

SOLID

#2.2013

GROUND

A MAGAZINE FROM SANDVIK MINING

◆ Inside the Chelopech copper-gold mine in Bulgaria.

Intelligence:
Future skill
demands

BULGARIA:
Cutting-edge techniques

MODERN TIMES

Pantera:
TOTALLY
DEDICATED

TH Trucks: Productive power Zambia: Deep expansion



Dear reader,

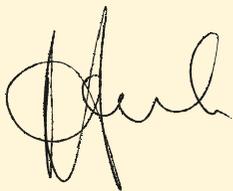
SANDVIK IS NEVER content to sit back. We recognize that current market conditions call for ever-increasing productivity and cost-efficiency, so please read on to find out about all the exciting things that you require – and more besides.

We're always looking for new, innovative ways to serve our customers, and one of the latest introductions is a digital offering guide for iPad and Android tablets, providing a comprehensive reference guide to our product and service offering, wherever you are and whenever you need it. In the same way, the recently launched Minestories.com acts as a single source of news for digital content about our industry's people, products, trends and technology.

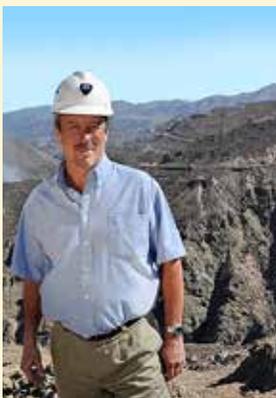
Of course, none of these innovations and enhancements distract us from our real focus, and that's on delivering the industry's most complete range of products and solutions.

YOU'LL FIND EXAMPLES of the latest developments inside this magazine, including the new Pantera DTH and TH drills. The latter are equipped with a unique tools concept for hole diameters between 152 and 178 millimetres – a range currently unmatched among global equipment suppliers. There's also news of the Sandvik TH551 and TH663, two new models of articulated underground dump trucks that take our commitment to safety and productivity to a whole new level.

The products themselves only take us so far. The mining industry also requires people, and the highly mechanized mines of the future will call for even greater levels of skills and expertise. Sandvik is working hard to address that need, through its apprenticeship programme and Mine Academy.



Gary Hughes
President
Sandvik Mining



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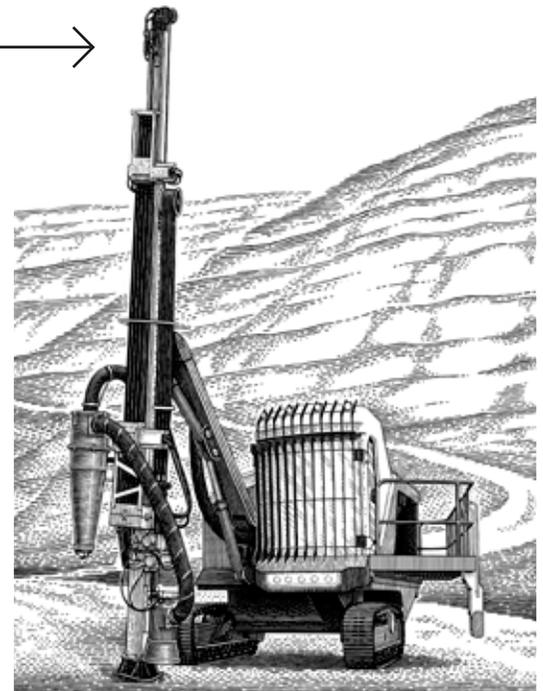
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Storytelling portal in a new suit

● Minestories.com, Sandvik Mining's redeveloped storytelling portal, is a single source for digital content about the industry's people, products, trends and technology.

The content hub, formerly located at solidgroundmagazine.com, has been redesigned. Video, photo and text material is attractively presented and easy to find and share through social media, whether you're on a computer or browsing from a mobile device. Brand new is the feature that lets you create your own newsletter.



INDIAN COAL EXPERT SPONSORED

● N.C. Jha, former chairman of Coal India Ltd, became the first Sandvik chair professor at the Indian School of Mines (ISM) in May.

Sandvik Asia is sponsoring the chair professor at ISM at Dhanbad in Jharkhand. In addition to academic tasks, Jha's role will include industry-institute interaction and R&D activities. A postgraduate in mining engineering from ISM, Jha has had three decades of varied coal industry experience.

Sandvik President and CEO Olof Faxander formally instituted the chair while the Sandvik Group executive management team was in India for a series of events focusing on company growth in the Asian country, an emerging mining market that holds great potential.

Soumitra Banerjee, president of the mining division of Sandvik Asia, says the company anticipates threefold growth by 2015 in the segments in which it is present. He says Sandvik has planned major expansion for its R&D centre in Bangalore, including the addition of 250 engineers over the next three years.

Olof Faxander (left) congratulates N.C. Jha.



The programme on HIV/AIDS has extended into the community.

GETTY IMAGES

Zimbabwe health effort honoured

● The Zimbabwe National Chamber of Commerce recognized Sandvik Zimbabwe earlier this year for its wellness programme. Sandvik was runner-up in the category of Best Corporate Social Responsibility (HIV/AIDS).

The company has partnered with the Swedish Workplace HIV/AIDS Programme since 2005 to form an AIDS awareness and testing programme that has extended beyond Sandvik and into the community.

Over the years, Sandvik has expanded the programme into a comprehensive wellness programme to manage and treat other ailments, ranging from high blood pressure to tuberculosis. Sandvik supports the cost of medication and necessary treatments for employees diagnosed with a manageable disease.

100

The number of Sandvik DR500 series drills manufactured and sold in less than two years. Sandvik celebrated the milestone at its Canning Vale, Australia, facility in May.

Dolled-up design highlights safety

● Sandvik DE712, the latest in the company's range of DE700 surface exploration drill rigs, meets the necessary safety, health and environmental requirements for CE certification in the European Union and is aligned with other internationally recognized safety standards.

The heavy-duty core drilling rig, based on a proven design, also has lower emission levels than its predecessors.

As part of the company's ongoing cooperation with Earth Moving Equipment Safety Round Table (EMESRT) members, the company already has an EMESRT Design Evaluation for Earth Moving Equipment Procurement process in place for DE712.

+ Sandvik DE712 operator compartment is roll over protection structure (ROPS) certified.



Major materials handling equipment order

Sandvik stackers are being delivered to Australia. Shown here: stackers at the Khumani mine in South Africa.

● Sandvik will continue executing major materials handling contracts in South America and Australia until 2015. A surface mine in South America will benefit from an 8.9-kilometre conveying system comprising two iron ore transfer conveyors with capacities

up to 28,500 tonnes per hour and two 9,500-tonne capacity waste conveyor lines. The Australian contracts include design, supply and delivery of materials handling equipment for iron ore stacking at peak rates of more than 11,500 tonnes per hour.

MANS BERG

THE QUOTE

“CUBEX’s knowledge of the ITH drilling method complements Sandvik’s already extensive offering.”

Gary Hughes, president, Sandvik Mining, on the signed agreement with Canadian Cubex Limited to acquire its drilling solutions business and operations.

Get the digital offering app!

● Sandvik Mining launched a tablet application that combines its diverse portfolio of innovative products and solutions into one convenient and easy-to-use resource. The Sandvik Mining Offering Guide for iPad and Android tablets gives mining companies a comprehensive digital reference guide to the company’s range of equipment and services on the go.

“Our aim is to be able to serve our customers’ needs at a moment’s notice, regardless of location, time zone or challenge,” says Jeanette Svensson, marketing communications manager at Sandvik Mining.



Digital offering app for tablets.

Record breaking safety record



● In August, Sandvik Mining achieved a full year with no lost-time injuries (LTIs) for the company’s entire APAC market area. APAC covers Australia, New Zealand, China, India, South East Asia, Mongolia and Indonesia, and includes more than 2,800 employees working across a wide range of locations and conditions, including many mining sites across the market area. “This remarkable achievement reflects the commitment, behaviours and culture of a workforce that values safety first,” says Stuart Evans, global head of EHS at Sandvik.

BACK TO SCHOOL AT THE MINE ACADEMY

● Delft University of Technology in the Netherlands held the first three-day Mine Academy 2 exploration training course exclusively for Sandvik in May. More than a dozen Sandvik exploration employees from Australia attended the inaugural course at Holland’s largest and oldest public technical university, facilitated by Mike Buxton, an associate professor of resource engineering.

Buxton, who has held senior geology and exploration positions with some of the largest Sandvik customers, shared his knowledge of mining companies’ exploration strategies and how they go about finding new ore deposits. Participants returned home with a better understanding of what drives Sandvik customers in exploration. The university plans to present more mine academy courses for Sandvik globally in the future.



Delft University of Technology has been providing technical education for 165 years.

**ABOUT
TRACY NEWINGTON**

POSITION: Supervisor MEM projects and overhauls, Rio Tinto Yandicoogina iron mine, Australia.

RESIDENCE: Perth, Australia

FAMILY: Husband Darren and their three dogs.

CAREER: Started as a diesel mechanic, before shifting up a notch when she joined Sandvik as a service technician in 2003. In September 2012 she moved to Rio Tinto for her current post.

Described as "Rio Tinto's First Mine of the Future", Yandicoogina is an open pit mining operation that commenced production in 1998. One pit is already run on a fully autonomous basis with 10 driverless trucks operating around the clock.

ALWAYS ON THE MOVE

FOR MOST PEOPLE working 9 to 5, their commute involves hopping on a train or driving a car. But Tracy Newington, supervisor of mobile equipment maintenance (MEM) projects and overhauls at the Rio Tinto Yandicoogina iron mine in Australia, takes commuting to a new level by jetting every week or so between her home in Perth and the mine some 1,500 kilometres to the north.

YOU'RE CERTAINLY NO STRANGER TO MINING SITES, ARE YOU?

"I've worked on many remote mine sites all over Australia. Since completing my heavy diesel mechanical apprenticeship in 1993, I've spent all my working life in the Australian mining and construction industry."

WHAT DOES THE JOB OF SUPERVISOR OF MEM PROJECTS AND OVERHAULS ENTAIL?

"I help ensure that rebuilds on heavy mobile equipment and general project activities are carried out in a safe and efficient way on a variety of mining and workshop equipment."

WHAT ARE THE BIGGEST CHALLENGES YOU FACE?

