

SOLID

#2.2015

GROUND

A MAGAZINE FROM SANDVIK MINING

Anti-VIBRATION
TECH
makes the
workplace safer

AUSTRALIA: SUNRISE DAM

Intelligence:
**Exploration
innovation**

The Expert:
**An unrepentant
maverick**

China:
**Knowing
the drill**

GOLDEN

OPERATIONS

Safety and productivity go hand
in hand in the Australian Outback.

Dear reader,

AS A SOLUTION SUPPLIER, everything we do is geared towards helping you, our customer, improve your efficiency and productivity, with a constant, shared focus on safety.

Productivity begins with products, and that's why we continue to introduce innovative new mining equipment, such as Sandvik MB670-1, the newest generation of bolter miners that have been proving themselves in demanding continuous mining applications for more than 30 years. We have also launched Sandvik LH204E, a 4.5-tonne electric loader designed for narrow-vein underground mining applications, as well as our new Sandvik 2700-series drill rigs.

RECOGNIZING THE IMPORTANCE of genuine parts and service support in today's challenging market, we are also investing in our rebuild facilities, equipping them to continue meeting our stringent quality standards for maintenance and testing.

THOSE WORKING IN our industry face tough environments, and Sandvik Mining is continuously striving to reduce the impact of noise, vibration and dust. A number of the features introduced not only make life more comfortable for the operator, they often bring benefits for the mine, such as lengthening the lifespan of the equipment or delivering fuel savings.

Our products, services and people are dedicated to meeting your mining needs, both now and in the future.



SCOT SMITH
PRESIDENT SANDVIK MINING



SANDVIK NEWS

A Latin American first..... 4

THE PROFILE

Overseeing a giant 6

TRADE NEWS

Living on diamonds 7

CHUANYANDONG PHOSPHATE MINE

A model of efficiency in China..... 10

SANDVIK MB670-1

The new face of bolter miners.....16

SUNRISE DAM GOLD MINE

Hefty hauling Down Under 20

SANDVIK AUTOMINE SURFACE DRILLING

Safer open-pit productivity 26

INTELLIGENCE

Groundbreaking gold detection 30

SUSTAINING SAFETY

Noise and vibration reductions 33

THE BIG PICTURE

One inspiring cave 36

PRODUCT RANGE

Productivity begins with products.... 38

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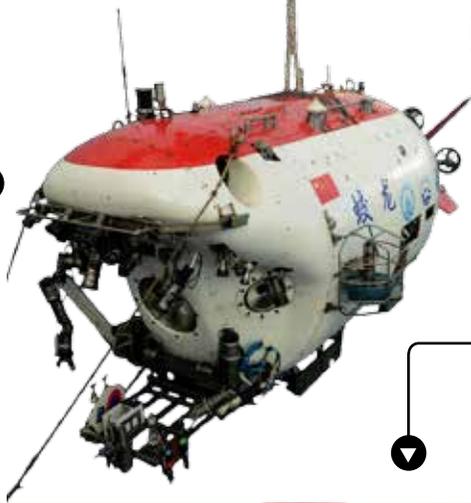
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CONTENTS **2.15**

09

A deep-
"sea"ted
partnership.



10

Phosphate mining in
Guizhou province.



26

Remote control
drilling has never
been easier.



20

Sandvik TH663 haul
trucks keep productivity
high in Australia.



16

The revamped Sandvik
MB670-1 features a myriad
of improvements.



30

The Gold Sniffer
analyzes minerals
like never before.



A new Drill Master in town

▶ Sandvik Mining has appointed Graeme Wolfenden to the new position of Australian Drill Master in a move to provide comprehensive training of its drilling products. The role is unique to Sandvik in Australia and offers customers the opportunity for a Mineral Ground Tools (MGT) expert to be on-call nationwide for maintenance, assessment and training purposes.

The Drill Master role is part of a new Sandvik initiative that focuses on a “carbide-to-customer” approach which ensures the entire service chain is trained to offer customer-specific service and appropriate products, from initial order through to replacement or disposal of machines, consumables, components and parts.

Wolfenden, an MGT professional with 30 years experience in the underground coal industry, has worked at Sandvik Mining for more than 10 years.

THE QUOTE

“The ideal end result is showing the value of Sandvik products in reducing costs and increasing production levels”

- Graeme Wolfenden, Drill Master MGT

Engaging customers

▶ Sandvik Mining Automation Days are an important, global interactive platform for Sandvik and its customers. This year’s event took place in Tampere, Finland, where a record 60-plus participants representing more than 20 companies attended. Participants from Peru, Mexico, Canada, Australia, Germany, South Africa, Ghana, Austria, Sweden, the Philippines, Estonia and Finland met with Sandvik product experts and discussed challenges and solutions.

Over two days attendees experienced first-hand the Sandvik automation offering of optimized products for their own unique mining operations.

The event was extremely well received by those in attendance, and featured demonstrations of the latest Sandvik technologies and customer presentations.

Sandvik Mining Automation Days present an ideal opportunity for customers to engage with product experts, enabling them to gain further insight into how to achieve a significant increase in both productivity and safety, together with a reduction in total cost of ownership.



The Red Dot double

+ Sandvik DD422i wins the Red Dot product design award for 2015.



reddot award
product design

▶ For the second year in a row, a Sandvik Mining product has earned top honours at the prestigious Red Dot Awards. The international 40-member jury gave the Sandvik DD422i development drill rig the 2015 Red Dot Award: Product Design; this on the heels of the Sandvik Pantera DI6400 down-the-hole percussive drill’s win in 2014.

The Red Dot Award: Product

Design is an internationally recognized quality label for outstanding design achievement and one of the world’s most sought-after seals of design quality. With almost 5,000 innovative entries from 2,000 participants representing 56 countries in 2015 alone, the Red Dot Award: Product Design is both the most recognized and most global product competition around.



A first for Latin America

▶ Sandvik Mining recently sold three units of its largest underground loader, Sandvik LH621, to one of the biggest local mining companies in Peru, Votorantim Group-owned Milpo. The loaders will start at Milpo's Cerro Lindo polymetallic mine this year. The deal also includes two Sandvik LH514 models for Milpo's El Porvenir mine. These are the first Sandvik

LH621 loaders ever sold in Latin America, and will be the first 21-tonne capacity loaders to operate in the region. A large number of Sandvik LH621 units are in operation in Australia, Europe, Africa and North America.

By adding these units to its fleet, Milpo can expect to see an increase in the amount of ore transported each loading and hauling cycle.

Electric loader for narrow-vein mining

▶ Sandvik Mining proudly announces the launch of Sandvik LH204E, a 4.5-tonne electric loader designed for narrow-vein underground mining applications. This electric version follows the recently introduced diesel-powered Sandvik LH204 and is a cost-effective solution that offers high productivity and low cost per moved tonne.

