deer Park, the superior nature of the new facility is crystal clear for those working with it on a daily basis. "The working conditions at this site compared to the old one are a big improvement," he says. "There's a very good dust extraction system, so that minimizes the dust by about 60 percent. And through the primary crushing area there's a better scalping circuit, so we have cleaner rock going onto our surge piles."

WHILE SANDVIK HAS extensive experience in designing and supplying processing plants across Europe and Africa, it is a relative newcomer in this field in the Australian market. Thanks to the early contractor involvement stage and through research, Sandvik was able to seamlessly adapt the plant design to Australian requirements. "The safety rules here are different than in Europe, and we took that into account right from the beginning when designing things like the spaces between the steps and different angles required," Bonneau says. "Once you know the rules, it's a matter of following them and using the same process that we use anywhere in the world."

With the project now approaching final handover, both Kane and Brown say they would be happy to work with Sandvik again. "The most impressive part of working with Sandvik was the team spirit that we were able to create together as a customer and a technology supplier," Kane says. "With that, we were able to overcome any technical and commercial issues that we were facing." ■

The Sandvik team has been helping out with most of the tasks we do around site



BORAL

Founded in 1946 as Bitumen and Oil Refineries Australia Limited, Boral is today a major international supplier of building materials with operations on three continents. The company had revenue of AUD 4.4 billion (3.3 billion US dollars) in FY2017 from its operations in Australia, the United States and Asia. Boral has more than 16,000 full-time employees in 17 countries. Some of its major products include quarry products, asphalt, concrete, cement, fly ash, plasterboard, roof tiles, bricks and light building products.



RANGER DXi BENEFITS

- Complete redesign for upgraded performance and safety
- New rock drill family for maximum power relative to size
- Extended coverage area to maximize productivity and minimize unnecessary tramming
- Excellent fuel economics for minimal opex and improved sustainability
- iCab provides a silent and ergonomic workplace
- Advanced automation options for excellent connectivity and improved productivity

Crossover kings

■ The Ranger series of top-hammer drill rigs for surface drilling has undergone a complete overhaul. The redesigned Ranger DXi series offers significant productivity, usability and sustainability improvements for a broad range of both mining and construction drilling applications.

Text: **TURKKA KULMALA** Photo: **SAMIR SOUDAH**

The Ranger series has enjoyed consistent popularity and success since its introduction in the 1990s. However, even good must sometimes evolve to become better.

“The Ranger rigs have become known as a versatile tool for a wide variety of demanding surface drilling applications,” says Jarno Viitaniemi, product manager for the Ranger DXi series at Sandvik Mining and Rock Technology, outlining the key improvements. “We wanted to respond to feedback from quarry operators and contractors by developing a new rock drill family specifically for these rigs. We also increased the coverage area and improved the fuel efficiency. The new cabin and advanced automation features serve to significantly improve the ergonomics, safety and productivity of the rig.”

THE NEW RANGER DXi series currently consists of two models, Ranger DX800i and Ranger DX900i, differing mainly in the engine output. The smaller Ranger DX800i, with a 185-kilowatt (248-horsepower) engine,

is ideal for infrastructure construction and civil engineering. The larger Ranger DX900i, rated at 210 kilowatts (282 horsepower), is primarily designed for large quarries and small mines. In mining applications, development drilling is the most likely application, while production drilling is also possible to some extent.

The new rock drill family makes the redesigned Ranger DXi rigs the most powerful in their size class, with up to 27 kilowatts of percussion output power in Ranger DX900i. All the rock drill alternatives can be upgraded with the CSL system option to reduce lubrication oil consumption by as much as 300 grams per hour.

The new Ranger DXi rigs have an entirely new feed system based on the leaf chain design to combine the benefits of both chain feed and hydraulic feed systems. The leaf chain will not stretch over time under load, resulting in longer maintenance intervals.

The new feed system also directly improves the productivity of the rig thanks to a redesigned moving retainer, which combines the collaring guide and



retainer in a single actuator. This eliminates the lost drilling distance between the retainer and ground level, increasing the drilled distance by 300 millimetres.

The design philosophy of the Ranger DXi rigs continues to be based on a revolving counterweight superstructure, which allows larger and heavier boom structures without compromising on excellent stability and reach. The

The new Ranger DXi rigs are the most powerful machines in their size class.





The new Ranger rigs are equipped with a wide range of automation features.

These are rugged but user-friendly units

to sit behind the operator, which can smooth out the learning curve of new personnel.

The standard HEPA filter of the air conditioning system complies with the F7 filtration class according to EN 779, effective down to $\geq 1 \mu\text{m}$ particles. This gives adequate protection against carbon black and inhalable dust. Optionally the filtration class can be upgraded to H13 (EN 1822) to provide protection comparable to hospital or food industry environments.

The Ranger DXi rigs offer a broad range of advanced automation features and options. With the full hole automatics option, the entire drilling cycle can be completed without operator intervention, including hole-to-hole navigation and aligning. The full radio remote control option makes it possible to remove the operator entirely from the vicinity of the drill rig, for example if the stability of the bench is questionable.

With the iTorque drilling control system, several selectable drilling recipes can be saved for varying rock conditions. Other advanced automation options include the TIM3D hole navigation system, which enables the simultaneous use of the surface model and drilling plan to more accurately adjust the operation for site-specific conditions. Wireless data transfer and data collection features are also available to effectively integrate the rig to the customer's overall drilling and blasting processes.

"All in all, the new Ranger DXi series rigs offer a superior combination of productivity and advanced health and safety benefits," Viitaniemi says. "These are rugged but user-friendly units for today's demanding requirements and conditions in the civil engineering, quarrying and mining industries." ■



The iTorque drilling control system offers several drilling recipes for varying rock conditions.

semicircular, 180-degree coverage arc of the old Ranger DX rig has now been upgraded by enabling the superstructure to revolve over an arc of 290 degrees. The reach of the boom has also increased by around 40 centimetres. All in all, the new rigs can cover a total area of 55 square metres without relocating. Even vertical uphill drilling is possible over a larger range of heights thanks to an extra tilt joint in the boom structure.

The increased coverage area significantly improves productivity by reducing the need for tramming. To illustrate, let us assume 28 holes, with a depth of 12 metres and hole size of 89 millimetres, totalling 336 metres to be drilled in a typical 2.5-by-3-metre pattern. With a conventional drill rig

and a rather conservative tramming time of five minutes per relocation, this would add up to 15 relocations, in other words a total of 75 lost production minutes.

WITH A RANGER DXi rig, the increased coverage area cuts the number of necessary relocations down to three, giving a total tramming time of only 15 minutes. This means that 60 minutes of productive drilling time can be saved in each shift. In difficult ground conditions, this can potentially increase the overall output by up to 100 metres drilled per shift.

From the operator's point of view, one of the most prominent features in the new Ranger DXi rigs is the remarkably silent iCab cabin. The noise level measured in standardized conditions, with the air conditioning fan switched to the maximum, is as low as 73.5 decibels. Even lower values are realistic in normal operating conditions.