"I guess the biggest challenge is the size of Australia. Managing logistics across the continent can be daunting at times."

HOW'S THE WORKING RELATIONSHIP WITH SANDVIK?

"I get fantastic support for underground equipment from Sandvik National Product Support Team and the Canning Vale Facility in Perth, West Australia, for parts, training and product advice."



Trillion-dollar ticket?

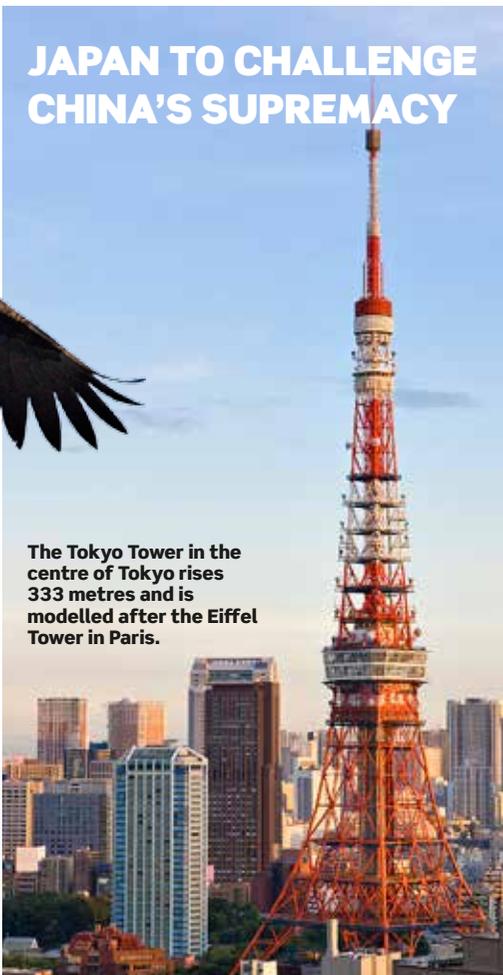
- American Mint, a Pennsylvania coin and memorabilia dealer, debuted a trial pattern for a US trillion-dollar platinum coin earlier this year. The issuance of such a coin has been advanced as a way to address the issue of America's debt ceiling, a limit on the government's borrowing authority. The country's Treasury Department has special discretion to mint platinum coins in any denomination.

Mali to boost gold

- Mali hopes to double its gold output over the next five years to 100 tonnes — more than 3.5 million ounces. Africa's third-largest gold producer plans to reach 57 tonnes this year after a 50-tonne output in 2012. Malian mines minister Amadou Baba Sy said in London in June that the country plans to support smaller miners to help expand production. Mali expects more than a dozen new mining operations to move into production within the next five years.



JAPAN TO CHALLENGE CHINA'S SUPREMACY

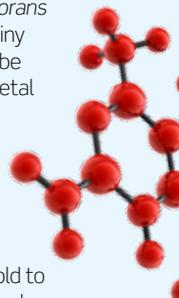


The Tokyo Tower in the centre of Tokyo rises 333 metres and is modelled after the Eiffel Tower in Paris.

- Scientists from Japan's Marine-Earth Science Agency and the University of Tokyo have discovered a massive deposit of rare earth elements in the Pacific Ocean that could produce materials up to 30 times more concentrated than those that come from China. While China is responsible for more than 95 percent of the global supply, Japan consumes half of the world's rare earth minerals in its electronic equipment and green-energy technologies. The scientists say deep-sea mud rich in rare earths is distributed in vast quantities throughout much of the Pacific. Some estimates say Japan will have access to 6.8 million tonnes of rare earths in its exclusive economic zone around the island of Minami-Torishima — equivalent to more than two centuries of current local demand.

Gold-mining bacterium discovered

- A biochemistry team from McMaster University in Ontario, Canada, discovered a species of bacterium that can turn water-soluble gold into its solid form. A molecule in *Delftia acidovorans* that extracts and condenses tiny pieces of gold could someday be used to collect the precious metal from mine waste piles. The researchers observed *Delftia acidovorans* on the surface of solid gold and investigated the connection, learning that the microorganisms convert the gold to nanoparticles to protect themselves from the metal's toxic soluble form.



Optimism in Mexico

- Mario Alfonso Cantu, mining coordinator at Mexico's economy ministry, says mining investment in the gold- and silver-rich country could top 25 billion US dollars by 2018 and is likely to surpass the 2012 record high of 7.65 billion dollars by the end of this year.

Zambian surge

- Zambia's mining industry is expected to grow to 1.35 billion US dollars by 2015 from 590 million dollars in 2010. The Zambia Extractive Industry Transparency Initiative (ZEITI) 2010 summary reconciliation report says the industry contributed around 11 percent to the country's GDP in 2010, a number that is forecast to balloon to around 50 percent by 2015. Copper exports accounted for almost 80 percent of Zambia's 2010 merchandise exports, according to ZEITI.



\$150,000,000,000

Australian mining companies' potential investment in Latin America over the next decade, according to Foreign Affairs Minister Bob Carr at the Paydirt 2013 Latin America Down Under mining conference in Sydney.

Finland tops mine ranking

● Finland, Sweden and a Canadian province ranked top three among the world's top 10 mining destinations in the Fraser Institute's Annual Survey of Mining Companies.

1. Finland
2. Sweden
3. Alberta
4. New Brunswick
5. Wyoming
6. Ireland
7. Nevada
8. The Yukon
9. Utah
10. Norway



Copper and zinc boost in Peru

● Peru's Mines and Energy Ministry expects mining investments in the country to continue increasing through 2014.

The world's third-largest producer of copper and zinc was forecast to boost its metals export revenue by 20 percent to 30 billion US dollars in 2013, and earlier this year the government projected investments for 2013 and 2014 to total 19.5 billion dollars as companies develop new mines or increase output through expansion projects.

Deputy Mining Minister Guillermo Shinno expects investment in new mines to more than double Peru's annual copper output from 1.3 million tonnes in 2012 to 2.8 million tonnes by 2016.



Peru is the world's third-largest copper and zinc producer.

Fiji is located in the South Pacific Ocean, and the land contains an abundance of minerals.



Diamond domination

● New research has hinted at the possibility of a diamond seam in the south-eastern region of India, according to the Deccan Chronicle.

This could make the country the world leader in the diamond market in the near future.

Earlier studies had suggested that the Indian lithosphere is thin, but the work of the scientists involved in the study suggests otherwise.

The team has found a 200,000-square-kilometre area with kimberlites and other kinds of rocks that are likely indicators of the presence of precious gems.

Kimberlites and lamproites are extremely difficult to locate, but the method could be the quickest and most cost-effective for diamond exploration.

The Indian scientists claim to have found a new, cost-effective and quick search tool, using earthquake data, for identifying regions where diamonds could potentially occur.



Skill chase for expanding industry

● To meet the skilled labour demand of Fiji's growing mining industry, the Fiji Higher Education Commission (FHEC) announced in April it will soon offer mining courses for locals interested in working in the sector.

FHEC qualification manager Eci Naisele says the national qualification for mining that the government is developing will be based on international standards of major mining countries including Australia and South Africa.



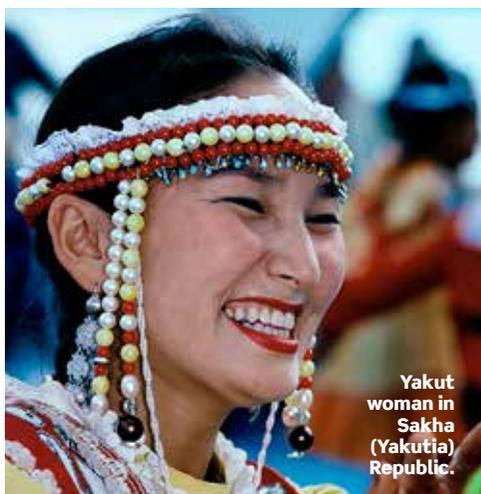
Small-scale fault systems have a strong correlation with the location of gold.

Gold's at fault

● A study of Western Australia's St Ives Goldfields reveals a strong correlation between small fault lines and the location of gold deposits.

Geological fault lines within the Earth's crust resulting from plate tectonics control all major gold deposits, but small systems are most likely to reveal the commodity.

The geological information can be used to develop predictive mineral maps, says Carsten Laukamp, a researcher from the Commonwealth Scientific and Industrial Research Organisation, Australia's national science agency.



GETTY IMAGES

Yakut woman in Sakha (Yakutia) Republic.

Remote rare earths

● ICT Group and state-owned corporation Rostec have reached a 1 billion US dollar deal to develop the Tomtor rare earths deposit in the Russian Far East.

Tomtor in the remote Sakha (Yakutia) Republic could be one of the largest undeveloped rare earths deposits in the world, with 154 million tonnes of ore containing 6.71 percent niobium oxide, 0.6 percent yttrium, 0.048 percent scandium and 9.53 percent terbium.

ICT-Rostec will also take control of 82,000 tonnes of warehoused rare-earth-containing monazite concentrate. Construction of a processing plant is expected to be complete by 2017.

THE QUOTE

“There’s more gold in a pound of electronics than a pound of gold ore.”



— Ken Beyer, CEO of electronics recycler Cloud Blue. According to the consulting group 911 Metallurgist, an iPhone 5 holds 13 times more copper and 324 times more gold than the equivalent amount of ore from the average mine.

Enticing space rocks

Asteroids containing rare earths have become attractive mining prospects.

● As private companies prepare for a developing space mining industry, the US space agency NASA announced in August it plans to launch a spacecraft in 2016 in an effort to pave the way for future asteroid mining expeditions.

“The mission will be a proof-of-concept — can you go to an asteroid, get material and bring it back to Earth?” says Dante LaRetta of the University of Arizona in Tucson, principal investigator of NASA’s mission.

The spacecraft will travel through the solar system for two years and begin a yearlong study of asteroid Bennu, which has an average diameter of around 500 metres. After studying the asteroid for a year, the spacecraft will return to Earth with a surface sample for further scientific study.

“Next, people will have to industrialize it so that the economy works out, so for the recoverable value in any given asteroid, you’re spending half that to bring it back,” LaRetta says.

The Expert

SARA SEAGER is an astrophysicist and planetary scientist at the Massachusetts Institute of Technology (MIT) whose research focuses on exoplanets. She is involved in the MIT-Harvard REXIS instrument on NASA’s OSIRIS-REx asteroid sample return mission.