The vehicle control and management system - unique in this class of loader -

monitors all loader parameters, including tramming speeds, operating temperatures and pressures, to expedite troubleshooting and minimize unscheduled downtime.

Sandvik LH204E is a highly manoeuvrable machine that operates in confined narrow-vein mining applications, and can handle higher payloads than similar-sized units on the market. The 4.5-tonne capacity electric LHD offers a highly productive solution with zero underground emissions.

A new rebuild facility in Nagpur

▶ Sandvik Mining has established a 2,450-square-metre refurbishment facility at Nagpur for catering to the aftermarket and maintenance needs of its customers in India.

Sandvik chose Nagpur to establish the rebuild facility as it is centrally located and also has the necessary industrial infrastructure for ancillary support. The facility has state-of-the-art refurbishment elements that comprise highly sophisticated tools, stringent quality standards for maintenance and testing that are in line with Sandvik global benchmarks and managed by a skilled team of service engineers, as well as international Sandvik product specialists.

Sandvik also plans to establish a Training Academy on the premises.

600

Approximate value, in MSEK, of materials handling contracts under which Sandvik will supply coal handling equipment in South Africa.



Launch of new rigs

▶ Sandvik Mining recently launched the Sandvik DD2710 single-boom electro-hydraulic drill rig for operations in small to mid-sized underground hard rock mining applications. This was followed up with the Sandvik DS2710 rock support drill rig and the Sandvik DL2710 production drill rig.

"The new Sandvik DD/DL/DS 2700 series is a field-proven range of drills that delivers a great price-to-performance ratio for 2.7-by-2.7-metre drifts," says Jukka Naapuri, Product Line Manager at Sandvik Mining. "Our parts and service support for the new series offers customers true peace of mind."



ABOUT THE COMPANY

Vale, a Brazilian multinational mining company, is the world's largest producer of iron ore, with a system capacity of 423.4 million tonnes per year.

Q & A

SMOOTH OPERATOR

VALE'S SÃO LUÍS port in northern Brazil is expanding its capacity with the Pier IV project to meet the growth of iron ore production from the Carajás Mine. When it is finished, Pier IV will have two stations, North and South, equipped with the world's biggest shiploaders, the model Sandvik PL400. The site will have four of the shiploaders, each with a capacity of 20,000 tonnes per hour. Ricardo Fonseca, manager of port operations, Vale, oversees the assembly of the equipment.

Q WHAT ARE YOUR MAIN DUTIES AS PORT OPERATIONS MANAGER?

I work as an operations analyst. I currently receive the parts for the Sandvik PL400 project. I oversee the assemblies and tests and observe the equipment's performance until it reaches the desired level. Then we approve the equipment and put it into operation.

Q HOW IRON IS ORE TRANSPORTED FROM THE MINE IN CARAJÁS TO THE SHIPS AT THE BRAZILIAN COAST?

In the Carajás mine the ore is loaded onto railroad cars, so the iron comes by train to São Luís. Here in São Luís, the train delivers the iron ore material to the port through railcar dumpers. Then the iron ore is recovered with reclaimers and transported on Sandvik conveyors to the Sandvik shiploaders, which load the iron ore onto the ships.

Q HOW LONG HAVE YOU WORKED AT VALE?

I joined Vale 14 years ago when I started at Vale's Railway division.



Q HOW LONG HAVE YOU BEEN HERE IN SÃO LUÍS?

I have been working at the São Luís port Pier IV project for four years.

Q WHAT IS THE MAIN CHALLENGE IN YOUR WORK?

Of course, to meet the goal of shipping the maximum amount of ore from São Luís each day. But the new Sandvik shiploaders help us achieve that goal.

Q IN YOUR OPINION, WHAT IS MOST IMPRESSIVE ABOUT SANDVIK PL400?

From what we have seen from the new project, the shiploaders are simpler and lighter than those we used to work with. Sandvik shiploaders are easier to operate and simpler in their conception.

RICARDO FONSECA

TITLE: Manager of port operations at São Luís port, Brazil.

COMPANY: Vale

AGE: 50

LIVES: São Luís, Brazil.

FAMILY: Married, one 10-year-old daughter.

Rich soil

While few people know what the plant *Pandanus candelabrum* looks like, it may soon become the most sought-after piece of herbage in the world. That's because this particular thorny plant typically grows on top of diamonds.

More accurately, the plant grows on top of kimberlite pipes. These subterranean carrot-shaped formations were created by volcanic eruptions and are now replete with potassium, magnesium, phosphorus and diamonds.

The entire process is spelled out in

an article published in the June-July 2015 issue of the journal *Economic Geology* in an article by Stephen Haggerty, a professor at Florida International University. Haggerty says he uses "diamonds as a proverbial window to Earth's deep interior".

He believes the plant has adapted to growing in these mineral-rich soils, providing a simple and efficient tool for identifying kimberlite pipes and potential diamond deposits. Kimberlite mining is less invasive than other types of mining because of the pipes' narrow shape.

Diamond deposits have been found under the roots of the *Pandanus candelabrum* plant.

Battery superpower

▶ Stanford University chemistry professor Hongjie Dai and his colleagues have invented the first high-performance, rechargeable aluminium-ion battery. Revealed in the April online edition of the journal *Nature*, the battery is long-lasting, quick-charging, inexpensive and durable. The team reported that it takes only one minute to fully charge and it is able to withstand 7,500 cycles, unlike today's lithium-ion batteries, which fail after around 1,000.

Researchers have been trying to make batteries out of aluminium for quite some time. The metal is inexpensive, has a high-charge storage capacity and is not flammable. The recent developments at Stanford have scientists, and the world at large, supercharged with anticipation.

The harrowing story of *The 33*

▶ Based on the 2010 Chilean mine disaster in which 33 miners were trapped and subsequently rescued, the new film *The 33* tells the longest underground survival story in history. The miners were trapped for 69 days more than 660 metres underground, enduring heat of 38 degrees Celsius beneath a million-tonne boulder twice the size of New York's Empire State Building. Scheduled for release in 2015, the film was shot in working mines in Colombia and Chile, and stars Antonio Banderas, Juliette Binoche, Lou Diamond Phillips, Rodrigo Santoro, Gabriel Byrne and James Brolin.

THE QUOTE

“Safety is the foundation of the work we do.”

-Turquoise Hill Resources CEO Jeff Tygesen, whose Oyu Tolgoi mine in Mongolia is expected to be the third-largest copper-gold mine in the world when it reaches full production.