Another benefit of iCab is its size. The cabin is large enough for two people, making it possible for a trainer



TECH SPECS

	Ranger DX800i	Ranger DX900i
Hole diameter	64-127* mm (3"-5")	89-140* mm (3½"-5½")
Sandvik rock drill	RD925M, RD925M-C, RD921S, RD921S-C	RD927L, RD927L-C
Percussion output power	25kW, 21kW, 33.5 hp, 28 hp	27kW, 36 hp
Rock tools	38, 45 and 51 mm (1½", 1¾" and 2")	51 and 60 mm (2" and 2¾")
Drilling coverage	55 m² (592 ft²)	55 m² (592 ft²)
Engine type	Volvo TAD871VE Tier 4, TAD851 Tier 3	TAD872VE Tier 4, TAD852 Tier 3
Engine output	185 kW, 248 hp	210 kW, 282 hp
Cabin type	iCab	iCab
Control system type	Sandvik SICA, PLC-controlled proportional electrohydraulics	PLC-controlled
Tramming/boom/ drilling control	PLC-controlled	PLC-controlled
Flushing air	8.5 m³/min, 300 cfm up to 10 bar	9.5 m³/min, up to 10 bar, 335 cfm
Total weight	19,600 kg, 43,210 lb	19,600 kg, 43,210 lb

*The manufacturing plant should be consulted for holes larger than 127 mm.

A quest to coexist

■ ONTARIO, CANADA. Goldcorp is developing the world's first all-electric underground mine, an ambitious project the company hopes will help inspire an industry-wide shift to more sustainable mining.

Text: ERIC GOURLEY Photo: ADAM LACH

By eliminating diesel underground and fully electrifying Borden, Goldcorp anticipates a 70 percent reduction in greenhouse gases.



The portal is a stone's throw from pristine Borden Lake.



This isn't the most instinctive location to build a mine. Goldcorp's Borden Lake project lies just south of the Chapleau Crown Game Preserve, the world's largest at 2 million acres (700,000 hectares). The portal is a stone's throw from the pristine body of freshwater for which the mine is named, brimming with trophy fish each spring. Part of the orebody Goldcorp will ultimately mine sits beneath the lake, whose water is sacred for the area's four First Nations communities.

It's no surprise, then, that Borden project manager Luc Joncas uses words like "invisible" and "silent" when he describes the development aims of the region's first mine.

"Mining is brand new in this area, so it's essential to build a sustainable mine," Joncas says. "We want to be accepted by the neighbours, whether it's the First Nations that live next to us or even the cottagers around the mine."

GOLDCORP SENIOR PROJECT

Engineer Maarten van Koppen produced Borden's pre-feasibility study and all associated engineering leading up to it.

"We knew that we had to create a mine in close collaboration and coexistence with our local stakeholders," he says. "It was very important to us to minimize all sources of emission, whether it's noise, dust or other

GOLDCORP

Goldcorp is a leading gold producer focused on responsible mining practices with low-cost production from a high-quality portfolio of mines throughout the Americas. A Canadian company headquartered in Vancouver, British Columbia, Goldcorp employs more than 15,000 people worldwide and is committed to being responsible stewards of the environment and to maintaining the highest health and safety standards.



By the time Borden Lake is in production, there will be no diesel-powered equipment underground.



pollutants. Going electric really helped in achieving those goals.”

Goldcorp has designed Borden Lake to become the world’s first all-electric underground mine when it reaches commercial production next year, an undertaking the company expects to not only help minimize community and environmental impact but also improve health and safety for employees – all while boosting Goldcorp’s bottom line.

John Mullally, Goldcorp’s director of government affairs and energy,

considers a shift to cleaner, more sustainable mining practices essential.

“There’s so many societal expectations and changing views on things like climate change,” Mullally says. “For us to be a modern company, we have to be moving sort of at the same rate as changes in society, so I think that energy overall, and climate change specifically and mitigating our impacts to climate, that’s become a big focus in the last three to five years with Goldcorp. We’re changing the culture inside the company and we want to encourage change in culture across the industry.”

BY THE TIME Borden is in full production, there will be no diesel-

powered equipment underground. A combination of tethered electric and quick-charge battery-powered equipment will make up the entire fleet.

“The battery technology advancements really enable us to go fully electric,” Joncas says. “Not only do we plan to prove to the industry it’s possible, we’re keen to prove that it will be cost effective and bring even more value to our shareholders than a conventional mine. We believe electrifying Borden makes sense economically, environmentally and socially.”

BY ELIMINATING DIESEL underground and fully electrifying Borden, Goldcorp anticipates a 70 percent reduction in greenhouse gases and annual savings of 2 million litres of diesel fuel and 1 million litres of propane. The company also expects to save 35,000 megawatt hours of electricity yearly, due in large part to drastically reduced ventilation needs.

“Electrification is the ultimate win-win, especially complemented by innovations like ventilation on demand and full connectivity,” van Koppen says. “The main benefits that we see with going electric are certainly the elimination of fuel, reduced maintenance, reduced greenhouse gases,

BORDEN LAKE PROJECT

The Borden Lake gold project is being developed as the world’s first all-electric underground mine. Decline construction began in mid-2017 and a 30,000-tonne bulk sample is expected to be extracted and analyzed by the end of this year, with production expected in 2019. Located in Ontario, approximately 11 kilometres north-east of the town of Chapleau and 160 kilometres south-west of Timmins, Borden Lake has gold reserves of 950,000 ounces and is part of Goldcorp’s plan to increase production by 20 percent by 2021. By eliminating diesel underground and fully electrifying Borden, Goldcorp anticipates a 70 percent reduction in greenhouse gases and annual savings of 2 million litres of diesel fuel, 1 million litres of propane and 35,000 megawatt hours of electricity.

We're changing the culture inside the company and we want to encourage a change in culture across the industry



John Mullally, Goldcorp's director of government affairs and energy.



Goldcorp depends on Sandvik DD422iE electric jumbos to develop the access ramp.

Bar none, best jumbo they got around

reduced power consumption, and of course the biggest one is the elimination of diesel particulate matter in underground environments, which is hugely beneficial to the health of the workforce.

“We were able to eliminate a return air raise and our intake raise, we could reduce the diameter from five metres to four metres, so there’s big cost savings to be had if you set it up right from the get-go.”

Miner Randy Harrison appreciates the absence of underground emissions at Borden after working in conventional diesel mines across four continents since 1980.

“**THIS IS LIKE** no other underground environment I’ve ever worked in,” Harrison says. “The air is so fresh.”

He’s behind the controls of a Sandvik DD422iE, one of two identical units Goldcorp depends on to develop Borden’s access ramp.

“The computer setup and the preciseness that you can get on the face, bar none, best jumbo they got around,” says Harrison, who’s operated development drills since 1989. “Sandvik has been on the cutting edge right from day one since I started operating them.”

Joncas calls the jumbo “the star of the fleet.”

“It enables better accuracy, more control, consistency from crew to crew. For us it enables also a safer operating workplace. We start from a fresh face with virtually no bootlegs. We manage the profile better and have less overbreak. It allows us to optimize the drilling pattern. Our holes are higher quality.”