Q: What are the most alluring space mining targets?

A: Asteroids are valuable for mining because metals of interest should be right under the surface. In contrast, on Earth, most of the heavy elements have sunk deep inside in a process called planetary differentiation, which occurs during an early hot phase under the planet’s gravity. Moreover, asteroids have low gravity, making them easier to land and take off from as compared to moons and planets. Asteroids are numerous, with nearly 10,000 designated as “near Earth asteroids”.

Q: Why are companies looking at asteroids as sources of metals?

A: The sheer amount of useful material in an asteroid, including iron, nickel, sulphur and platinum group metals, is compelling enough to motivate asteroid mining. One of the most interesting valuations is that one platinum-rich asteroid 500 metres in diameter actually has as much platinum in it as has been mined in the history of mining.

Q: Do you envision space mining as a booming industry someday?

A: With two asteroid mining companies now in the running, billionaire backers, intermediate self-sustaining business plans and a nearly unprecedented enthusiasm in the asteroid mining workforce and at large — all at a time when much of the technology maturity is present or within reach — asteroid mining will become a successful industry in the coming decades.



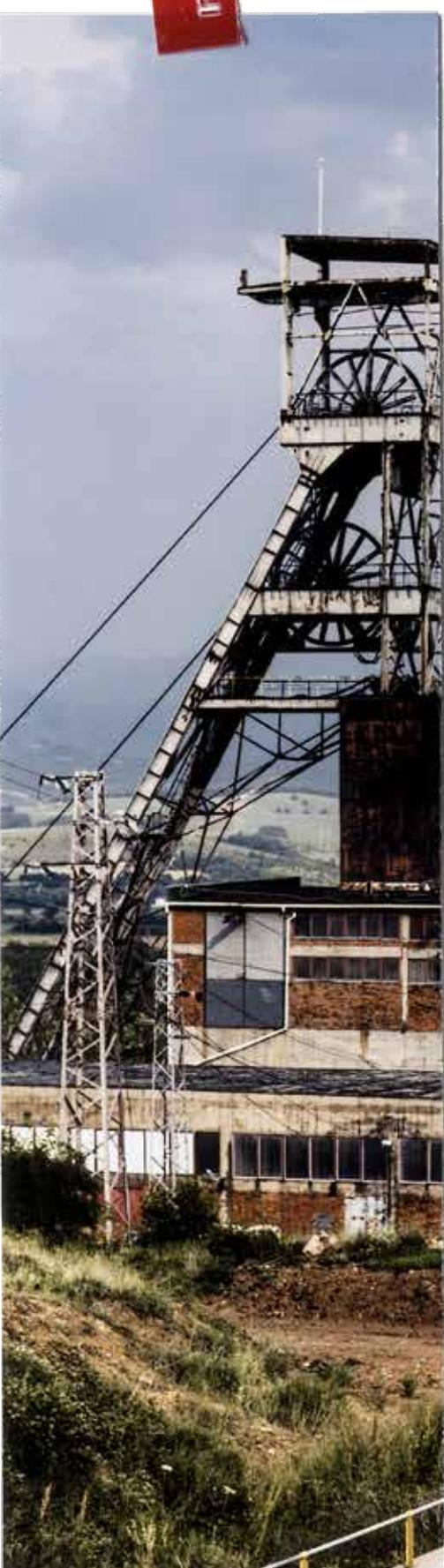
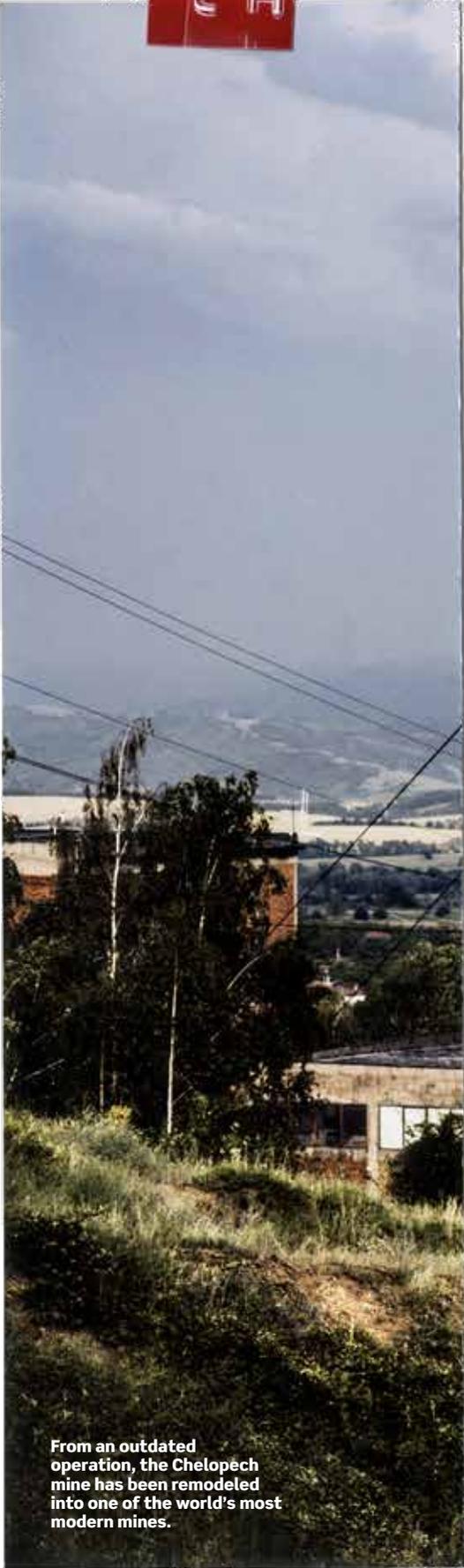
For more with Seager, visit minestories.com.

CHELOPECH MINE

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From an outdated operation, the Chelopech mine has been remodeled into one of the world's most modern mines.



WHERE NATURE MEETS HEAVY INDUSTRY

■ **CHELOPECH, BULGARIA.** In less than 10 years, an old-fashioned mine in the heart of Bulgaria has been transformed from an unprofitable health and safety hazard to a state-of-the-art underground operation. Since then, it has tripled its output as part of a modernization programme based on the latest technology and processes.

Text: **ALANNAH EAMES**

Photo: **ADAM LACH**



Nikolay Hristov, general manager at the Chelopech mine, is satisfied with the fact that it is one of the world's most modern mines, and that he now has more connections in the global mining industry.

“Our mine was years behind time, and we had to bring it back to reality.”



The goal to reach a capacity of 2 million tonnes per year has been achieved.

It looks like a picture postcard. Sheltered by the Balkan mountain range, the Chelopech copper-gold mine is tucked into a lush green valley surrounded by gently rolling hills and forests and overlooking a small lake. At the entrance are manicured gardens, with no trace of belching smoke and minimal noise. Health and safety procedures have been rigorously enforced. Employees earn double the average Bulgarian salary, and rusty equipment has been replaced by cutting-edge technology.

The transformation began when Canada-based Dundee Precious Metals Inc (DPM) purchased the mine in 2003. DPM wanted to improve efficiency and turn it into one of the most modern

mines in the world, ramping up annual ore production to 2 million tonnes.

“As a relatively small player in the mining world, Dundee Precious Metals’ management believed you had to be innovative and find ways to do business better than the others,” says Nikolay Hristov, the mine’s general manager. “We said at Chelopech that we would do everything possible to succeed.”

The transformation plans were complicated by the administrative challenge of operating in a country burdened by the legacy of rules from the previous regime and changes brought about by Bulgaria’s entry into the European Union in 2007. On the operational side, the relatively high arsenic content in the Chelopech copper concentrate made it challenging to find a market. Since 2010, the concentrate has been shipped to DPM’s smelter in Namibia for further treatment.

To start with, the transformation team looked at the latest technology on the market and how it could be adapted to the underground environment. Real-time reporting and technology would optimize operations.

To enable this, the first step was to

2 million

tonnes per year is the production capacity of the Chelopech mine.

install a wireless network throughout the mine. Starting in 2009, it now became possible to track the location of people and vehicles, increasing safety and efficiency.

“From this point on we could look at connecting machines, people, voice communication and data transfer,” Hristov recalls.

“This is where Sandvik kicked in alongside other partners,” he says. “We had a great vision. However, to make it happen we needed partners with the same appetite for challenges and taste for efficiency. Sandvik helped us to conduct audits to benchmark ourselves ▶▶

Chelopech is located in the heart of Bulgaria, in eastern Europe.



BULGARIA'S MINING INDUSTRY

- Mineral exploration and mining were important under the communist government in Bulgaria, resulting in a well-qualified labour force. However, Bulgaria’s mining industry has declined since then. Many deposits are underdeveloped due to a lack of modern equipment and low funding. The industry is estimated to be worth around USD 760 million and employs around 120,000 people, making it one of Bulgaria’s most important sources of export earnings and a significant contributor to economic growth.

Bulgaria has deposits of iron, manganese, ore, coal, lead, zinc and gold. Several of Bulgaria’s minerals are extracted commercially, and 80 percent of the mining is done by open-pit excavation.



To compensate for the increased output capacity of 2 million tonnes per year, an underground Sandvik crusher has been installed. ▶▶



The cutting-edge equipment provides safety and comfort for the operators.



► against others and to identify the needs of a modern mine.

“Our mine was years behind time, and we had to bring it back to reality. That meant everything – the reliability and utilization of the machines, optimization of our processes and communication, which can be challenging as the mining industry tends to work in silos.”

The next issue was to change the mindset about planning. “We had to convince everyone that it is possible for a mine to plan and schedule



Vesselin Kandarshev, territory manager, Sandvik.

“I prefer this way of working. It’s much less paperwork.”

everything down to the task level,” he says.

The previous materials-handling system was unable – and too old – to handle the increased output. A new underground crushing system was installed in 2012 to handle 2 million tonnes of material per year. A four-kilometre-long conveyor belt running along the Chelopech mine’s second decline to carry the crushed material to the surface was added the same year. Both were supplied by Sandvik.

Driving down the two-kilometre-long ramp into the mine, it’s clear what DPM’s CEO Rick Howes meant when he said the company was “taking the lid off” by making operations in underground mines as visible and well controlled as those in open-pit mines. Most of the underground mine is a wireless secured area, and the modern, remote-controlled ventilation provides a good work environment. The cutting-edge equipment provides safety and comfort for the operators, and everything is clearly marked, making the mine look like a model of good housekeeping.