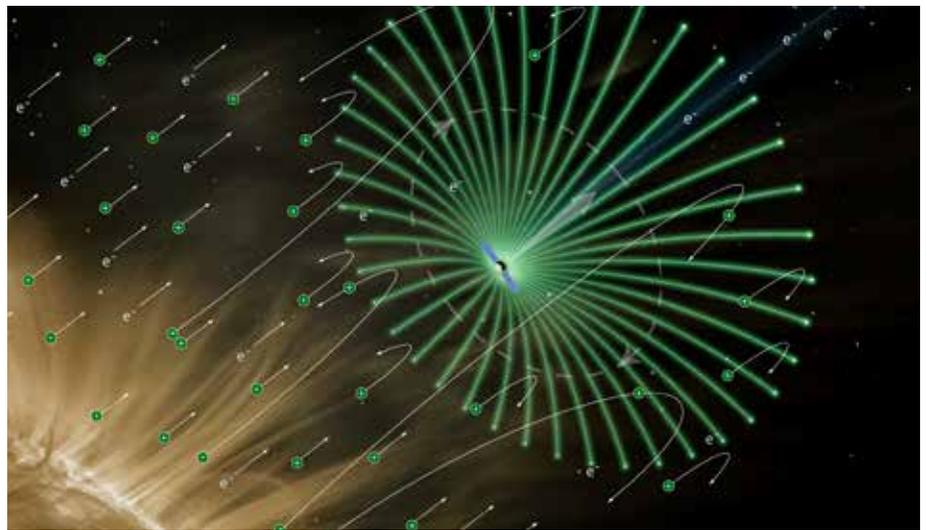


PHOTO: ANTIGRAVITE / SZAMES

E-sails and asteroid mining to fuel space exploration

+ **Current and future tech could pave the path to interplanetary travel.**

▶ Electronic solar wind sails, or E-sails, could make asteroid mining a reality even sooner, according to researchers at the Finnish Meteorological Institute. Created in Finland in 2006, E-sails use long, charged tethers to convert solar wind flow into propulsion. E-sails could make asteroid mining possible by providing essentially free fuel logistics in the solar system outside of Earth's magnetosphere. This type of asteroid mining could support longer forays into space by convert-

ing water found in asteroids to fuel. Theoretically, a mining unit powered by E-sails could be sent to extract the water from an asteroid. The extracted water would then be transported with an E-sail into orbit around Mars or Earth, where it would be split into hydrogen and oxygen, liquefied and used as fuel for other spacecraft travelling between the two planets. Intermediate “fill-ups” would reduce the launch mass dramatically, making space travel more practical and less expensive.

The spectacular now

▶ The world's largest copper miner, Codelco, will soon start using robotic machinery at its Minera Gaby division in Chile's copper-rich Antofagasta region. Robots at Minera Gaby will inspect equipment prior to their scheduled maintenance, which is expected to reduce service time and minimize oversight. This latest innovation is in addition to fully automated haul trucks used at the mine. With ageing mines to manage, Codelco has been using a wide range of new technologies to increase efficiencies, including harnessing extremophiles, microorganisms that help extract copper from sulphide ore. The company is also in the midst of a 5.4 billion-US-dollar expansion project

of its El Teniente mine, the world's biggest underground copper mine, which would extend its production life by 50 years. At the new mine, all mining, processing and transport activities will be fully automated and controlled remotely from the corporate building in the city of Rancagua, 50 kilometres from the mine site.

+ **Extremophiles (below) are microorganisms that help extract copper from sulphide ore.**

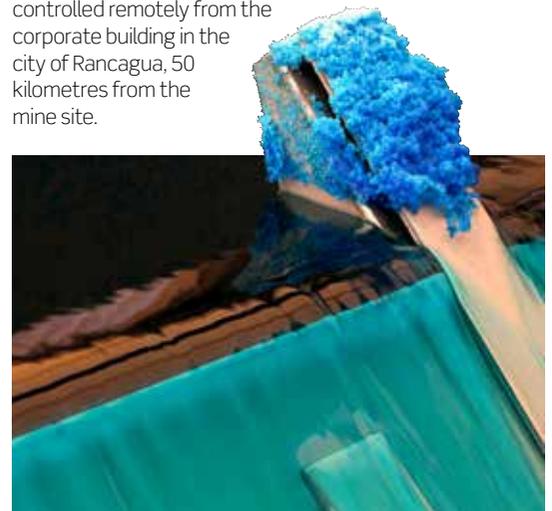


PHOTO: DIRK WIERSMA / SCIENCE SOURCE

The Expert

THERE IS NO debate about it: J David Lowell is the most accomplished mineral prospector in the past 100 years. Over his lifetime he has discovered 17 orebodies, more than anyone on record, and at 87 years old he shows no sign of slowing down.

Q: You have praised the advantages of freedom and said you excel at being wrong. How have these traits helped you become perhaps the most successful mining explorationist ever?

A: Mineral exploration is all about risk-taking: from the risk that commodity prices will fall to the risk that taxes will rise and many things between. Also, there's the risk that, for some unrecognized geologic reason, the ore deposit model just didn't work this time, or that for a few years global mining finance has dried up. There are a jumble of risks, and you can do one of two things: either take no risks and probably never in your career find a new mine, or you can try to play the odds and if you think there is one chance out of 10 that a new drill hole will find a new mine, you drill 10 holes and be wrong nine times and be a hero the 10th.

Q: Which are the most important qualities necessary for a successful mine explorer?

A: I think experience is of more value than education. It also helps to know something about geology, but it may sometimes help more to know a lot about mines because the definition of "ore" is "rock that can be mined at a profit". An explorationist should also know a bit about business and understand mineral economics. He should be optimistic, very hard-working and dedicated to finding an orebody. He should be a maverick willing to ignore dogmas. He should also be honest and truthful.

Q: You've stated that new technologies have played a "very small" role in mine discoveries over your lifetime, yet mining companies are constantly looking to use new technologies to discover mines. Why is that?

A: Quite a bit of mining exploration technology has been borrowed from the oil industry, where 10,000-metre-deep offshore drill holes cost several billion dollars and are based on the very sophisticated technology necessary to find the target and design the drilling equipment. Their reward as well as their cost is an order of magnitude higher than in the mining industry. Hitting a big oilfield is like hitting the haystack and hitting a deep orebody is like hitting the needle in the haystack. "Broad-brush" oil technology doesn't work well in mineral exploration. In a time of exploding technology there is pressure to tell your shareholders that you are using the cutting edge of technology. I have found that the simplest and cheapest common geophysical survey, the magnetometer survey, is also the most useful and reliable when used to map the underground contacts of relatively magnetic rocks like granite in contact with low magnetic susceptibility rocks like limestone.

Q: Do you consider yourself a maverick, and if so, why?

A: I am an unrepentant maverick. Almost every square metre of the world's rock outcrop has been looked at. I assume that every obvious orebody would have been found 10, 100, 500 or 2,000 years ago by some diligent, hard-working explorationist using the current dogma. When looking for new mines I assumed none of the classic dogmas had worked, so I tried to come up with a new explanation for why an orebody might be present that didn't fit the dogmas. It's fun being a maverick.