SANDVIK DD422iE IS connected to the grid at Borden while drilling, during which the jumbo charges the battery it uses to manoeuvre between faces.

“We thought charging-while-drilling was a great concept, something that could potentially be very valuable in other equipment in the future,” Joncas says. “I was impressed that the jumbo can handle multiple voltage standards. We had a training camp at a mine with a 600-volt standard, and the jumbo works equally well on the 1,000-volt network here.”

Goldcorp expects to save 35,000 megawatt hours of electricity yearly, due in large part to drastically reduced ventilation needs.



Maarten van Koppen,
Goldcorp senior
project engineer.



The rig's fully integrated battery technology means no change-outs, a safety and productivity benefit, Joncas says. He also cites the regenerative braking system as a plus and says the electric driveline in Sandvik DD422iE makes it much easier to maintain than conventional jumbos.

"When we purchased the fleet, one thing we were extremely attracted by was the fact that a lot of the mechanical components are removed," Joncas says. "No more diesel engines, no more oil changes to be done."

GOLDCORP BOUGHT BORDEN from a junior explorer for 526 million US dollars in 2015. With current gold reserves of 950,000 ounces, the operation figures to produce more than 100,000 ounces per year over at least a seven-year mine life.

"We are confident that our exploration will extend that," Joncas says. "The longer our mine life, the more cost-effective our initial capital investment in an all-electric fleet."

Ore will be trucked 160 kilometres (100 miles) to Timmins for processing at the Dome mill at Goldcorp's Porcupine Gold Mines.

"Using an existing facility that operates extremely efficiently and not having to permit and build a new mill

and tailing facility minimizes our cost and our environmental footprint," Joncas says.

Decline construction at Borden began in mid-2017 and a 30,000-tonne bulk sample is expected to be extracted and analyzed by the end of this year with production expected to begin in 2019.

"We believe Borden will be a great pilot to prove that there are tremendous financial and environmental benefits from the adoption of cleaner technology," Mullally says. "It's really exciting to be a part of. Once other companies see that the business case works, we hope to see large-scale adoption at a meaningful rate across the mining industry." ■

SANDVIK DD422iE

Sandvik DD422iE is an electric development jumbo designed to drive down production costs while reducing the environmental impacts of drilling and tunnelling. By using electric energy from an onboard battery during tramming, Sandvik DD422iE produces zero emissions while manoeuvring between headings. This improves health and safety for miners working underground. Less diesel usage in a mine thanks to diesel-free drilling can ease ventilation requirements, while also reducing associated diesel logistics and maintenance expenses. Using a mine's existing electric infrastructure, the Sandvik driveline technology enables the battery to recharge during the drilling cycle. The battery will even recharge while Sandvik DD422iE is tramming downhill, using energy generated by the braking system.

Tunnel vision

- The new Sandvik LH202 narrow-vein loader offers the best payload-to-own-weight ratio of its class for tunnel widths ranging between 2.0 and 2.5 metres – as well as many other benefits in usability and sustainability.

Text: TURKKA KULMALA Photo: SANDVIK Illustration: ERIK NYLUND



Product designations of mining equipment typically denote specific characteristics such as engine output or weight.

This is also the case with Sandvik loaders for narrow-vein mining applications. “Sandvik LH202 initially meant a loader designed for tunnels sized two metres across and for a payload of two metric tons,” says Kimmo Ulvelin, product line manager for narrow-vein and low-profile loaders at Sandvik Mining and Rock Technology. “This was the original logic, but today the actual payload is in fact three tonnes.”

The key challenge for economy in narrow-vein mining is dilution. Because of the often complex geometry of narrow-vein mineral deposits, with varying depths and shapes, mechanized extraction unavoidably results in some degree of dilution by waste rock. Because all the material must nevertheless be processed, this represents a significant cost factor that must be minimized to maximize the profitability of the operation.

ONE OF THE MOST important ways to achieve this is to design the mine tunnels to be as narrow as possible, which obviously necessitates appropriate equipment capable of operating in such tunnels. Sandvik has responded to this challenge by developing a comprehensive range of compact loader and drill rig pairs, starting from a minimum tunnel width of 1.5 metres, going up to 3.0 metres. The loader payloads range between 1.0 and 6.7 tonnes.

Sandvik LH202 raises the bar for narrow-vein loaders by delivering a three-tonne payload for tunnel widths of two metres and above. In addition, Sandvik LH202 is narrower than competing loaders with a comparable payload. This is an unprecedented capacity rating for this size class, essentially enabling more tonnes to be moved safely at less cost.

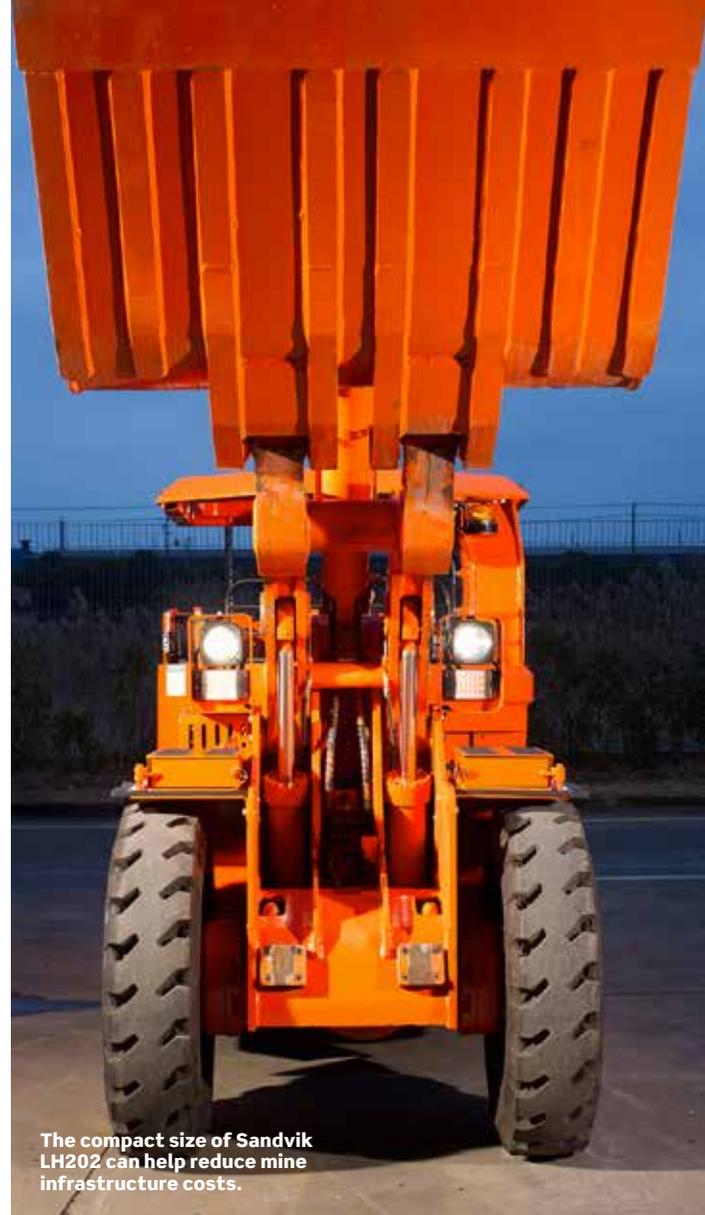
“The cost savings can be up to 36 percent per tonne of ore, primarily thanks to the tight turning radius achieved due to reduced width and length compared with similar models in the same size class,” Ulvelin says. “The manoeuvrability is simply better.”