Chelopech’s management realized that it couldn’t achieve its dreams alone. “I believe in partnership,” says Hristov. “You want to be able to say to your partner, ‘Look, this is my problem’ and be heard. Sandvik believed in our vision and wanted to help us. We really appreciated that.”

As Sandvik already supplied all the vehicles used in the mine, equipping them with OptiMine and InSite (from its partner Geovia) was a logical next step.

Truck operator Georgi Slavchev has worked at the Chelopech mine for 10 years, and he says his job is better since the introduction of the new software. “I prefer this way of working,” he says. “It’s much less paperwork.”

Instead of keeping track of his work on paper and handing it over at the end of his shift, he now simply logs on to the system in his truck, completes his tasks electronically in real time – the results are instantly fed to the control room upstairs – and logs off seven hours later.

Georgi Atanasov, the mine’s underground mobile equipment supervisor, has worked for both Chelopech and Sandvik. He says his major task, and challenge, is to avoid maintenance surprises and improve the allocation of regular maintenance activities.

“With OptiMine we can check the technical condition of the equipment,” he says. “For example, overheating is a common problem, so we get an alert, which means we can troubleshoot and solve the problem before it escalates.”

Integrating the systems was important. “We integrated the relevant systems so that the right information gets to the right people at the right



Anna Ivanova, director of business systems at Dundee Precious Metals, has integrated the relevant systems.



The automated system checks the technical condition of the equipment and gives an alert directly so that any problem can be solved at once, meaning less downtime.



time,” says Anna Ivanova, director of business systems for Dundee Precious Metals. “We really got down to the processes, incorporated them into systems and made the systems work together.”

Besides offering round-the-clock support, sharing best practices is important in an often conservative industry like mining.

“Sandvik leverages on the fact that they are a global supplier, and via their networks and forums they put us in contact with other people in the global mining industry,” Hristov says. “Through their forum we visited automated mines in Scandinavia, which helped us piece by piece to visualize how things work in different ways.”

The experience at Chelopech has benefited both parties.

“It’s always nice to have this kind of mine as a partner,” says Taina Heimonen, business development manager for mine automation at Sandvik. “It’s more than just a normal business relationship as we share the same vision and passion to see how we can take that extra mile together. I believe some of the best practices here will certainly be taken further.”

Vesselin Kandarashev, Sandvik territory manager for South EU, agrees. “Customers like this are important for Sandvik as we share the same journey in innovation wanting to be pioneers.”

Today, Chelopech is a reformed mine. Water usage in operations has been reduced by 60 percent. CO₂ emissions have been decreased by reducing transport journeys and putting the crusher underground, compensating for the increased production output.

Modernizing the mine and process plant has decreased the volume of waste on the surface by 30 percent, reduced electricity consumption by 25 percent and cut fuel usage by up to 70 percent. The railway line is currently being upgraded to eliminate truck transport.

What’s the next step? “It’s difficult to read the future, as I don’t know what challenges tomorrow will bring,” Hristov says. “But let’s just say that we are not done yet. We got to 2 million tonnes of ore per year, and nobody believed we could reach that. Now we need to continue on this basis for the mine’s life and find new ways to

60%

The reduction in the amount of water used in operations since the new equipment has come into use.

squeeze more efficiency out of the process.”

Back outside in the warm sunshine, three vintage Sandvik vehicles are parked alongside two brand new Sandvik loaders that will soon go into operation. Out with the old and in with the new as the journey at Chelopech continues. ■



See a video about Chelopech at www.minestories.com

About Chelopech

● **Location:** 70 kilometres east of Sofia, Bulgaria, on the main route between Sofia and the Black Sea port of Burgas.

Operations: Underground mine extracting copper-gold ore. The copper concentrate, which also contains gold and silver, is transported by truck and rail to Burgas for shipment to the Tsumeb smelter in Namibia for further treatment. A gold-in-pyrite recovery project is currently under way to improve the recovery level in the mined ore.

Size: Production ramped up from 550,000 tonnes in 2003 to more than 1,800,000 tonnes in 2012.

Owner: Canada-based Dundee Precious Metals (DPM) Inc. DPM also owns the Kapan gold, copper, zinc and silver mine in southern Armenia and the Tsumeb concentrate processing facility in Namibia, and it has an



exploratory project at Krumovgrad in south-eastern Bulgaria.

History: Started extracting copper in 1954; purchased by DPM in 2003. Embarked on an extensive transformation project in 2004 to turn the mine around. Invested more than 500 million US dollars in the operations and about USD 12 million in the development of the local communities. Sandvik Trans4Mine was part of the transformation process.

Employees: About 1,000.

SANDVIK TH551 AND TH663



New dump trucks:

FURTHER

Sandvik TH551 and TH663 each boast more than 60 safety features.

■ With two new models of articulated underground dump trucks, TH551 and TH663, Sandvik takes its comprehensive approach to safety and productivity to a new level.

Text: ÅKE R MALM Photo: MÅNS BERG



FORWARD



The new dump trucks are designed with focus on safety and uptime.

“The goal is to make sure every single trip the truck makes is a productive one.”

MINNA PIRKKANEN

Sandvik TH551 and TH663 are two new underground dump trucks with first-class operator environments. A reliable design maximizes uptime and tonnes per hour. The first step in the development of the new family members was a reality check.

“We went out to mining companies and listened to their problems in truck usage and hoisting,” says product manager Minna Pirkkanen.

The result is TH551 and TH663, with payloads of 51 and 63 tonnes respectively. They have been designed for optimal interaction with operators, maintenance staff, loaders and the mine

itself. Let’s take a closer look at these areas.

“The comfort and well-being of the operator is very important,” Pirkkanen says. “A happy operator is generally a more productive operator.”

Pirkkanen elaborates on the ergonomic features, which include a safety cabin that is 35 percent larger than on the previous models, fitted with a four-point safety belt and a trainer seat. A vehicle control and management display with all vital information allows operators to keep their eyes on the road. Comfort is provided by a fully adjustable seat and, in another invention on these trucks, a front-frame suspension. The attention to detail includes a cooling box integrated with the climate



Minna Pirkkanen, product manager

control system. This allows the operator to keep food and beverages fresh on board the truck.

“These are just some examples of the cabin’s ergonomics and user-friendliness,” Pirkkanen says. “It is a really nice place to be.”

Safety has been the major focus area during the development of TH551 and TH663. Each has more than 60 safety features to protect the operator, maintenance staff and the truck itself. They include certified cabin roll-over and fall-over protection structures (ROPS and FOPS).

Looking at safety from a maintenance perspective, daily service can be done from ground level to reduce the risk of falling accidents. The design also ►►

Customer case, Mittersill, Austria:

Tungsten on board

Among the first companies to put one of the new Sandvik truck models in action was Wolfram Bergbau und Hütten AG in Mittersill, Austria. Underground mining began there in 1979, and now 500,000 tonnes of Scheelite (CaWO₄) ore per year is extracted in a highly automated

process. The mine opted for a TH551 with a payload of 51 tonnes.

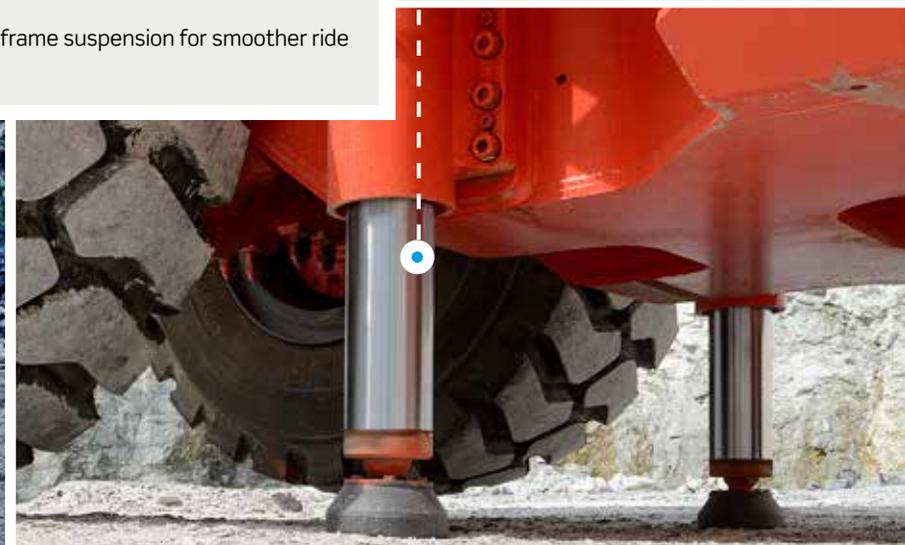
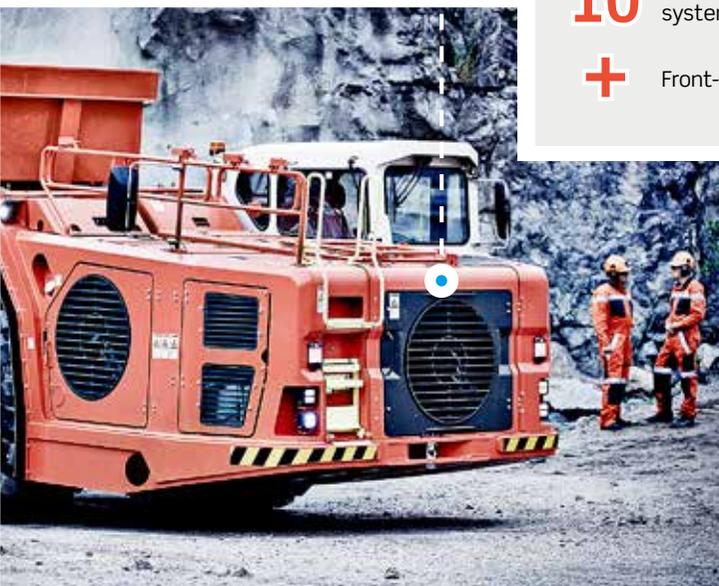
“It is very powerful and very productive,” says mining manager Felix Gaul. “Every mine nowadays has to get more and more productive. This will be the fight of the future, not only for our mine.”