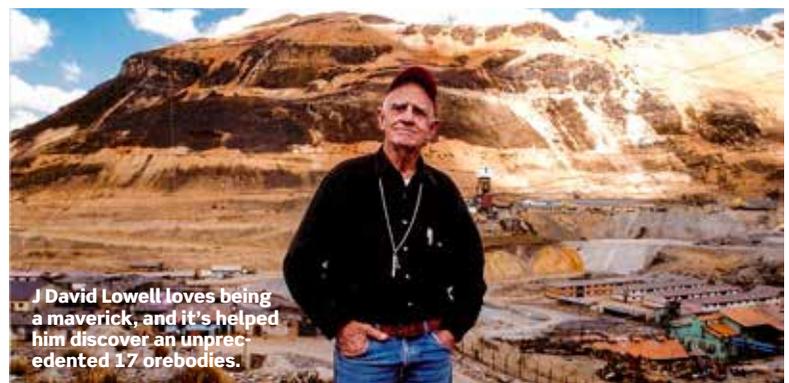
PHOTO: GETTY IMAGES

Underwater partners

▶ Following the completion of a four-month voyage of the deep-sea manned Chinese submersible Jiaolong in the south-western Indian Ocean, China has announced its desire to cooperate with India on deep seabed mining in the Indian Ocean. During the trip, the Jiaolong reported having discovered large deposits of gold and silver. The submersible successfully carried out 13 dives to observe different hydrothermal areas, the characteristics of hydrothermal fluids and deep-sea biodiversity, gathering a huge amount of data and more than 700 samples.

Silver production to drop in 2015

▶ According to the World Silver Survey 2015, global silver production is expected to drop this year as supply from active projects will not be able to replace production losses from ageing operations. The study, published by the Silver Institute and Thomson Reuters GFMS, says that while global silver output increased by 5 percent in 2014 to 877.5 million ounces, mine supply is set to decrease in 2015 due to weak silver prices. The price of silver dropped 20 percent in 2014, closing at 15.70 US dollars an ounce after having lost 36 percent of its value in 2013. The report concludes that while silver prices will see some short-term weakness, they are likely to end 2015 at more than USD 17 an ounce, with a couple of years of modest price increases to follow.



J David Lowell loves being a maverick, and it's helped him discover an unprecedented 17 orebodies.



Text: VANESSA YANG Photo: ADAM LACH

AT FULL BLAST

■ **GUIYANG, CHINA.** Nestled in the mountains of China's Guizhou Province, some three hours from the provincial capital, the Chuanyandong open-pit phosphate mine is a model of drilling and blasting efficiency.

I T IS SUMMER in China's Guizhou Province – a time of cool, pleasant rainfall that is perfect for sowing crops. Around a three-hour drive north-east of the provincial capital of Guiyang lies the junction of Fuquan City and Weng'an County, where the Guizhou New Orion Drilling Technology & Services Co. Ltd. works with the Wengfu Phosphate Group at the Chuanyandong open-pit phosphate mine, producing 3.5 million tonnes per year.

This south-western area of China has abundant mineral resources, and it is an important production base for phosphates in China. Processed phosphate is used as a fertilizer to revitalize plants and soil. China is one of the world's three leading producers of phosphates, together with the United States and

Morocco. World phosphate rock production capacity is projected to reach 256 million tonnes in 2015, up nearly 20 percent from 215 million tonnes in 2011.

The Wengfu Phosphate Group is a state-owned enterprise principally involved in internationally contracted projects, but its base is the large-scale production of phosphate, and that is what made finding the right contractor for the job at the mine so important.

Initially, the 3.36-square-kilometre mine hired small-scale drilling equipment companies that used outdated technology, but these practices ultimately proved that such drilling and blasting techniques were not the way to achieve optimum production capacity and also did not measure up to Environment, Health and Safety (EHS) standards.





For open-pit mining to be effective, several layers of rock need to be blasted away.

▶ Zhao Mingxing, Wengfu’s deputy mine and production manager, says the mine had to look to another channel and find a contractor that embraced advanced drilling equipment. Once efficiency was prioritized, he says, New Orion became the obvious choice, as the company uses state-of-the-art, heavy-duty Sandvik rigs.

“The first step in mining is blasting, and the first step in blasting is drilling blastholes,” Zhao says. “Since we’ve had Sandvik equipment on site we’ve increased our efficiency and sharply scaled up production. That’s why we chose New Orion – for the company’s rich boring experience and also because they have Sandvik rigs.”



NEARING THE MINE along a narrow, winding road, one side features a lush mountainside and on the other is a babbling creek in a gully – a refreshing scene. As the altitude increases, fog descends on the scenery, as in a mist-shrouded Chinese landscape painting. The only reminder that a phosphate mine is close is the endless procession of heavy-duty trucks that trundle up and down the mountain.

Some 20 minutes later, the fog has dissipated and the mine is revealed. From a viewing platform, the ground slopes downward toward terraces into the pit itself like some Hollywood scene depicting the construction of the pyramids – although the area is busy with vehicles and modern drilling rigs. Among the latter are the familiar shapes of Sandvik D245S and Sandvik D50KS rigs.

In open-pit mining, layers of rock frequently have to be blasted aside, and the first step is drilling the blastholes for the explosives. This is where Sandvik rigs’ advanced technology comes in.

Luo Qingxin, chairman of New Orion, points to where there will be blasting on this day. The entire process of drilling blastholes is to be handled by Sandvik D245S.

14
metres, the depth of each individual blasthole.

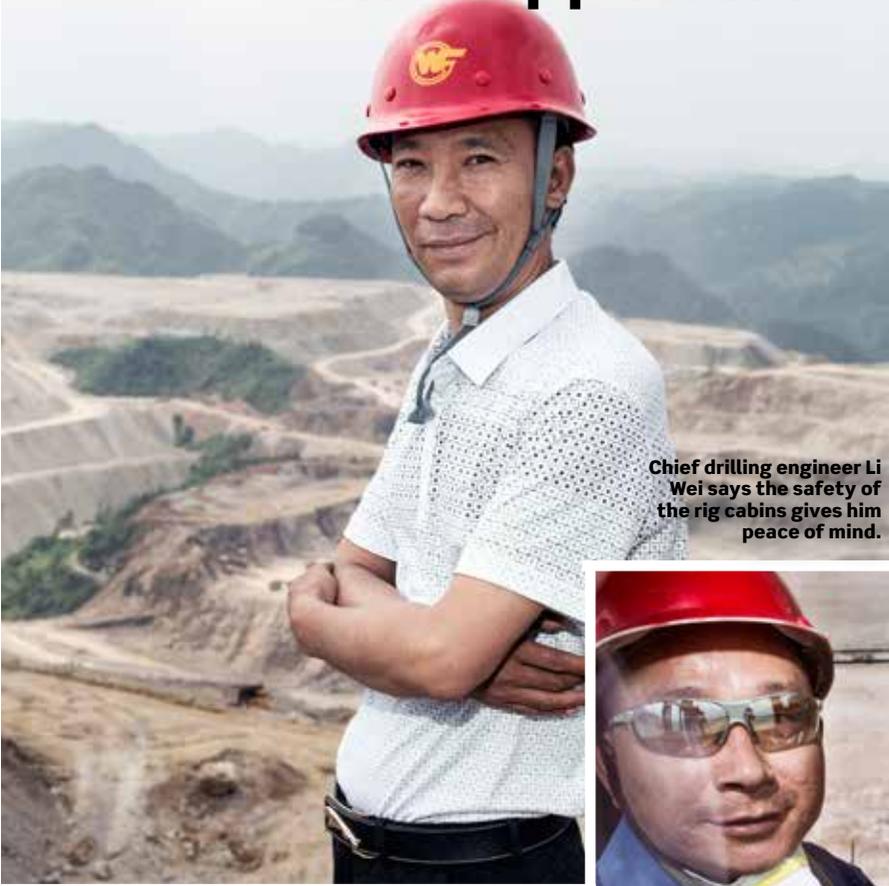
Luo explains that the blastholes are made at a drilling distance of six to seven metres, and that each blasthole is 200 to 250 millimetres in diameter and 14 metres deep. After the blastholes have been loaded with explosives, short-delay blasting technology is used to set off the blasts, ensuring minimum impact on surroundings.