The extremely compact size creates interesting possibilities for mine planners. The tunnel size can be decreased for lower dilution and reduced mine infrastructure costs. A reduction as small as 25 centimetres in the tunnel width can decrease mining costs by up to 5 percent.

Beyond the compact size, the larger capacity is another way that Sandvik LH202 can reduce mining costs. The upgraded bucket design enables easier bucket filling and faster dumping. Combined with the three-tonne capacity, Sandvik LH202 has the potential for more tonnes per cycle and consequently fewer loading cycles and less fuel consumed.

THE MAXIMIZED CAPACITY combined with a very light machine, relative to its size, reduces the cost per tonne and offers superior productivity. Decreasing the need for engine power also improves productivity while cutting fuel consumption and reducing the load on mine ventilation.

“One of the definite highlights of Sandvik LH202 is the new powerful



The compact size of Sandvik LH202 can help reduce mine infrastructure costs.

hydrostatic transmission,” Ulvelin says. “It is efficient and easy to use, which helps the operator to stay focused and productive.”

The fully reversible drivetrain eliminates gear shifting and enables simple, stepless operation compared with a standard driveline. This makes Sandvik LH202 a significantly easier

BENEFITS

- Superior three-tonne payload for excellent productivity and reduced life-cycle costs
- Reduced width, length and turning radius compared with other machines in the same size class enable effective dilution control and lower cost per tonne
- Improved powertrain for better loading efficiency, reliability and simple usability
- Daily maintenance on the ground level for better productivity and safety
- Optional Tier 4 engine for superior sustainability
- Operator's compartment in the rear frame and other advanced safety features to stay safer and more productive

The cost savings can be up to 36 percent per tonne of ore

loader to learn, even for an inexperienced operator.

In addition to simplified operation, the hydrostatic transmission also helps to minimize maintenance and operating costs. The drive optimizes hydrostatic brake performance regardless of operating conditions, which minimizes brake wear and tear and reduces the oil temperature within the transmission system.

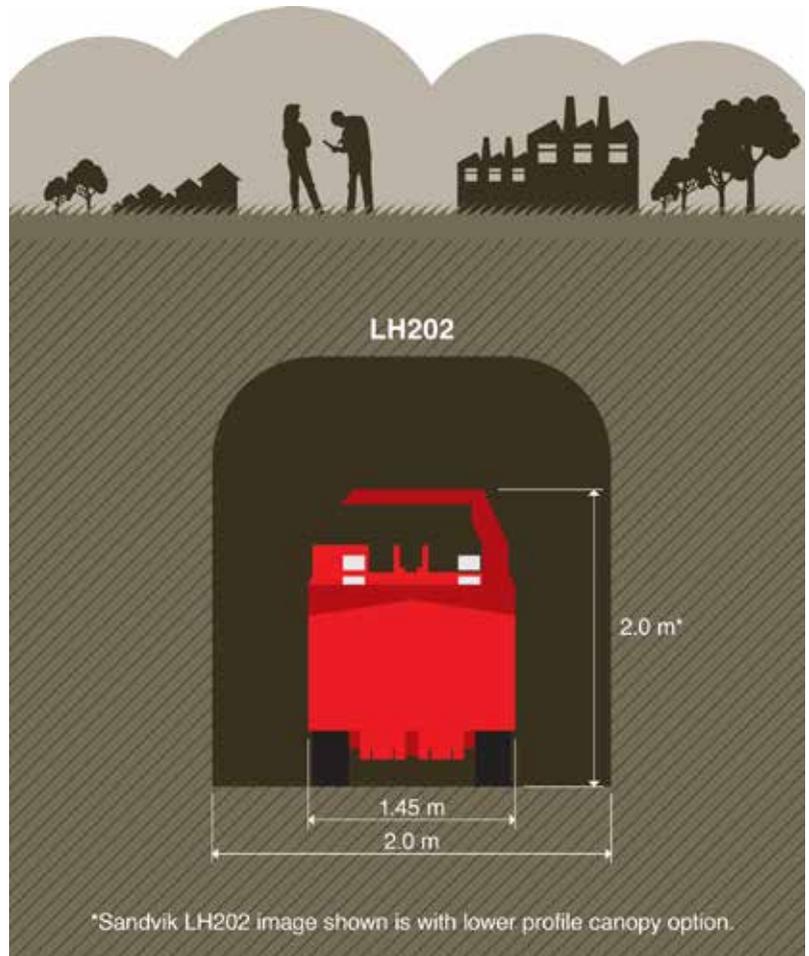
The hydrostatic powertrain also helps to provide a high breakout force and fast acceleration, enabling effective handling of larger rocks with fewer interruptions, even in challenging conditions.

Ergonomics is not only about operator friendliness – it is also a significant productivity factor. A good, highly ergonomic work environment can boost the productivity of an individual operator by up to 60 percent.

SANDVIK LH202 REDUCES the strain on the operator by providing more space and limiting heat sources near the driver’s seat, to support full focus on the task at hand. The instrument panel is located optimally in the operator’s field of view. Other ergonomic features include canopy lighting and fully adjustable seat and arm rests.

Sandvik LH202 supports safer underground loading and hauling by placing the operator in a canopied ROPS/FOPS-certified compartment located in the loader’s rear frame, farther away from falling rocks during bucket loading.

The standard canopy gives the loader a total height of 2,134 millimetres, which can be reduced to 2,017 millimetres by using the low-profile canopy option. Other advanced safety features include door and neutral brake interlocks to prevent any sudden movements of the unit when stopped. Powerful LED lights are standard equipment to improve visibility and



avoid collisions with the wall, other equipment and people.

The new loader is equipped with a Tier 2 diesel engine as standard, but a lower-emission Tier 4 engine option is available for markets with more demanding engine emission regulations.

Sandvik LH202 is designed for excellent maintainability: all daily

servicing tasks can be performed on the ground level, reducing risk of slips, trips and falls. The design of the hydrostatic transmission also inherently reduces maintenance needs because there is no brake cooling to be serviced and no gears vulnerable to abuse, and the load on the drivetrain is lower than in mechanical transmission systems. ■

TECH SPECS - SANDVIK LH202

● Dimensions (L-W-H)	5.86 m-1.45 m-2.13 m
● Trimming capacity	3,000 kg
● Breakout force, lift	57 kN
● Breakout force, tilt	63 kN
● Engine	Deutz BF4L914, Tier 2
● Engine power	50 kW
● Maximum speed	10 km/h
● Total operating weight	8,800 kg
● Canopy	ROPS/FOPS

Dilution resolution

■ CRESCENT VALLEY, NEVADA. Minimizing ore dilution has enabled narrow-vein specialist Klondex Mines to produce record ounces at its flagship Fire Creek operation – the world’s highest-grade gold mine.