Ten + one reasons for TH-trucks

- 1** Matching LHDs for optimized loading and hauling process
- 2** High capacity, high speed and more uptime for higher productivity
- 3** Ergonomic operator ROPS/FOPS safety cabin with trainer seat
- 4** Integrated Vehicle Control and Management (VCM) system
- 5** Integrated weight measurement and production monitoring system
- 6** Low own weight, resulting in low fuel consumption
- 7** Daily maintenance points accessible from the ground
- 8** Optional tyre-monitoring system
- 9** Tier4i/Stage IIB compliant engine option
- 10** Optional on-board hydraulic jacking system for increased safety.
- +** Front-frame suspension for smoother ride





The envelope sizes are made for 5x5- and 6x6-metre haulage ways.

Manufacturing in high-strength steels is more demanding than in traditional ones. Sandvik relies on long experience and deep metallurgical know-how to take full advantage of the materials. On TH663 the result is three tonnes more in the back, compared with the previous model. But that doesn't help if the extra capacity isn't fully utilized. This is why both trucks have a set of weight indicator lamps on the outside. They tell the operator of the loader when the dump box is empty, almost full, full or overloaded. The latter also makes it possible to protect the trucks from misuse.

"The goal is to make sure every single trip the truck makes is a productive one," says Pirkkanen.

The signals are just one part of an integrated production monitoring system. This is perhaps the most significant productivity-improving feature on the truck. It senses the weight in the dump box and combines that with information about position and shift, for example. Also, the operator can let the system log what is on board the truck, whether ore or overburden.

"When you have many different operations going on in the mine, you're able to track the route of each load," Pirkkanen says. "The whole idea is to measure and optimize the operation." ■

► allows replacement of large components, such as the engine transmission, with a minimum of downtime. One specific area of improvement that came up in the dialogue with the mining companies was punctures.

One of the biggest reasons for downtime and danger was when a hoisting truck going up a ramp fully loaded got a flat tyre," Pirkkanen says. "We were told it could take anything up to three days to repair and move the machine out of the way."

This would stop production completely, and fixing the tyre demanded thorough risk assessment to avoid dangerous situations.

"It is very difficult to jack up such a heavy machine in a confined space with an inclination," says Pirkkanen.

The remedy that TH551 and TH663 offer is an optional on-board jacking system for faster and safer tyre changing. There are two hydraulic jacks in the front and two in the rear, all working independently of one another. Another new feature is a tyre monitoring system that registers pressure and temperature inside in real time. This makes it possible to identify problems before they occur, not least a potentially devastating tyre fire.

Then we come to the trucks' interaction with the mine itself and other mining equipment. To reduce exhaust emissions and the corresponding ventilation requirements, TH551 is the only underground truck available with a Tier 4i/Euro Stage IIIB compli-

35

percent increase in safety cabin size compared to previous models.

ant engine alternative. Looking at the envelope size, they are made for 5x5- and 6x6-metre haulage ways. To make sure the links in the production chain match each other, the dump boxes accommodate precisely three passes by the corresponding Sandvik LH517 and LH621 loaders.

The biggest challenge we had was to increase the payload, because the tyres set a certain limit," Pirkkanen says. "So we had to reduce the overall vehicle weight. What we did was to develop a completely new frame structure in high-strength steels, which allowed us to use less material."

Tech specs

	TH551	TH663
Payload capacity	51,000	63,000 kg
Length	11,570	11,580 mm
Width	3,200	3,480 mm
Height	3,160	3,460 mm
Box range	24 - 30	30 - 38 m ³
Operating weight	41,000	43,000 kg
Total loaded weight	92,000	106,000 kg
Standard engine	Volvo TAD1642VE-B ¹	Cummins QSK 19
Configuration	In-line six	In-line six
Power	515/691 (@ 1,800 rpm)	567/760 (@ 2,100 rpm) kW/hp
Max. speed (loaded)	37.4 (@ 6 th gear)	42.5 (@ 6 th gear) km/h

1) Tier 2. An engine compliant with Tier 4i/Euro Stage IIIB emission standards optional.

Anders Sträng (left) and Anders Jonsson make up half of the Orefields raise boring team.

SUSTAINING SAFETY

Raising awareness

■ Orefields, a newly formed raise boring contractor inside the Arctic Circle in northern Sweden, is building on its backyard success while sustaining a steadfast commitment to safety.

Text: **ERIC GOURLEY** Photo: **HANS UTSI AND ERIC GOURLEY**



Håkan Antonsson exudes an enthusiasm that can't be faked as he highlights the features of his 22-tonne raise borer in a workshop 775 metres below Kirunavaara mountain at LKAB's famed Kiruna mine in Sweden.

Antonsson, an entrepreneur with a background in electrical engineering, had never operated mining machinery of any kind before he founded Orefields in 2010.

"I was performing electrical maintenance on raise borers and became fascinated with them," he says. "I wanted to work with the machines in a different way, and I just had a feeling I could do it better and safer than other companies."

Three years later, Orefields is assembling an impressive resume that includes multiple successes at the world's largest underground iron ore operation, widely considered the world's most modern underground mine.

"We're thinking in a different way, and we're very glad that LKAB has bought into our philosophy," says Anders Jonsson, Orefields' senior supervisor and mechanical superintendent, whose 15 years of raise boring experience span four continents. "Our goal is not to be the biggest raise boring company in the world. Our goal is to have high performance and a high safety standard."

Raise boring was developed to meet underground mining demands, but new

"Our goal is to have high performance and a high safety standard."

applications continue to arise due to its inherent safety benefits and other advantages over conventional drilling and blasting.

The raise boring method enables construction of circular mechanized shafts between two mine levels without the use of explosives. A borer is set up on the upper level and drills a narrow pilot hole, typically between 23 and 35 centimetres, to accommodate a drill string. A reamer head is then attached to the drill from the lower level and raised back towards the machine.

"Raise boring holes have very smooth walls compared to blasted holes, and you rarely need to reinforce them with rock bolts or other ground support," Jonsson says. "You can also raise bore in areas where you couldn't drill and blast."

Not only is raise boring safer than conventional methods, it's also quicker and more economical because it works in a non-cyclic fashion, which facilitates faster advance rates, and because it requires less manpower while leaving less rock behind.

Raise boring can be used for a variety of mining applications, from ore shafts – where ore is tipped directly into crushers – to shafts for ventilation, water or cable installations.

"It's becoming more and more



Håkan Antonsson founded Orefields in 2010.

popular," Jonsson says. "There are no real disadvantages with it."

Almost two years after Antonsson founded the company, and after he and Jonsson had spent many months amassing equipment as small as screwdrivers and as big as the borer itself, Orefields started operations on LKAB's Block 19 in January 2012.

The company bored four inclined ore production shafts about 50 metres long and 2.4 metres wide. LKAB's Mikael Hjortborg oversaw the four-month project.

"Orefields finished the project on time and with very high safety standards," Hjortborg says. "We preach 'safety first' here at LKAB – we're always striving to eliminate accidents – and Orefields shares that vision."

Whether it's careful consideration and analysis of the risks and benefits of moving its massive boring machine or cautious handling of the 1.5-metre drill rods that weigh nearly 500 kilograms each, the Orefields team never loses sight of the importance of safety.

"It's possible to always work safely underground," Antonsson says. "That's our philosophy. Safety is everything in this business."

Orefields operates a TRB Rhino 1298 DC raise bore for its shaft drilling projects. The company also uses

23

Combined years of raise boring experience among Orefields' four-man team, who range in age from 22 to 45.



SANDVIK SOLUTION

Kiruna is home to the world's largest underground iron ore operation.

Big power

- Orefields, a new raise boring contractor based in northern Sweden, operates a TRB Rhino 1298 DC raise borer from TRB Raise Borers OY (CEO Jarko Salo) for its shaft drilling projects. The versatile machine is nearly five and a half metres tall, weighs 22 tonnes with crawler, and packs plenty of power in its mid-sized frame for holes 2.4 to 3.5 metres in diameter.

Sandvik Mining equipment for all boring, from stems and cutters to high-penetration reamer heads that are quick to assemble and highly stable and that boast low torque and maintenance demands.

“When you’re building up a company, it’s very important to not only have a good team surrounding you, but also good suppliers,” Antonsson says. “We have a great partnership with Sandvik.”

Jonsson adds: “I’ve been working with both Sandvik and other leading raise boring suppliers for many years, and Sandvik is my favourite by far. They build very reliable equipment and they deliver fast. If we ever have a problem with something, we just call Göran Strand, their raise boring product line manager, and he solves it. We have great communication and a great relationship, and we appreciate having a partner that shares our safety focus.”

Sandvik reaming heads and cutters are engineered for optimum service life in any rock condition. Strand says the ultimate goal, which is already achieved in many projects, is to enable operators to finish a raise in one pass without ever having to lower the reaming head for service.

“Performing service under or near an open raise can put operators in a vulnerable position, because they can be exposed to falling rocks from the face where the reaming was stopped,” Strand says. “Extended cutter life



Raise boring is cost-effective and improves safety in mines.

A safer alternative

- Raise boring is a safer alternative to the conventional drill and blast method. Once the reamer head is attached to the borer, no personnel need to be in a shaft until spoil removal, eliminating exposure to falling rocks and explosives. Raise boring also disturbs the rock structure less than blasting, so the method can be used safely in geologically sensitive mines.



Mikael Hjortborg oversaw Orefields’ first project on LKAB’s Block 19.

reduces the need for service, in turn making the equipment much safer to use.”

Orefields built a custom operator cabin that features more amenities than many studio apartments. “I can live there for a month at a time,” Antonsson jokes.

The outside of the cabin is fixed with emergency LED lights that activate during any power failure underground. Orefields stores tools and spare parts in a custom shed, and the company emphasizes order and neatness wherever it bores.

“A tidy worksite is a safer worksite, and a more productive one too.”

Orefields has an emergency box for oil spills caused by hydraulic accidents. “But we never grab anything out of the emergency box unless there’s an emergency.”

Another safety initiative that has impressed many mineworkers at LKAB is a lighted, portable “assembly point” sign the Orefields team erects near each worksite.

“We’re always trying to do our best to think in innovative ways. We should be a company always looking into the future.”

A few months after its debut project, Orefields took on a project in Shaft 91 at the Kiruna mine, drilling a single three-metre-wide, 130-metre-long inclined shaft to replace a collapsed ore pass. The company has since completed a multiple-shaft assignment for Swedish engineering company NCC in the Kiruna mine.