Since blasting jobs of this kind are so common in open-pit mines, the rigs need to be able to carry out the drilling work efficiently and also be able to move about the rugged terrain rapidly to carry out work in different locations. Sandvik drill rigs are particularly suited to such tasks at Chuanyandong. ▶

▶ SANDVIK SOLUTION ◆◆◆◆◆◆◆◆

- Due to Sandvik rotary drills’ durable and flexible chassis and their climbing ability, the rigs can move rapidly to designated areas and undertake vital drilling work, and after completing the task quickly move to a safe area ahead of the blast, or rapidly move on to the next designated drilling area. The comprehensive Sandvik drilling offering includes large-aperture 200-250mm blasthole drill rigs that carry out drilling production tasks efficiently. Sandvik engineers provide support in terms of operation, repairs and maintenance training, guidance and technical advice.

Since we've had Sandvik equipment we've increased our efficiency and sharply scaled up production



Chief drilling engineer Li Wei says the safety of the rig cabins gives him peace of mind.



Sandvik D245S drills 14-metre-deep blastholes.





TECH SPECS SANDVIK D50KS & D245S FOR GUIZHOU

	D50KS	D245S
Hole diameter	152 mm - 251 mm (6"-10")	127 mm - 200 mm (5"-8")
Drill pipe	9.14 m (30')	9.14 m (30')
Hole depth	15 m (49')	15 m (49')
Undercarriage	S30HD Excavator	S25HD Excavator
Max pulldown	222 kN (50,000 lbf)	185 kN (41,500 lbf)
Bit load	267 kN (60,000 lbf)	209 kN (47,000 lbf)
Engine	403 kW (540 hp)	354 kW (475 hp)
Compressor	37.4 m ³ /min (1323 cfm)	29.7 m ³ /min (1050 cfm)
	6.9 Bar (100 psi)	6.9 Bar (100 psi)
Rotation speed	152 rpm	171 rpm
Rotation torque	8221 Nm (72,762 in-lb)	5336 Nm (49,000 in-lb)
Operating wt	50 tonnes	35 tonnes
Feed type	Hydraulic cylinder	Chain feed

Sandvik drill rigs make moving around the open-pit mine much more efficient.

No matter whether it's the sales managers or engineers, they're always ready to help



▶ **NEW ORION'S CHIEF** drilling engineer, Li Wei, works with drill rigs every day. He says that in the past, moving rigs around in mines was extremely inconvenient, particularly in rugged areas, where the process could take up to half a day. He adds that the equipment's drilling efficiency and precision were also of a low standard in the past.

Sandvik rigs make moving around a mine much more efficient, he says, as they are not restricted by the terrain, while their drilling efficiency and precision are unrivaled. At Chuanyandong, it is possible to drill 50 metres of blastholes an hour on average.

Li points to two new vehicles the company just purchased: "Improved work efficiency has increased earnings and enabled such improvements."

But the advantages that Sandvik provides are not limited to the contractor's bottom line. Li says the safety qualities of the Sandvik rig cabins give him peace of mind.

Another New Orion employee, machinery manager Jiang Changshun, who oversees maintenance and repairs, says it is a pleasure to work with Sandvik equipment.

"Sandvik's excellent performance and reliability have made maintenance work a breeze," he says. "Following the Sandvik-issued maintenance guidelines for the rigs to stay productive greatly reduces downtime for maintenance."

New Orion Chairman Luo is a mining equipment engineer with rich experience, having worked in the United States in the 1990s and in the deserts of

the Middle East from 2008 to 2009. He has seen how new technology has brought increased efficiency to the mining industry.

Luo says that in 2008 he visited the Sandvik production unit in Alachua, Florida, where he had fruitful technical discussions with Sandvik engineers and saw the supplier's rigs in operation. Subsequently, he bought a Sandvik D1500 DHR drill. After cooperating with Sandvik, he was struck by the company's integrity and reliability.

"No matter whether it's the sales managers or engineers, they're always ready to help," he says.

In the following years, he bought two more Sandvik rigs – Sandvik D245S and Sandvik D50KS.

Zuo Yong, Sandvik China Southwest Region sales manager, says his clients over the years have always become his friends. Zuo says he often visits the mines and becomes familiar with the circumstances there to better help the customers resolve problems.

Luo says he has always believed in the power of advanced blasthole technology, even in the beginning when it was difficult to get people to recognize its importance. "But I stuck to my guns and in the end I was proved correct," he says. "Sandvik was the right choice." ■



About Guizhou

▶ Guizhou New Orion Drilling Technology & Services Co. Ltd. specializes in drilling mining blastholes, undertaking domestic and international blasting projects at mines and at large-scale hydroelectric sites. It has a staff of 60 and an annual turnover of CNY 50 million. The company has a number of senior engineers with 30 years of rig production, assembly, repair and operations experience. With its range of specialized, large-scale, modern drilling equipment, the company can provide optimized blasting plans based on mine reserves, the scale of production and specific geological formations. In addition, it also offers sales of various types of rigs, with technical-support services, including equipment installation, maintenance and technical modifications.



See a video about
the Chuanyandong mine
at minestories.com

Text: **TURKKA KULMALA** Photos: **MÅNS BERG**

BOLDER THAN EVER

■ **Sandvik MB670-1** represents the newest generation of the company's innovative bolter miners that have proven themselves in demanding continuous mining applications for more than 30 years. The revamped machine delivers dozens of significant productivity and EHS improvements.



The new bolter miner offers a fully automatic cutting cycle, enabling even more efficient planning.