Text: **ERIC GOURLEY** Photo: **ADAM LACH**



SANDVIK FLEET AT FIRE CREEK

- 3 x Tamrock EJC65 loaders
- 3 x Sandvik LH410 loaders
- 2 x Sandvik DD210 jumbos
- 2 x Sandvik DS311 bolters
- 1 x Sandvik LH202 loader
- 1 x Sandvik LH204 loader
- 1 x Sandvik DD311 jumbo
- 1 x Axera D07 jumbo

Operator Craig Roberts uses a remote control to navigate a two-yard loader into a stope barely wide enough to accommodate it. He soon manoeuvres the narrow-vein unit back out of the stope, its bucket full of high-grade gold and silver ore that will be trucked 160 kilometres for processing at the mill at Klondex Mines' Midas operation.

Klondex hauls just 300 tonnes out of its Fire Creek mine in north-central Nevada every day, but at an average gold head grade of nearly an ounce per tonne. For general manager Sid Tolbert and his underground mining crews, minimizing dilution is the key to profitability.

"The grades at Fire Creek are unlike anything I've ever experienced in my 25 years mining," Tolbert says. "The challenge with those high grades in the

narrow vein is keeping your dilution down, which the miners here do a great job at. We're doing extremely narrow, extremely well-controlled drifting and cut-and-fill mining to ensure we deliver the highest grade possible for the tonnes that we excavate. We need to make sure that every tonne we're sending to the mill is a valuable tonne."

THE SOFT-SPOKEN TOLBERT

personifies the quiet evolution of Klondex from a single-property exploration company to a mid-tier gold and silver producer with five assets in the United States and Canada. While Klondex has created much of its success by acquiring and transforming aging narrow-vein operations since President and CEO Paul Huet took the reins in 2012, the growth at its flagship Fire Creek mine has been purely organic.

Despite plans for Fire Creek to become a surface mine, Huet had different ideas. Klondex brought the mine into production under a bulk sample permit in late 2013. Four years later, the underground operation produced 108,126 gold equivalent ounces (GEOs) – nearly a 40 percent production increase from 2016 and more than half of the 189,456 GEOs Klondex produced in 2017.

"Fire Creek is an amazing deposit," Tolbert says. "We don't yet know the full potential, but as we continue to drill, explore and develop the mine, our resource is getting larger and larger. In every direction, we're continuing to see minable high-grade vein structures."

LESS THAN FIVE percent of the world's known gold deposits have a grade above 10 grams per tonne. Fire Creek's head grade averages more than 25 grams per tonne. The mineralization lies between 1,500 metres and 1,750 metres above sea level in the hills overlooking the tiny town of Crescent Valley. Primary veins Vonnie and Joyce range in width from five feet to only six inches, and Klondex uses a combination of long-hole, cut-and-fill and shrinkage stoping to mine the ore.

Such an operation requires a diverse mobile fleet, from the Sandvik jumbos developing 5-metre-by-5-metre waste development drives to the two-metre Sandvik narrow-vein loaders for remote mucking that Tolbert calls the mine's "workhorses".

"We use them to mine on the vein, on the structure, keeping our dilution down to just over three percent from design," he says.

Mine general foreman Rosco Hamilton says the nature of the operation makes equipment reliability essential.

"Our footprint is so small that if we do have one hiccup, it really kills our tonnes and then we're hurting," Hamilton says. "Everything has to kind of click and work and you don't get a lot of options for mistakes. There's no other place to go if you don't get the tonnes out of this stope."

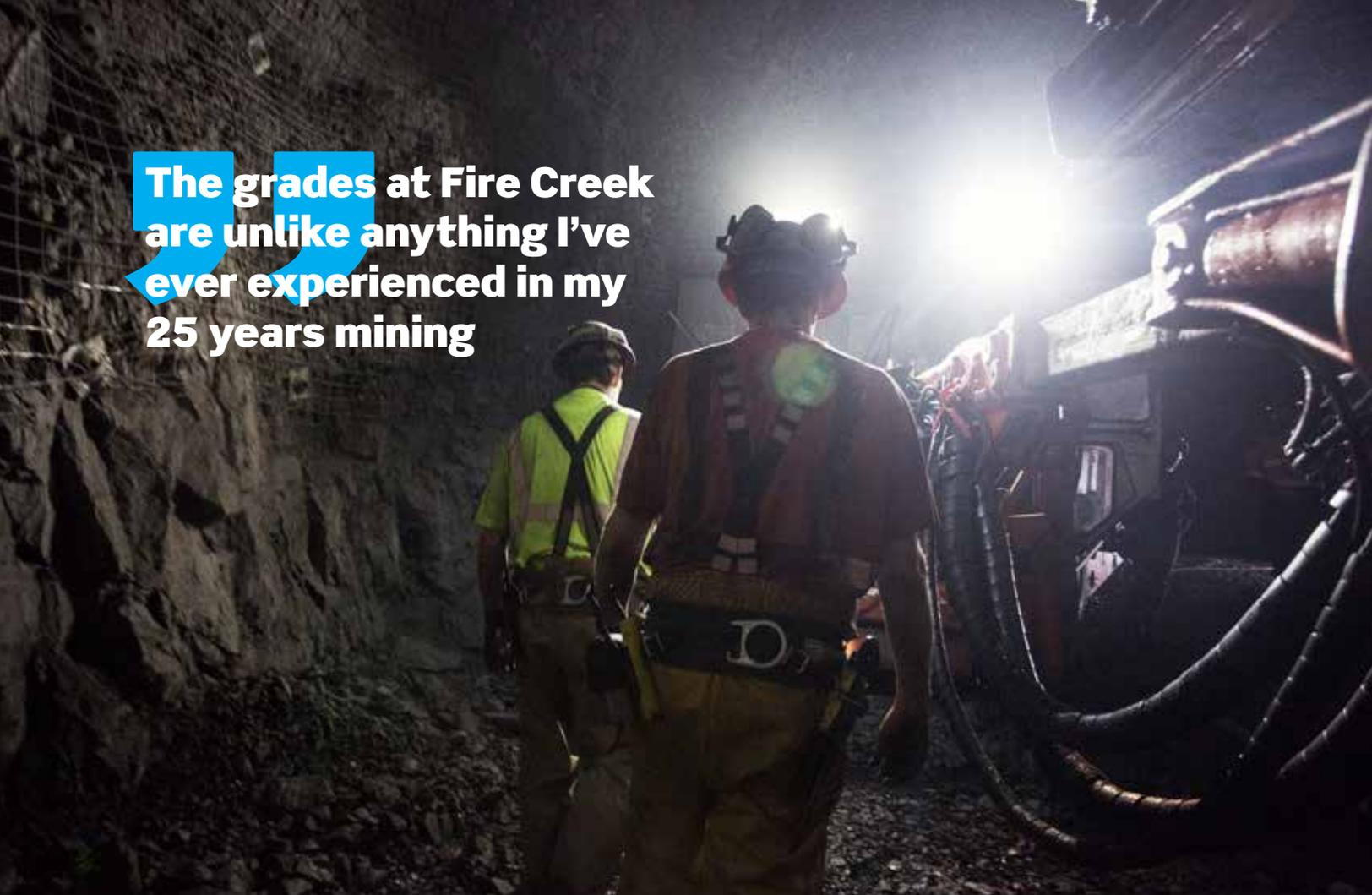
To help guarantee reliability, Klondex partners with Sandvik to perform all mobile maintenance at Fire Creek.