In addition to its safety commitment, Orefields also prides itself on precision, averaging less than 1 percent deviation.

Orefields hopes to take its operation global, and the company has started by developing a positive domestic reputation.

“From the beginning, LKAB took a chance signing a contract with a company that at that point didn’t even have a machine,” Antonsson says. “It’s made the success that much sweeter for everybody. We’re so fortunate to have had these opportunities to prove that a small company with the right people can also do these complex raise boring jobs. Our goal has been first and foremost to establish ourselves here locally, and we feel we’re well on our way. We are only starting our journey along this road.” ■



Mikael Hjortborg, Håkan Antonsson and Anders Jonsson share a laugh next to Orefields’ TRB Rhino 1298 DC raise borer in a workshop at LKAB’s Kiruna mine.

Dedicated purely to mining

CORE FOCUS

■ New Pantera is a robust and productive range of trackdrills, designed with the environment, health and safety in mind. The drill platform comes in down-the-hole and top-hammer versions for surface mining.

Text: ÅKE R MALM Illustration: TATA TRIKOZ

With a weight of more than 34 tonnes and a width of three metres, the all-new Pantera trackdrills are built to stand their ground. They're based on a modular design with down-the-hole (DTH) and top-hammer (TH) versions, for blast holes, pre-split and mine development in the four-to-eight-inch segment.

"When we developed the specifications we identified three major stakeholders: the mining companies, the operators and the maintenance staff," says Jan Petzold, vice president,

mining, surface and underground production drilling equipment at Sandvik. "Their needs guided us in everything we did during the design process."

Several things turned up on the short list: productivity, safety, ergonomics, sustainability and automation. The combination was demanding.

"It had to be a machine dedicated to mining and the future needs of the mining industry," Petzold says.

As a result, the Pantera range is completely designed for wall control, pit development and production drilling

in open pit mines. With an industrial designer on the development team, the drills are a stylish addition to any fleet of mining machines.

Pantera drills are available in DTH or TH versions, where the DTH drills blast holes in diameters from 115 to 203 millimetres up to a depth of 45 metres. The TH Pantera handles blast holes in diameters from 152 to 178 millimetres up to a depth of 36 metres.

Looking more closely at the productivity of the Pantera range, much attention has been paid to uptime. This shows in the rugged design and choice ▶▶



Safety and ergonomics are combined to improve performance. Reliable components keep uptime in focus.



Ergonomic operator cabin with automated features.



Easy access to service points.



Longer drill time thanks to fewer rod changes.

“It had to be a machine dedicated to mining and the future needs of the mining industry.”

JAN PETZOLD

of reliable components, but also in the layout of the engine compartment. Inside and outside galleys provide maintenance technicians fast and easy access to service points. With a roof height of 1.8 metres, there is enough space to walk around key systems such as the engine, hydraulics and pneumatics. During operation, however, everything is protected by large covers.

Another productivity-increasing feature is a new feed module. It is fitted with a linear magazine that accommodates up to five drill rods, which are longer than on earlier carousel models.

“This means you can drill longer between the rod changes, which are very time-consuming steps in a drilling operation,” Petzold says.

Safety and ergonomics go together on the Pantera drills. One example is the operator cabin, where a body-integrated canopy constitutes the roll-over and fall-over protection structure (ROPS and FOPS). The cabin is suspended under the canopy, which is certified for the weight of the machine and falling objects.

“This means we are not required to test the cabin itself any longer, and that allows us to use new components and materials,” says project manager Markus Reinikka. “Historically, cabins are made out of steel. We have designed a structure of composite materials and aluminium.”

The cabin is much larger than usual. It is spacious enough for an operator and a trainer to sit comfortably together with a second student when required. The composite material absorbs vibrations and noise better than steel, and offers better insulation against both high and low temperatures. An ergonomic operator interface and drill support system also contribute to improved productivity.

Both the DTH and TH Pantera rigs feature a fuel-efficient 399-kilowatt engine that complies with the latest emission standards. The range of drills is built on the same platform for both drilling methods but uses different types of power packs. The TH Pantera is fitted with a 45-kilowatt hydraulic rock drill,

TECH SPECS NEW PANTERA TRACKDRILLS

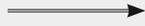
	DI6400 DTH	DP2000 TH	
Hole diameter range	115 – 203	152 – 178	mm
Pipe/rod diameter/length	89 – 140 / 7,500	127 / 6,100	mm
Maximum hole depth	45	36	m
Engine Tier 2 or Tier 4	399	399	kW
Air compressor capacity	28	14	m ³ /min
Air operating pressure	Up to 35	10	bar
Rock drill output power	-	45	kW
Maximum rotation torque	5,000	5,000	Nm
Operating weight	34,000	34,000	kg

FEATURES & BENEFITS

What's in it for me?

Feature: User-friendly layout and man-machine interfaces, including location, access and space around service points

Benefits: Easy access to service points, giving fast and safe maintenance



Feature: Automated functions, including the number of drilling cycle phases and cycle time

Benefits: Maximum operator performance and process control



Feature: Safe and ergonomic cabin and control interface, including layout, visibility, noise level and FOPS/ROPS concept

Benefits: Safe operation and maximum operator performance



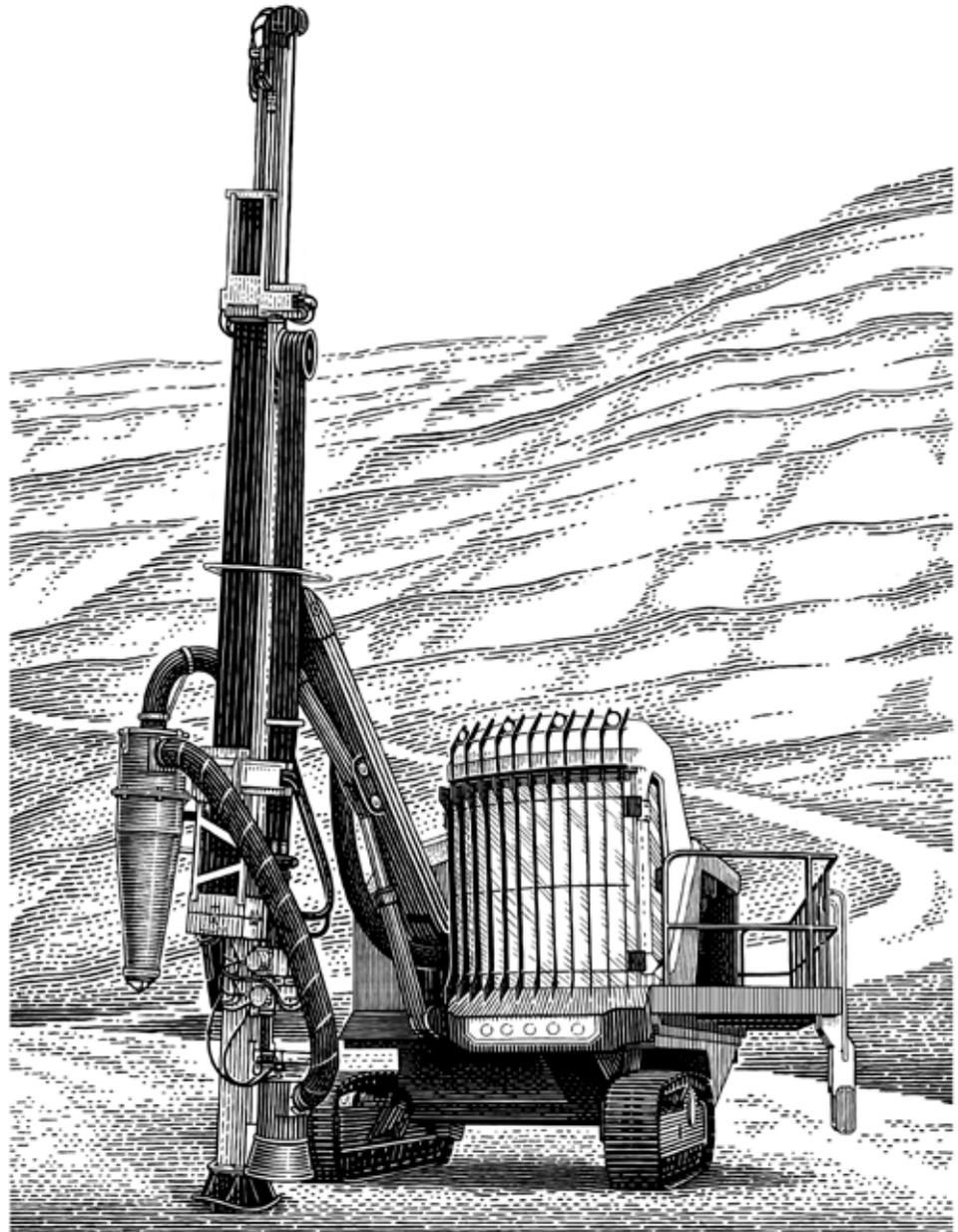
Feature: Optimized power pack alternatives, matching expectations for drill performance and economy

Benefits: High drilling capacity, long service life and minimized operating costs



Feature: Heavy-duty platform, including choice and rating of components

Benefits: High reliability and stability together with long service life



a drilling method with lower energy losses than DTH drilling. There the percussion comes from a pneumatic hammer just behind the drill bit. It is propelled by compressed air fed through the drill rods at a maximum air pressure of 35 bar.

While DTH drilling has higher inherent energy losses than TH, the DTH Pantera comes with a new sustainability package that allows fuel savings of up to 20 percent. The result is a substantial reduction of both costs and emissions, particularly in round-the-

clock mining operations.

With the Pantera range, Sandvik takes operator training to a new level. In addition to the improved conditions in the cabin, the company has developed a simulator for the new drills.

“It means you can train new operators before they actually get on a drill rig,” Petzold says. “This increases safety, reduces the risk of damage and helps to improve the performance of the drill operator.”

A simulator is also a tool to train the trainers and any operators who return from leave with their skills a bit rusty.



Jan Petzold points out that Pantera is dedicated purely to mining.

In addition, the operator of the drill rig is supported by a high level of automation, including single-hole automation, automatic feed alignment and feed positioning. The automation also includes a drill health monitoring system and drill support system, the latter with GPS navigation as an option. It's possible to configure Pantera drills for remote operation.