The new spool monitoring system will automatically prevent the machine from starting up if it detects a spool in an inappropriate position.

SANDVIK MB670 BOLTER miner is the company's flagship product for developing roadways in longwall mining. This method of mechanical continuous mining, also involving hydraulic roof supports and longwall shearers, is mainly used for coal in countries including Russia, India, Australia and China; in fact, more than 90 percent of global longwall installations are found in China.

With several hundred units delivered globally over 20 years, Sandvik is a leading supplier of longwall development machines. However, even great machines need continuous improvement to meet customers' evolving needs. Sandvik aims to proactively keep and strengthen its position against other premium bolter miners, as well as help new customers and markets improve their safety and productivity. One aspect is the modularization of electric-hydraulic systems between different flame-proof standards and different machine offerings.

THE BASIS OF SANDVIK MB670-1

and all the legacy models is the patented design concept of a sump mechanism that incorporates two different operations and functions – cutting and bolting – into a single machine. Practically this means the capability to sump into the face to be cut independently of the mainframe and tracks, and to simultaneously bolt the roof and the rib of the roadway.

Feedback that Sandvik received from the field indicated that the customers' needs could be summarized in five main points: The machine should allow data logging and an automated cutting cycle; there is constant need to reduce

operating costs and the total cost of ownership; the mean time between failures must be increased; safety requirements are ever more stringent; and there is constant pressure to improve productivity.

SANDVIK SET OUT to methodically address these needs in order to offer improvements that translate into tangible benefits for mining companies and contractors as well as individual operators and maintenance mechanics.

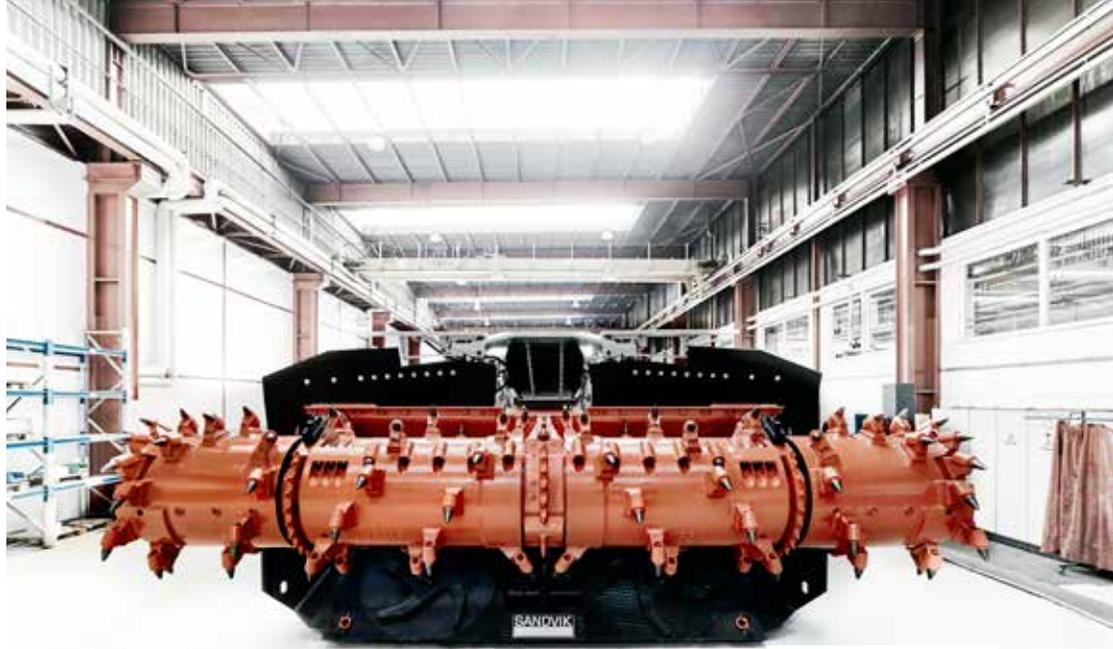
Sandvik MB670-1 for the first time offers a fully automatic cutting cycle, in which the cutter head moves to predetermined coordinates within a predetermined time window. The same cycle is consistently repeated time and again, which enables more efficient planning. More even roadway floors result in less equipment damage and better safety. Coal sizing is more accurate thanks to adjustable sumps. The bolter miner itself suffers less wear and tear. All these things increase productivity and lower the total cost of ownership.

The electric and hydraulic systems of the new Sandvik MB670-1 have also undergone significant upgrading, including features such as a new simplified hose and connection point layout and a new, more compact power

The common thread is better safety thanks to less need for manual work

Sandvik MB670-1 Key improvements

- Improved user-friendliness, less training-intensive, higher productivity, less operator fatigue
- **Improved safety and ergonomics** – engineered with features to help avoid LTIs, better operator satisfaction
- Improved productivity – higher tonnage per operating hour
- **Longer lifetime of components, easier maintenance, lower total cost of ownership**



Electric and hydraulic versions of the new bolter miner feature new remote control systems, electric panels, displays and more.

pack, as well as new electric panels and displays and remote control systems.

Perhaps the two most important improvements over the old versions in this respect are the new spool monitoring systems and strategically placed emergency stops. Essentially a safety feature, the spool monitoring system will automatically prevent the machine from starting up if it detects a spool in an open position that would lead to an instant movement of a component when starting the machine.

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Percent mean noise level reduction thanks to a new wet scrubber exhaust system.

THE MECHANICAL PARTS and systems have also received a lot of attention during the upgrade process, including a new capability of removing cutter pick sleeves by means of oil injection in the cutter drum, new wear materials to ensure longer lifetime in the boom, slide mechanism and loading device, and a number of individual structural and maintenance improvements. The common thread tying all of these together is better safety thanks to less need for manual work as well as increased productivity and lower total cost of ownership through simplified maintenance needs.

One of the most important innovations in the subsystems of Sandvik MB670-1 is the new wet scrubber exhaust system. The redesigned

scrubber emits much less noise than the predecessor model. Mean noise levels have decreased by more than 10 percent, from around 90 to 100 decibels, depending on the scrubber version, to around 77 to 90 decibels.

As in all industries, mining operators are keen to utilize the possibilities afforded by the modern data acquisition and transmission systems. The live view data logging features of Sandvik MB670-1 enable simple web-based, device-independent reviewing of the machine status, runtimes, counters and other customizable content, potentially from any computer connected with the mine network and without any need for installed software. The machine provides that data via OPC data interfaces into the mine-based network environment. ■



Sandvik MB670-1 uses a sump mechanism design concept that incorporates two different operations, cutting and bolting, into a single machine.