"THE BENEFIT OF that is we've got the buying power of Sandvik behind us for parts availability," Tolbert says. "We've

KLONDEX MINES

Mid-tier gold and silver miner Klondex Mines specializes in narrow-vein underground gold and silver production. The Canada-based company operates the Fire Creek mine and Midas mine and mill in Nevada and the True North mine and mill in Manitoba, Canada. Klondex also owns the Hollister mine and the Aurora mine and mill in Nevada.

**The grades at Fire Creek
are unlike anything I've
ever experienced in my
25 years mining**





Sandvik technicians support Fire Creek with strategies, scheduling, parts planning, troubleshooting and more.



got the warehouse here. We don't have to stock the parts on site, which drives our maintenance costs down considerably. And with them doing the maintenance for us, they guarantee availability on that equipment, which keeps the mining continuing here at Fire Creek."

Under the Sandvik 365 Expertise On Site service agreement, Sandvik technicians also support Fire Creek with maintenance strategies and scheduling, parts planning and forecasting and troubleshooting.

"SANDVIK DOES A great job maintaining our equipment," Tolbert says. "It's a pleasure to work with their staff here, and there's a great benefit to have partners such as Sandvik."

Adds Hamilton: "Sandvik is really good about what our needs are on a day-to-day basis, and those needs do change from day to day. If a loader breaks down and this is the only stop we're mucking today, the guys drop everything they're doing and come get it fixed."

Klondex mobile maintenance manager Neil Miller says that despite an ageing fleet at Fire Creek, mobile equipment operating costs hover around 21 percent of total mining costs.

"If we get a truck go down, you know, we're probably losing USD 250,000 a day in lost production, so it's critical that we keep our trucks and

loaders, muckers, everything going," Miller says. "The Fire Creek mine is critical to the profitability of Klondex Gold. It's high-grade, low tonnes, so we've got to keep all our equipment good. Downtime's really critical to us."

Under the agreement, Sandvik provides genuine spare parts and technical training for Fire Creek's maintenance staff.

"The more technical training you have, you see the reliability start to increase right away," Miller says. "The training is critical for the reliability of our equipment. Reliability is really the critical part of it. You can have high availability, but if the unit's not reliable, then it's not ready when we want it to bog headings or truck dirt out of the mine."

The service agreement has increased mean time between failures and reduced downtime while enabling Klondex to focus on production and core business processes at Fire Creek. Klondex is concentrating on continuing the mine's expansion during 2018, developing the primary access and advancing a second portal. Exploration drilling continues to show potential to expand the mineral resource.

"Fire Creek's future is very promising," Tolbert says. "We're stepping out from the mine workings, starting to find more and more veins that are high-grade, and it's very exciting times. We're finally into production, and have a steady flow of muck coming out of the mine, and we're looking to advance that in the near future, and build our future here that lasts decades." ■

FIRE CREEK GOLD MINE

The Fire Creek mine is the world's highest-grade gold operation. Located in north-central Nevada, 100 kilometres west of Elko, Fire Creek holds proven and probable reserves of 229,000 gold equivalent ounces (GEOs). The Fire Creek land package covers approximately 17,000 acres. Klondex uses a combination of long-hole, cut-and-fill and shrinkage stoping to mine the high-grade ore.



The face of digitalization

■ Digitalization is revolutionizing the way industry functions right in front of our eyes. And while its full potential has yet to be reached, questions abound about the importance of people management during this transformation.

Text: **DAVID NIKEL** Photo: **SHUTTERSTOCK**

The focus of most discussions about the digitalization of industry is often on technology and equipment. Be it automated trucks, intelligent drill rigs or the potential for reading biometric data, the conversation is largely about how technology allows us to do things that have previously seemed impossible.

Still, the benefits of digitalization run much deeper. While a variety of tasks can be improved with a digital solution, the importance of people to the digital transformation process should not be overlooked.

Decision-makers from as far afield as Australia and China came to Tampere, Finland, for the Sandvik Global Mining Summit. Digitalization was top of the agenda, both in terms of

to using digital tools to share thoughts and ideas from all aspects of our lives.

The trend is slowly making its way into the workplace, too. Employees now expect open and honest communication from their employers. Nowhere is this more important than in a workplace undergoing the sweeping changes associated with digitalization.

Including employees in the digital conversation is a key building block for success, especially when many people view digital tools not so much as a benefit, but rather a threat to their job security. “I don’t think we’ll see a huge reduction in jobs, at least not in the short to medium term,” says Neil Moloney, digital transformation manager at Goldcorp. He does, however, believe that job roles will change.

“We are already seeing the job of mine general managers change, as automated reporting solutions allow them to focus on other things,” he says. “Operators are still necessary, but the definition of what they do will change. Some of our miners don’t even own a mobile phone, so suddenly filling their cab with automated tools is a scary proposition for them. Change management is absolutely critical for this to work.”

A clear strategy needs to be put in place to manage the people aspect of digital transformation. Those driving the changes need to have a service mentality, both for the users of the technology and for their end customers. All technology needs to be rolled out with a full support system in place, and having engaged the people who will be impacted most.

THIS STARTS WITH an analysis of what is truly needed in your business.

There is a great risk of succumbing to “shiny object syndrome” when it comes to technology, so it’s crucial to consider both the everyday users and the company’s long-term strategy when considering change.

One option is to take lessons from the start-up world, where employees are empowered to make decisions using digital tools, and temporary business models allow new ways of working to be tested without fear of failure. Whatever you decide, it’s important to involve your people in the process through research. What technology will make their day-to-day working lives easier?

RESEARCHERS AT SCANDINAVIAN institute SINTEF have been working on a two-year strategic research project on decision-making. The overall goal of the project is to improve performance within time-critical complex domains, such as emergency management, air traffic management, maritime and train dispatching, by developing a new-generation decision support tool.

This support tool enables better human/automation collaboration during decision-making, says Amela Karahasanovic, senior scientist on the project.

“The tool lets the operator in a train-dispatching centre tell the system in which sequence he plans to dispatch the trains by tactile interaction and/or augmented reality techniques,” she says. “The tool would then, only if needed, propose a better but understandable sequence by using 3D animation and present how this would affect punctuality.” Karahasanovic says that in the long run, this will improve human operators’ trust in the decision support tool, increase their competence and improve the quality of decisions they make with and without support.

Fuelled by the rise of the Internet of Things, Big Data is, according to the consulting firm McKinsey, “the next frontier for innovation, competition and productivity.” The amount of data generated from a mining operation continues to increase, yet this data is worthless without the skills and abilities required to analyze it.

ALEX HOLDER, THE group technical services manager for South African company Petra Diamonds, is excited about the potential value hidden in the data the company has been collecting

Operators are still necessary, but the definition of what they do will change

what’s working now and what needs to happen in the future.