All versions share the same platform, control system and automation infrastructure, which keeps the cost of training, maintenance and ownership down. ■

METOREX CHIBULUMA COPPER MINE

Sandvik underground trucks have helped the Chibuluma mine increase monthly production to more than 48,000 tonnes of run of mine copper ore.

PROPER COPPER

■ **KALULUSHI, ZAMBIA.** Cap lamps flash along both sides of the decline at Metorex's Chibuluma mine as workers performing ramp upkeep move out of the way to allow a maintenance vehicle to pass.

Text: **ERIC GOURLEY** Photos: **ERIC GOURLEY AND HELGE OLSÉN**

Chibuluma is located in the heart of Zambia's Copperbelt.



Zebras are found throughout Zambia, including in the Copperbelt Province.

C

hibuluma has equipped its underground mobile equipment fleet with anti-collision and proximity detection systems. Cap lamp batteries have also been fitted with transmitter and receiver tags, creating a system that alerts miners and machine operators when they are in close proximity to one another.

It's an exemplary safety initiative at "Zambia's Model Mine", as the welcome sign at the main gate proclaims.

Chibuluma, in the heart of Zambia's historic Copperbelt Province, has persevered through nearly 60 years, and exploration efforts continue to extend the mine's life.

The modern, mechanized operation is only 12 kilometres west of Kitwe, an industrial centre of 500,000 and Zambia's second-largest city behind the capital Lusaka.

The highway from Kitwe to the mine is more paved than many roads in the area and is packed with trucks transporting industrial equipment. A herd of a half-dozen goats roam free along the roadside, which is dotted with stalls brimming with the fruits and vegetables that many young Zambians sell to earn a living.

Metorex, a South African copper and cobalt miner with assets in Zambia and the Democratic Republic of Congo, acquired Chibuluma when the Zambian government privatized the country's copper industry in the late 1990s in the face of slumping commodity prices.

Zambia Consolidated Copper Mines (ZCCM) operated 10 mines, three smelters, two refineries and a tailings

leach plant under nationalization. As copper prices plummeted in the late 1990s, the government sold ZCCM and split it into seven units.

Chibuluma was the first mine to be privatized when a Metorex consortium bought 85 percent of the operation in October 1997. Metorex acquired the consortium members' interests after a reorganization of the company two years later. The Zambian government, as shareholder of ZCCM-IH, retains its 15 percent interest to this day.

Copper and cobalt ore have been extracted at Chibuluma since 1955. Metorex mined the Chibuluma East and West ore bodies until their depletion in 2005. In July of that year, Chibuluma South became the first new underground mine to open in the copper belt in 30 years, and it remains the main operating asset on the property today.



Engineering manager Dyson Galatia has worked at Chibuluma since 2001.

Chibuluma initiated extensive exploration drilling in 2010 that has drastically boosted ore reserves and extended mine life.

The mine's most exciting current project is Chifupu, an exploration property 1.7 kilometres southwest of Chibuluma South. Charles Sihole, safety and technical services manager at Chibuluma, says the mine has already installed much of the necessary surface infrastructure and recently commenced excavation of the cut box.

Ore production from Chifupu is slated to start in the second half of 2015.

"Without that ore body, the current ore body takes us to 2017," Sihole says. "Once that project comes to fruition, the mining will be done at two ore bodies, and the life of mine is extended to 2021. Of course, it's likely to go beyond that because we haven't fully determined the bottom part of the ore body." ▶▶

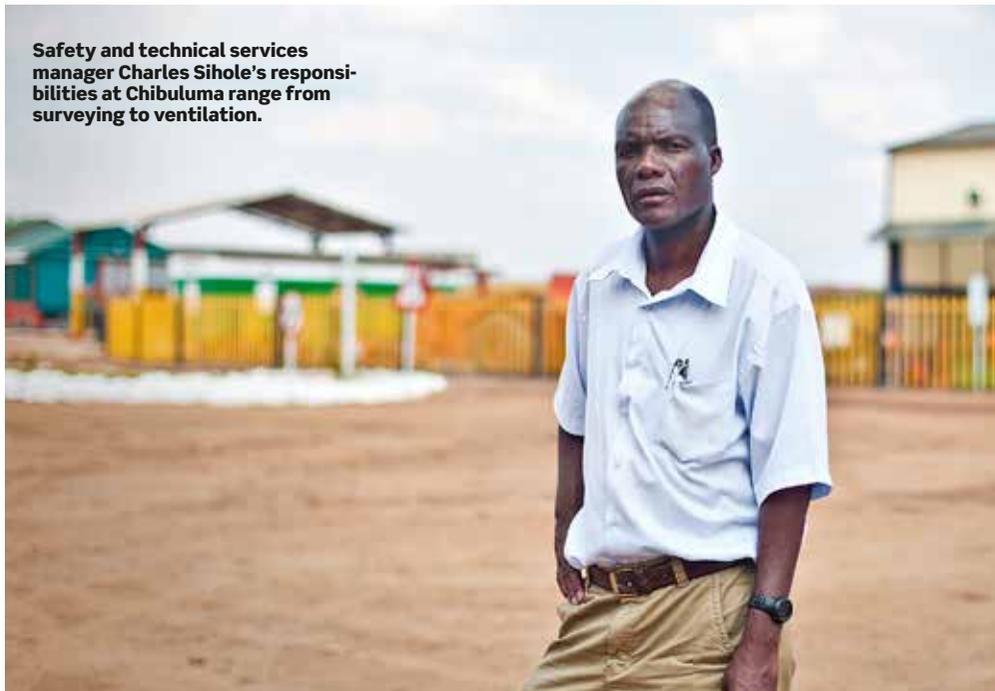
SANDVIK SOLUTION

Optimized operations

Chibuluma and Sandvik have been building a partnership since 2005. Sandvik has helped the mine achieve its cost and budget targets, not only by providing a modern mobile fleet but also through a supervisory maintenance contract, local training courses for operators and Trans4Mine initiatives that have optimized operations and developed a carefully defined asset appraisal method aligned with production planning.



Safety and technical services manager Charles Sihole's responsibilities at Chibuluma range from surveying to ventilation.



as Chile and the United States, Chibuluma is among the nation's lowest-cost producers due in large part to an ore grade that has remained relatively high and because mining occurs at comparatively shallow depths of around 600 metres in an area dominated by deep drop shaft operations.

"We've obviously got some challenges," says Sihole, whose additional responsibilities as technical services manager range from surveying to ventilation. "Apart from the copper price itself, which we can't control, one challenge is to always look at where productivity improvements will come from. One of them is fleet management and utilization, which has always been a challenge. You really have to increase the tonnes per hour that are transported to surface."

The mine implemented programmes to ensure that trucks are always filled to capacity below the surface before transporting ore to the crushing plant, and that no dead weight remains in the beds when the trucks return underground.

Chibuluma operates a fleet of nine Sandvik TH540 and TORO 40 trucks paired with four Sandvik LH514 LHDs and a Sandvik LH410 (TORO 7) LHD. The mine also uses a Sandvik DL311 (Solo 5-7C) drill rig for long hole production and a Sandvik DD311 (Axera 5) single-boom development jumbo.

Most of the machines are active underground on a sunny April day.

► Chibuluma announced last November the investment of at least 28 million US dollars in four promising exploration projects aimed at further increasing copper reserves and mine life.

"If we find ore in those areas, then we may be talking about 30 years from now, so the future as we are speaking is bright," says Dyson Galatia, engineering manager at Chibuluma.

The mine's outlook wasn't always so rosy. Metorex placed Chibuluma South on care and maintenance when low metal prices and high operating costs rendered mining unprofitable in the early 2000s.

600

Average depth, in metres, of mining at Chibuluma, which is located in a region of deep drop shaft mines.

But as copper prices surged to record highs in recent years, the mine's fortunes improved, and it has thrived thanks to higher production rates and cost-control measures.

Production has increased steadily to more than 48,000 tonnes of run of mine copper ore each month at an approximate grade of 3.4 percent. Chibuluma produces 18,000 tonnes of copper annually and employs 600 full-time workers and as many as 200 contractors.

Although production costs are generally higher in Zambia than other major copper-producing countries such

SANDVIK FLEET AT CHIBULUMA

● Chibuluma's modern fleet of Sandvik underground trucks, loaders and drills has helped the mine steadily increase production to more than 48,000 monthly tonnes of run of mine copper ore at an approximate grade of 3.4 percent.

- Five Sandvik TH540 trucks
- Four Sandvik TORO 40 trucks
- Four Sandvik LH514 LHDs
- One Sandvik LH410 (TORO 7) LHD
- One Sandvik DL311-7 (Solo 5-7C) drill rig
- One Sandvik DD311 (Axera 5) single-boom development jumbo

The Copperbelt Province in Zambia is rich with mineral finds and mines.



The temperature 600 metres deep isn't warmer than the 27 degrees Celsius on the surface, but high humidity at that depth makes it feel much hotter.

Chibuluma and Sandvik have been building a partnership since 2005. The supplier has helped the mine achieve its cost and budget targets. When Chibuluma needed support in optimizing operations and determining a replacement schedule for its ageing fleet, Sandvik's Trans4Mine team implemented a site-specific replacement model.

Chibuluma now has a carefully defined asset appraisal method aligned with production planning.

"Sandvik also gained valuable insight into the machine forecasting process to ensure machines are available when a customer requires

"I always take my guys for refresher courses at Sandvik."

them," says Danielle Nardini, Trans4Mine project manager.

The partnership extends to maintenance. Aswell Makungu, the mine's mechanical engineer for all underground and some surface operations, says Sandvik helps Chibuluma solve diagnostic problems, among other maintenance issues.

"We've entered into a supervisory contract with Sandvik, where they've got a person on site every day," Makungu says. "This person's role is to see to it that whatever we are doing, the quality is attached to it. If the maintenance is not done right, the machine won't be released, so Sandvik is very involved in day-to-day operations."

The supplier offers local training courses for inexperienced artisans all the way up to veteran maintenance technicians, and Galatia sends his employees to the courses each year.

"In terms of skills, we have got very competent guys," he says. "In the same vein, what I do is I always take my guys for refresher courses at Sandvik. That is a must."