TECH SPECS SANDVIK MB670-1

Dimensions

- Total length: 11.16 m
- Total weight: approx. 105 t
- Height in tramming mode: 2.65–3.3 m
- Machine body width: min. 4.36 m
- Cutter drum retraction per side: 0.25 m
- Floor clearance: 0.27 m

Operational data

- Cutting width: 5.2–6.24 m
- Cutting height: 2.8–5.0 m
- Sump depth: 1.0 m
- Ground pressure: 29 N/cm²
- Four wet roof bolting rigs DO200
- Two wet rib bolting rigs DO800

Power ratings

- Total installed power: max. 546 kW
- Cutter motor: 1 x 270 kW
- Hydraulic drive motor: 1 x 132 kW
- Loader motors: 2 x 36 kW
- Conveyor motors: 2 x 36 kW

SUNRISE DAM GOLD MINE

An aerial photograph of the Sunrise Dam Gold Mine. The image shows a large-scale open-pit mine with multiple levels of terraced rock walls. A network of wide, light-colored dirt roads winds through the site. Several pieces of heavy machinery, including haul trucks and a bulldozer, are visible on the roads and within the mine's levels. The terrain is rugged and rocky, with some areas showing reddish-brown soil. The overall scene depicts a complex and active mining operation.

Sunrise Dam's open pit operation has given way to its expanding underground mine as the source of its ore.



Text: **JIM WARD** Photo: **ALCO WILLEM**

ROCK 'N' GOLD

SUNRISE DAM, AUSTRALIA. Drilling through hard rock in the harsh, burnt-orange environs of the Australian Outback is how Barmingo gets to the gold at Sunrise Dam in Western Australia.

A **CHANGE IN** the aircraft's engine tone signals its descent. Sunrise Dam looms ahead, a tiny oasis in a dry sea of the iridescent salt lakes that are a feature of this remote area. It's a gentle hint of things to come – a precursor of the harsh conditions in which mining is carried out in this part of the world, throwing down a stern challenge for both man and machine. Sunrise Dam, 220 kilometres north-east of Kalgoorlie in Western Australia, is owned by AngloGold Ashanti Australia Ltd (AGAA), a wholly owned subsidiary of AngloGold Ashanti Ltd, the world's third-largest gold producer.

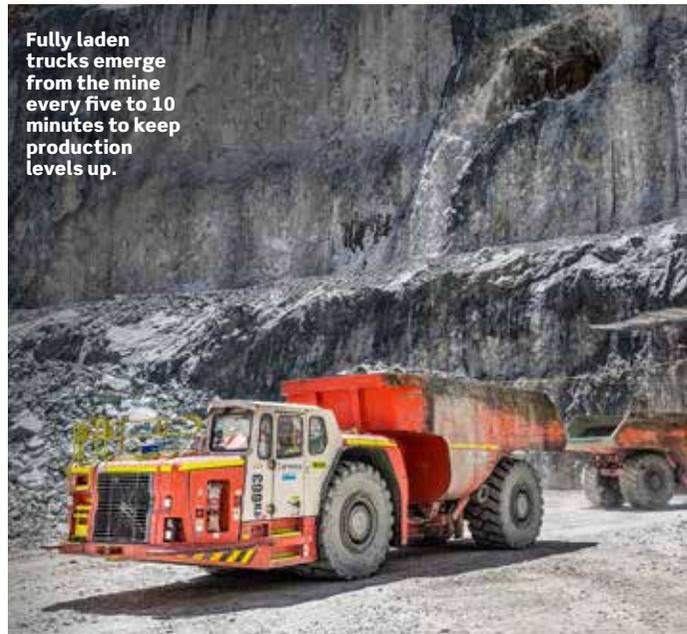
The mine began production as an open cut operation in 1997, and from 2004 until 2014 ore came from both open-cut and underground sources. The open pit was finally completed at a depth of 490 metres in early 2014, and AGAA now sources its ore exclusively from its rapidly expanding underground mine – a veritable rabbit warren of more than 12 kilometres of tunnels extending nearly 800 metres below ground level. This is the environment in which Barmingo, the underground mining contractor at Sunrise Dam, operates its load and haul fleet for two 12-hour shifts every day.





These safety attributes have made a direct impact on driver productivity

Fully laden trucks emerge from the mine every five to 10 minutes to keep production levels up.



▶ **TO THE UNINITIATED**, the massive Sandvik TH663 trucks seem to fit into the narrow tunnels as snugly as pistons. In reality there is a metre of clearance on either side of the truck, which is a testament to the skills of the highly trained driver of a vehicle that weighs over 100 tonnes fully laden, working in absolute darkness relieved only by the headlights.

The loader fills the truck in just three passes with its massive bucket. The truck heads off to the surface and within minutes is replaced by another. The next stage in the load and haul process is at the portals, the entry points to the mine. Trucks emerge from the portal of the mine every five to 10 minutes and dump their ore just a few hundred metres away

on a stockpile. From there it is transferred to giant surface trucks and transported to the mine's crusher. Gold is extracted from the pulverized ore by a conventional carbon-in-leach and gravity process.

Sunrise Dam is recognized as a world-class ore body, but most of the gold is very finely disseminated and only occasionally visible to the human eye. The average grade of ore hauled from the underground mine is 3.5 grams per tonne. A laden truck emerging from the portal carries, on average, 55 to 57 tonnes of ore. This mass of rock, when processed, will yield just under six ounces of gold.

Extensive drilling and geological interpretation have determined that bulk mining methods are the most effective at Sunrise Dam. As most of the operating costs are fixed, this means that operational efficiency is vital – the more ore you mine and treat, the more gold you will produce, bringing costs down.

MONTHLY TARGETS ARE currently 220,000 tonnes of ore. To meet these targets, consistent productivity is demanded, first from the drill and charge-up operators and then from the load and haul teams.

Barmingo Chief Operating Officer Victor Rajasooriar explains that the

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tonnes of ore, once processed, will yield just six ounces of gold.

increasing demands on production had prompted the company's decision to purchase five Sandvik TH663 trucks. "Having equipment that enhances the safety and productivity at our operations is key to our success," he says. "Sandvik TH663 held high promise of being a cost-effective unit now and in the long term. So far, it's delivering for us."

Sandvik TH663 brings to the table outstanding reliability, the biggest tub capacity in the business, low fuel consumption, low diesel particulate emissions and, for a vehicle that weighs well over 100 tonnes fully laden, impressive manoeuvrability and speed across open ground. But from the perspective of Craig Metzke, Barmingo's Sunrise Dam alternate project manager, possibly the biggest single attribute of the new truck is the attention that Sandvik engineers have paid to operator comfort and safety.