Three Sandvik customers spoke about their approach to digitalization, and a fascinating trend emerged. Their focus wasn’t so much on the systems and technology, but on how digital solutions can improve everyday activities, and the importance of people management to success.

ONE OF THE most noticeable changes in the digital revolution is a more open approach to communication. In barely a decade we have become accustomed

SANDVIK’S DIGITAL OFFERING

Sandvik’s three-pronged approach offers customers flexibility and choice when building their own digital strategies.

Automation: AutoMine is a modular IT system that manages elements of your operations, from scheduling and location tracking to a 3D mine visualizer.

Fleet management: The My Sandvik web portal gives customers online access to data and information about their fleet. You can improve transparency, order parts and understand the status of your fleet.

Analytics: OptiMine software offers customers predictive insight and real-time analytics based on collected data to improve operator and asset performance.

for the past five years. “Our spatial database gives us the ability to map correlations such as grades against locations, helping us to increase the likelihood of finding the high-value diamonds,” Holder says.

But McKinsey says there will be a shortage of talent necessary for organizations to take advantage of such opportunities. By 2018, the United States alone could face a shortage of up to 190,000 people with the necessary deep analytical skills, as well as more than a million managers and analysts with the know-how to make effective decisions based on such analysis.

THE NEED TO retrain existing staff and recruit a different kind of talent into industry will not be news to anyone, but how many have considered how automation can help a company retain the skills, knowledge and experience of an ageing workforce? Coupled with the potential health and safety improvements, automation could significantly improve working conditions, and help people stay working for longer.

John Welborn, managing director and CEO at Australia’s Resolute Mining, says that the safety of the workforce is paramount, and that automation creates opportunities to improve safety and security beyond the obvious hazards within the mines themselves. “We operate gold mines in remote parts of Africa, and historically we’ve operated in places with safety and security concerns,” he says. “Automation creates an opportunity whereby the people operating the machinery don’t actually have to be physically in the mine zone or even in the same country as the mine.”

But while there is broad agreement that safety will be improved by technology, some are urging caution. The effects of digitalization on health and safety are, in many cases, yet to be felt. That’s according to findings from CEEMET, the European employers’ organization representing 200,000 companies in the metal, engineering and technology-based industries.

The report says we do not yet know the potential problems that may be encountered by workers who must use these new technologies, such as head-mounted displays, as part of their daily routine.

The question is further complicated



by the increasing overlap between what people do in their private lives and at work. When does health and safety stop becoming the employer’s responsibility? In the case of someone working remotely from a home office, where is the line drawn?

While there is much excitement about the potential benefits of tracking and biometric technologies, such data collection gives companies a whole new headache beyond operations.

As legislators rush to catch up with the immense amount of personal data kept by the likes of Facebook and Google, the mining industry should be paying close attention, advises Manny Maloney,

Sandvik general counsel. He says all mining companies must have a policy to ensure they are in compliance with the EU General Data Protection Regulation that comes into force this year.

This is especially important if the tracking of people within the mine forms part of your digitalization plans. While there are no doubts about the impact on safety, some labour unions have expressed concerns about the constant monitoring of employees.

While the answers will be different for every company, the question remains: How can you put people at the heart of your digital transformation? ■

EUROPE'S NEW PRIVACY REGULATIONS

The EU General Data Protection Regulation (GDPR) is the most important change in data privacy regulation in 20 years. From 25 May 2018, all companies processing the personal data of subjects residing in Europe need to abide by the GDPR, regardless of the company's physical location.

Companies should hold and process only the data absolutely necessary for the completion of their duties, and limit access to personal data only to those needing to process it. There are also rules on the right of subjects to access data that relates to them. Strict fines are in place for breaches of the regulations. More at eugdpr.org.



A MARVEL IN MARBLE

The picturesque Apuan Alps in northern Tuscany have provided many an artist and architect with fodder for their masterpieces.

Text: **FRANCIS DIGNAN** Photo: **RF123**

THERE ARE FEW places on earth where you can expect to see snow year round. All but the highest peaks tend to lose their shining white tips during the summer months, so what is it about the Apuan Alps that makes them perpetually gleam?

After all, the mountains lie in Tuscany, an area in the north of Italy known for warm summer months and mild winters. The peaks themselves don't exceed 2,000 metres, which may sound high, but they are dwarfed by numerous mountains in Italy alone. If these mountains were anywhere else with the same sort of climate, they would show their greens and greys when the warmer weather arrives.

So, what keeps them winter-white? It has nothing to do with the climate at all, but what lies beneath the surface. This region is home to the world-famous Carrara marble quarries.

The many sheer faces of the Apuan Alps which appear to be eternally covered in snow are actually just showing the results of more than 2,000 years of quarrying. What began in the time of ancient Rome still carries on to this day, and evidence points to at least 650 quarry sites. Around half of these are now abandoned or have been fully worked, but that still leaves a huge amount of the desirable rock to be extracted.

Marble from this region is arguably the most famous in the world, with millions of admirers gazing upon the unique, beautiful sculptures and structures for which the rock has been used.

From Michelangelo's David to the Oslo Opera House, the snow-coloured rock that was discovered two millennia ago has been influential in art and architecture alike. After all these years it would be easy to assume

that the mountains don't have much more to give, but continued digging, exploration and production suggest otherwise.

The quarries themselves can look just as impressive as the end products. The sheer rock faces are scarred with giant staircases, where the machinery used to carve away the blocks shrinks in the face of the gargantuan reserves they chip away at. As the quarries are worked, they transform into enormous amphitheatres with the workers turned directors using the subtlest hand signals to guide the diggers to where they need to be.

The Apuan Alps are where machinery and natural majesty meet. Mountains of marble have been extracted, exported and shaped for an extraordinary amount of time. Not only has this region given the world the rock for countless sculptures, but it is now home to the breathtaking image of an eternal winter, even in the height of summer. ■



A comprehensive catalogue

The range of products and services that Sandvik Mining and Rock Technology supplies is broad, addressing your needs across a variety of applications. And with offices in 130 countries around the world, you can reach us day or night, 365 days a year.

ENVIRONMENT, HEALTH AND SAFETY (EHS)

Stay safe. Our objective is to eliminate harm to people and the environment. EHS is a fundamental consideration in all Sandvik operations, especially product development. Our ambition is to provide the safest products on the market. From our emission-reducing Compressor Management System for surface drills to fire protection, our products are designed to minimize environmental impact and reduce health and safety risks in your operations.



GENUINE PARTS AND SERVICES

Prioritizing uptime. In an industry where an hour of downtime can cost thousands, Sandvik 365 parts and services can save you millions, with round-the-clock service, qualified engineers and genuine parts on demand. When you can predict your productivity, you predict profitability. We not only supply industry-leading mining and construction equipment, our comprehensive aftermarket offering includes service solutions to add even more value to your operation, and genuine parts to extend your equipment lifetime.