Galatia came to the mine in 2001 as a mechanical engineer before being

promoted to engineering manager in 2009. He now looks after all engineering for the mine, both underground and on the surface.

He keeps equipment availability around 85 percent through a reliability-centred maintenance policy.

"I need a machine to be reliable," Galatia says. "I need the machine to give me the hours that I want in a day, in a month and in a year."

To help ensure that reliability, Galatia also periodically turns to Sandvik for assistance with maintenance audits.

"As a mine, we look at different types of machines," he says. "Sandvik, they've got a specific type of machine. Hence, their expertise actually would be more than ourselves. They are more familiar with these machines. If I've got a problem, I always phone Sandvik to sort out the problem for me. That's the advantage I've got with having Sandvik by my side." ■



See a video about Chibuluma at www.minestories.com



Chibuluma employs 600 full-time workers, many of whom are operators of Sandvik mobile equipment such as the LH514 LHD below.



About Metorex and Chibuluma

● Metorex is a copper/cobalt mining company with production and development assets in Zambia and the Democratic Republic of Congo. In 1997 Metorex acquired 85 percent of Chibuluma copper mine. The remaining 15 percent is held by the Zambian government as shareholder of Zambia Consolidated Copper Mines Investments Holdings Plc (ZCCM-IH). The mine produces 18,000 tonnes of copper annually and employs 600 full-time workers and 200 contractors.





MIND THE GAP

■ The mining industry job market is currently a mixed and somewhat puzzling picture. The energy sector is hiring, while other sectors are struggling and suffering redundancies. However, one thing is clear: the highly mechanized mines of tomorrow will require more highly skilled workers than in the past.

Text: **JOAKIM BÅGE** Illustration: **VALERO DOVAL**

Mining natural resources is a massive 7 trillion US dollar industry employing millions of people.

But it is not business as usual anymore. Around the world the mining industry is seeing increased attention to sustainable alternatives, a recent slowdown in mineral demand from China and more government regulation than ever before.

However, the industry is rising to meet these challenges. The responses involve more mechanization, virtualization and modern technologies to achieve better “lean and mean” processes for producing more and wasting less. These new “smart” mining techniques require fewer employees overall, but a much higher proportion of highly skilled mine workers.

“We have seen more mining

companies put in place management training programmes than ever before,” says Professor Greg Adel, head of the Mining and Minerals Engineering department at Virginia Tech in the United States. “As the older-generation mining professionals are retiring, they need to get a new generation of talented young engineers up to speed quickly. We also see our graduates move up the ladder faster than in the past, because their skills are very much in demand.”

As a result of the rapid mechanization of mining, the industry is facing a major skills gap over the coming years. In Canada, for example, fewer mining workers have a university level education (11 percent) than the average for the Canadian labour force (22 percent). However, tomorrow’s miners will be more educated than their peers in other industries. They need to be engineers from top schools with degrees in geology, thermodynamics, electrical circuits, hydraulics and other concentrations. This forces the mining

industry to totally rethink its recruiting practices.

While administrative and corporate services roles are often located in urban areas, some mining projects require people to relocate to remote mining communities and may require extensive travel or fly-in/fly-out working arrangements,” says Ryan Montpellier, executive director of the Canadian Mining Industry Human Resources Council (MiHR). “Mining companies need to provide competitive compensation packages as well as other benefits such as learning and development opportunities, mentorship and interesting and challenging work if they are going to be successful at attracting, recruiting and retaining these key people.”

Mining companies and equipment manufacturers need to get a unified message across to a new generation of talented recruits that modern mining is a great career choice, with safe working conditions and steady, high

In the future, more mechanized mining techniques will require the right skills to meet demand.



pay for the foreseeable future. But, perhaps even more importantly, they need to make it known that the job entails cutting-edge work in areas not traditionally associated with mining, such as communications and innovation.

“Many of our students are attracted to the chance to work solving real problems in the world such as minimizing environmental impact,” Adel says. “We work very closely with the industry on developing courses, internships and good scholarship support, but perhaps the biggest change over the last 10 years has been our increased attention to developing the communication skills of our students. Communication is key to the success of any modern mining company.”

Adds Montpellier: “In a competitive global economy, innovation is essential to the success of producers of goods and services. The mining and exploration industry is no exception. Mining and exploration organizations will need to increase their focus on recruitment, retention and succession planning.” ■

Preparing for the future

- Sandvik is making a significant investment in its apprenticeship programme, but it is also looking at developing more rigorous mentoring relationships between senior employees and new workers as well as Corporate Social Responsibility (CSR) programmes.

“The understanding should be that if we can make mechanized mining successful and help the mining industry to move away from conventional mining, making the mine a safer and better place to work, then Sandvik will be successful,” says Sunet Marx, global talent and performance manager at Sandvik Mining in South Africa. “This of course is a great challenge, and therefore we need young, brilliant minds to understand this and help us change the mining culture.”

“Addressing this generational and talent gap is of utmost importance to Sandvik and the mining industry at large,” Marx says. “The apprenticeship programme makes a big difference, and our customers also join us in this programme. In many instances we make this part of our CSR action where we train apprentices for the mining industry at large and not just for us. In South Africa this is a huge investment which helps create jobs in a country where we have a 25 percent unemployment rate.”

Sunet Marx believes addressing the knowledge gap will help create jobs.





A winning concept

NORTHWESTERN UNIVERSITY described the research as a prime example of serendipity at work, brought to fruition by contemporary fundamental science.

The industrial application of the discovery would be good news for both the environment and the mining industry, since the waste product from cyanidation poses a major environmental hazard that is costly to protect against.



Alpha-cyclodextrin, derived from cornstarch, has been found to isolate gold in a green way.

Golden surprise

Just by accident, a cornstarch method has been discovered as a new, eco-friendly way to extract gold. Simple test-tube chemistry lies behind the discovery that can turn the mining business a lot greener.

Text: **DAVID NOBLE**

● When chemistry postdoctoral fellow Zhichang Liu started trying to make three-dimensional cubic structures suitable for storing gases and small molecules, he had no idea he was about to discover a potentially green and cheaper solution to recovering gold.

As he carefully mixed together dissolved gold-bromide salts and cyclodextrin in his team's laboratory at Northwestern University in the US state of Illinois, Liu expected to see extended cube structures with large pores take shape. Instead, to his astonishment, he got needles, which had formed rapidly within a minute upon mixing the two solutions.

"Initially, I was disappointed when my experiment didn't produce the cubes I was expecting, but rather a shiny pale-brown precipitate," Liu says. "However, when I saw the needles forming, I got really excited. I wanted to learn more about the composition of these needles."

After discovering the needles, using simple

test-tube chemistry, Liu went on to screen six different cyclodextrin complexes. He found that it was alpha-cyclodextrin, a cyclic molecule composed of six glucose units derived from cornstarch, that isolated gold best of all.

"Alpha-cyclodextrin is the gold medal winner," says Sir Fraser Stoddart, the chemistry professor leading Zhichang Liu's research team. "Zhichang stumbled on a piece of magic for isolating gold from anything in a green way."

"The elimination of cyanide from the gold industry is of the utmost importance environmentally," Stoddart says. "We have replaced nasty reagents with a cheap, biologically friendly material derived from cornstarch."

The Northwestern method extracts gold from crude sources and leaves behind other metals that are often found mixed together with the gold. According to Liu, the process can also be used to extract gold from consumer electronic waste. The cyclodextrin method is now poised to find a technological application. ■

Efficient equipment

Sandvik Mining's diverse portfolio of leading-edge products and solutions is the industry's most complete range for excavating, transporting and processing ore safely and productively.

Discover the complete product range at mining.sandvik.com, and by scanning the QR codes below to download the new Sandvik Mining Offering Guide app.



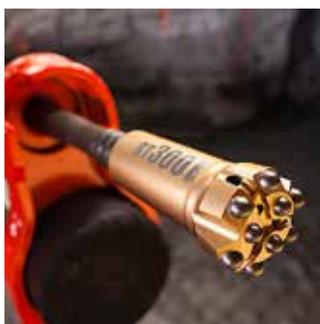
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ROCK TOOLS AND SYSTEMS

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 machines raise productivity sharply.



DRILL RIGS AND ROCK DRILLS

Know the drill. Sandvik rock drilling equipment is renowned for quality, reliability and productivity. Every machine we make is designed to give the lowest possible cost per foot drilled and a low life-cycle cost. To meet the needs of all customers, we offer a wide choice of machines, ranging from robust and simple drill rigs to semi-automated units that give extraordinary production rates and low total cost.



LOAD AND HAUL MACHINES

The powerful trucks. Sandvik underground loaders and haul trucks are extremely productive and reliable. They are vigorous and highly manoeuvrable, offer enormous capacity for their size and return a very low cost per tonne.



CONTINUOUS MINING AND TUNNELLING

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



CRUSHERS AND SCREENS

Maximum size reduction.

Sandvik crushing and screening equipment is engineered for productivity. 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 a wide range of consumables.



CONVEYOR COMPONENTS

Roll it up.

Sandvik focuses on developing and manufacturing conveyor components to meet customer needs in mining applications. The complete Sandvik offering supports modern mining practices and includes rollers, frames, pulleys and belt cleaners, safety and control devices, and dust control systems. With an emphasis on performance and reliability, they are easily available through the global Sandvik network both as original components and as replacements in existing systems.



BULK MATERIALS HANDLING EQUIPMENT

Total handling.

Sandvik has the long-term experience to design, manufacture and install virtually any kind of bulk materials handling system. From mining systems on the surface and underground to integrated stacking and reclaiming systems for mines, terminals and port facilities, we offer total solutions and turnkey installations. We also offer a wide range of conveying equipment and quality components for plants, as well as upgrading and modernization services.



BREAKERS AND DEMOLITION TOOLS

Hit harder.

Sandvik demolition tools make short work of difficult breaking and demolition jobs. They are optimized to deliver high-impact cutting or crushing force. With high power-to-weight ratios, easy interfaces and simple connections, they transform a wide range of excavators into highly productive demolition machines.



MINE AUTOMATION

Total control.

Sandvik has a deep understanding of modern mining operations and of how automation of loading and hauling processes can contribute to safer, more efficient transport.



SAFETY AND ENVIRONMENT

Keep it safe.

Sandvik focuses on the environmental, health and safety aspects of all its products, but some are designed especially for safety. An example is the broad range of products for fire protection.





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