SURFACE DRILLING

Power and precision. Sandvik surface drilling equipment is renowned for durability, reliability and productivity. For decades, our surface top hammer, surface down-the-hole and dimensional stone drilling rigs have delivered low total cost of ownership in quarrying, opencast mining and construction applications. We specialize in engineering surface drilling equipment that marries power and precision while improving operator safety and productivity.



UNDERGROUND DRILLING

Know the drill. Sandvik underground drill rigs are engineered to maximize your productivity in mining and tunnelling applications. Equipped with high-performance hydraulic rock drills, they are ergonomic, efficient and reliable. Every underground drill rig and rock drill we engineer is designed to deliver you the lowest possible cost per metre drilled and a low life-cycle cost. Our drills range from robust, simple rigs to automated units that deliver extraordinary production rates.



CONTINUOUS MINING AND TUNNELLING

Always advancing.

Sandvik continuous mining and tunnelling equipment reflects the unique advantages of total in-house control over the equipment and cutting tools alike. Optimized cutting technology and machine design result in high productivity, long service life and low total costs.



LOADING AND HAULING

Reliable loaders and trucks.

Sandvik underground loaders and haul trucks are engineered for safety, productivity and reliability in the toughest of applications. Rugged, compact and highly manoeuvrable, the ergonomic products offer enormous capacity for their size and return a very low cost per tonne.



CRUSHING AND SCREENING

Maximum size reduction.

Sandvik crushing and screening solutions are engineered for productivity in mines, quarries and civil engineering projects. We offer advanced solutions for any size-reduction challenge, stationary or mobile. We can upgrade existing plants, deliver complete solutions and effect turnkey installations. We also supply individual crushers and screens, as well as key components and consumables. Whether you're crushing tonnes of hard rock or producing several sized aggregates with our mobile screens, our solutions deliver the robustness and versatility you need.



BREAKING

Hit harder.

Sandvik breakers and demolition tools make short work of difficult jobs. They are optimized to deliver high-impact cutting or crushing forces, with high power-to-weight ratios, easy interfaces and simple connections. Whether you're looking for breaker booms for your crushing applications or hydraulic breakers for your demolition projects, we have the precision tools and equipment you need to get the job done efficiently.



MINE AUTOMATION

Complete control.

The AutoMine family covers all aspects of automation, from single equipment to full fleet control. In the safety and comfort of a control room, operators can simultaneously control and monitor the movements of a fleet of driverless loaders, trucks or drill rigs. By adding remote monitoring and process management capabilities, supervisors are able to directly communicate with equipment and operators from wherever they are working.

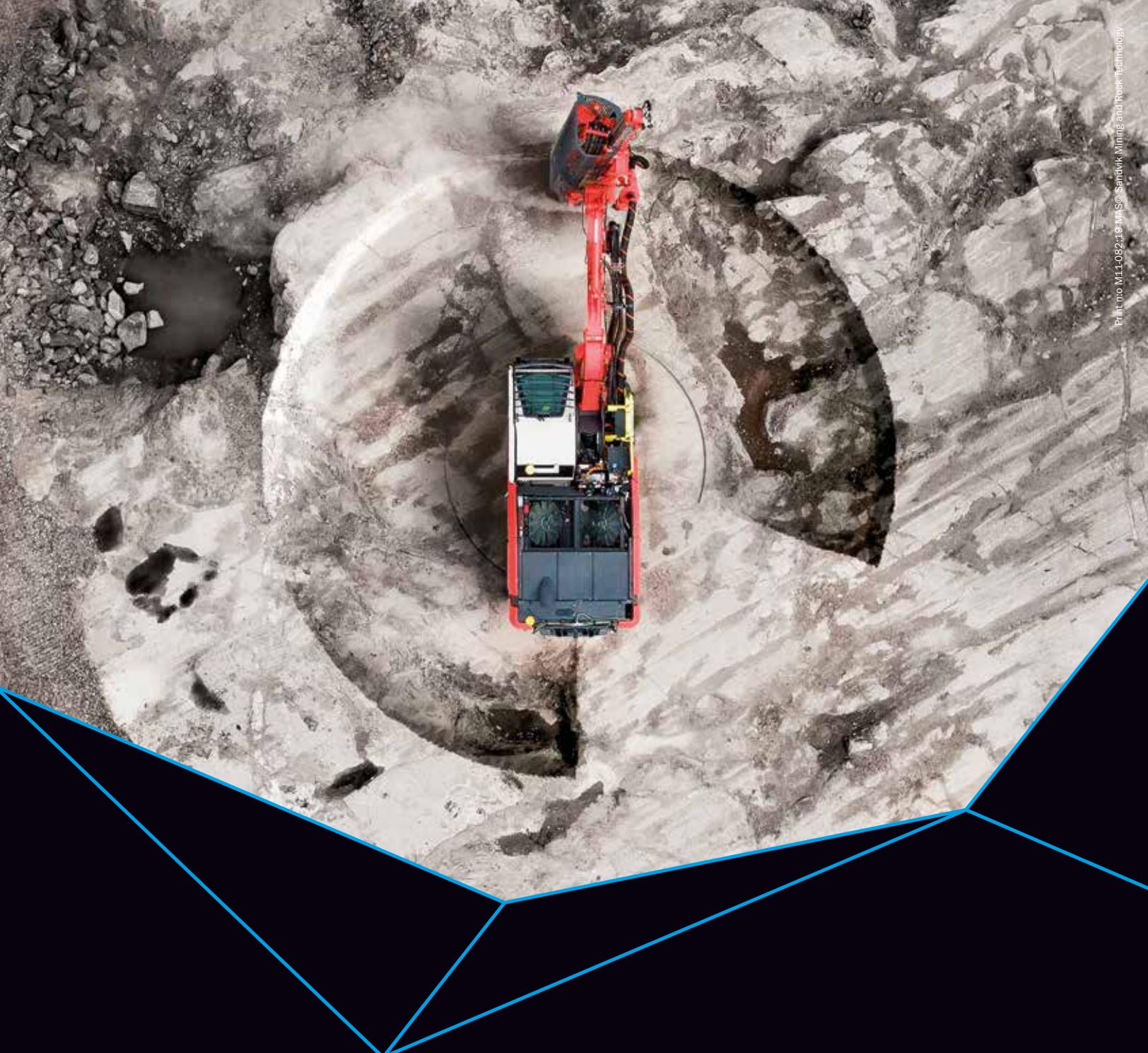


ROCK TOOLS AND SYSTEMS

Deep impact.

Sandvik offers the world's most comprehensive range of tools for exploration, rock drilling, raise boring, coal cutting, mineral mining, tunnelling, trenching, road grading and cold planing. As world leaders in steel and cemented carbide technology, our products have revolutionized the rock drilling industry, while our advanced tool systems for mining equipment raise productivity sharply.





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TAKE A BIGGER PIECE OF THE PIE

Our new Ranger DXi is the most powerful and efficient top hammer drill rig in its class. It offers an enormous drilling coverage of 55 square metres, and features the most powerful new rock drill, Sandvik-style intelligence and unprecedented fuel efficiency. With all these qualities, it is a true representative of the new revolutionary generation of the Ranger product family.

ROCKTECHNOLOGY.SANDVIK