Perth ● Sydney ● Melbourne

TECH SPECS SANDVIK TH663 HAUL TRUCK

- Sandvik TH663 weighs in at 43 tonnes, about eight tonnes lighter than the model it replaced, with a resultant drop in fuel consumption. Its fully laden weight is 106 tonnes.
- The truck is powered by a Cummins QSK19 Tier 2 diesel unit rated at 567 kW, which gives a maximum haul speed of 42.5 kilometres per hour.
- Operator comfort and safety is enhanced by an ergonomic and noise-suppressed ROPS- and FOPS-certified safety cabin, 35 percent larger than on earlier models.
- Sandvik TH663 has been designed with speed and safety of maintenance in mind. All regular service points are accessible from ground level.
- A unique feature of the truck is its built-in jack system, which provides a much faster and safer means of changing a wheel in the event of a tyre blowout underground.
- With an overall length of 11.58 metres and a width of 3.48 metres, the truck has an outside turning circle radius of 9.35 metres.



“The trucks have a front axle suspension specifically designed to cushion operators from the jarring they experience in every other underground truck in the business,” Metzke says.

“With five Sandvik TH663s we are consistently shifting more ore than we did with our previous fleet of six trucks of a similar load capacity.”

Not only is the fleet moving more ore, he says, but it is using substantially less fuel in the process. Current consumption at Sunrise Dam is 15 percent less

compared with earlier vehicles. Sandvik TH663s are also delivering a significant reduction in diesel emissions compared with earlier fleets operated by Barminco. This allows the fleet to operate in sometimes sub-optimal ventilation areas, where the emissions from earlier haul trucks might have posed a hazard.

Barry Martin, Sandvik product support, load and haul, is currently working with Barminco staff on site setting up a wireless data logging system that will ultimately enable data

to be remotely accessed from any point in the mine by Barminco and Sandvik personnel at the mine site or even at their respective Perth offices.

“The system will transmit production information to enable management to track performance against target,” he says. “But the main benefit is the maintenance data transmitted. This gives early warning to maintenance crews of developing problems, enabling these to be dealt with quickly at an early stage, which minimizes both downtime and the cost of repairs.”

Sandvik TH663's built-in jack system lifts provide safe access to the underside of the truck.





SANDVIK SOLUTION ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦

• Sandvik equipment features prominently in Barminto's underground fleet at Sunrise Dam, with five Sandvik TH663 underground trucks, all delivered in 2014, two development drills and three production drills. An additional truck is scheduled for delivery early in 2015.

In recent months the drill team has set new records for the mine in terms of development meterage, and the new five-vehicle truck fleet is exceeding haulage targets. Currently each truck is hauling more than 800 tonnes per shift, giving a fleet total of more than 8,000 tonnes a day.

Sandvik has developed a close working relationship with Barminto through Peter Campain, the contractor's general manager of assets, who provided input into the design of Sandvik TH663. Sandvik technical staff members maintain a regular presence at Sunrise Dam, helping to bed down the new fleet and working with Barminto management, mining supervisory staff and operators to further refine its products.

Equipment that enhances the safety and productivity of our operations is key to our success



Sandvik TH663 fits the narrow confines of the tunnels below Sunrise Dam perfectly.

▶ **A UNIQUE SAFETY** feature of Sandvik TH663 that has particularly endeared the truck to the Barminco team at Sunrise Dam is its in-built jack system.

“Because of the very confined space underground, which limits the amount and type of equipment you can bring to bear on the problem, it can take half a shift or more to effect a wheel change,” Metzke says. “Sandvik TH663 has a built-in hydraulic jacking system that enables the truck’s body to be lifted clear of the ground in literally just a couple of minutes, even if it is fully laden, with no additional equipment. It’s a sensational innovation.”

While the new truck fleet is very much the focus of attention at the moment, Metzke is quick to acknowledge the importance of the role played by the drilling teams.

“We have a fleet of five Sandvik units, two development drills and three production jumbos here at Sunrise Dam, and they do a magnificent job,” he says.

“This month two of the jumbos set a new benchmark for this mine, notching up 448 metres of advance each. That’s a major achievement in the sort of conditions we’re dealing with here.”

It’s said that the ground conditions at Sunrise Dam give a whole new meaning to the expression “hard rock mining”. As one of the maintenance crew quipped, “If gear works here, it will work anywhere.”

That’s Sunrise Dam in a nutshell: hard rock, modest ore grades, hypersaline ground water, harsh weather conditions and high production expectations. A close working relationship with Sandvik is helping Barminco to rise to all these challenges. ■



See a video about the Sunrise Dam gold mine at minestories.com

AngloGold Ashanti and Barminco

• The Sunrise Dam mine is owned by AngloGold Ashanti Australia Ltd, a wholly owned subsidiary of AngloGold Ashanti Ltd, the world’s third-largest gold producer. Since its inception in 1997 the mine has produced almost 6 million ounces of gold. Underground reserves and resources are significant, with remaining mine life and the high potential for further extensions to the existing ore bodies taking production well into the next decade.

All underground work at Sunrise Dam is handled by leading Australian mining contractor Barminco, which was awarded the original contract in 2003. The current contract covers all underground development work as well as production.

About 500 people are employed at Sunrise Dam, including the Barminco workforce of 220.

Barminco employs more than 1,500 people across Australia and boasts one of the largest fleets of underground equipment in the country, comprising more than 200 vehicles and drills. The company currently owns five Sandvik TH663s, all of which are deployed at Sunrise Dam, and will take delivery of six more in 2015.

TOTAL CONTROL

■ Sandvik AutoMine Surface Drilling enables simultaneous control of multiple drill rigs by a single operator, delivering substantial safety and productivity benefits to open-pit operations.

Text: **TURKKA KULMALA**

Illustrations: **BORGS.NU** Photos: **ADAM LACH**



Up to four automated units can be controlled by a single operator.



Sandvik AutoMine Surface Drilling enables operators to work in safer environments.

SANDVIK AUTOMINE SURFACE Drilling is a system that can remotely control several drill rigs, helping surface mines maximize safety and productivity. Its main innovation over traditional systems is that the operator supervises the drilling process instead of manually drilling the holes. The system provides the operator with a real-time view of the whole production area and enables process optimization.

All new Sandvik products are engineered to contribute to the company's Environment, Health and Safety (EHS) focus. With Sandvik AutoMine Surface Drilling, the safety benefits are particularly pronounced. Mine automation directly removes operators from hazardous locations and instead allows them to work in a safe control room, virtually eliminating the risk of injury and the hazards of noise, dust and vibration. Another major safety benefit

is improved visibility over the entire work area.

A camera system enables 360-degree visibility of what's going on at each drill, with several onboard cameras and a remotely controlled pan-tilt-zoom camera for drilling, rod handling and tramming. Also, the actual workstation – seat, displays, controls – is identical to the drill rig itself.

Easy and safe functionalities ensure fast start-ups and switching between rigs in all conditions. Furthermore, the automation system joins all the drilling equipment in an integrated system with diagnostics for easy troubleshooting.

The entire Sandvik AutoMine Surface Drilling system is scalable across four different levels of automation, from intelligent control of the rig equipment (level 1) to an increased level of integration for remote monitoring and reporting, production management and information management (level 2), teleremote control of several units (level 3),

The entire system is scalable across four different levels of automation

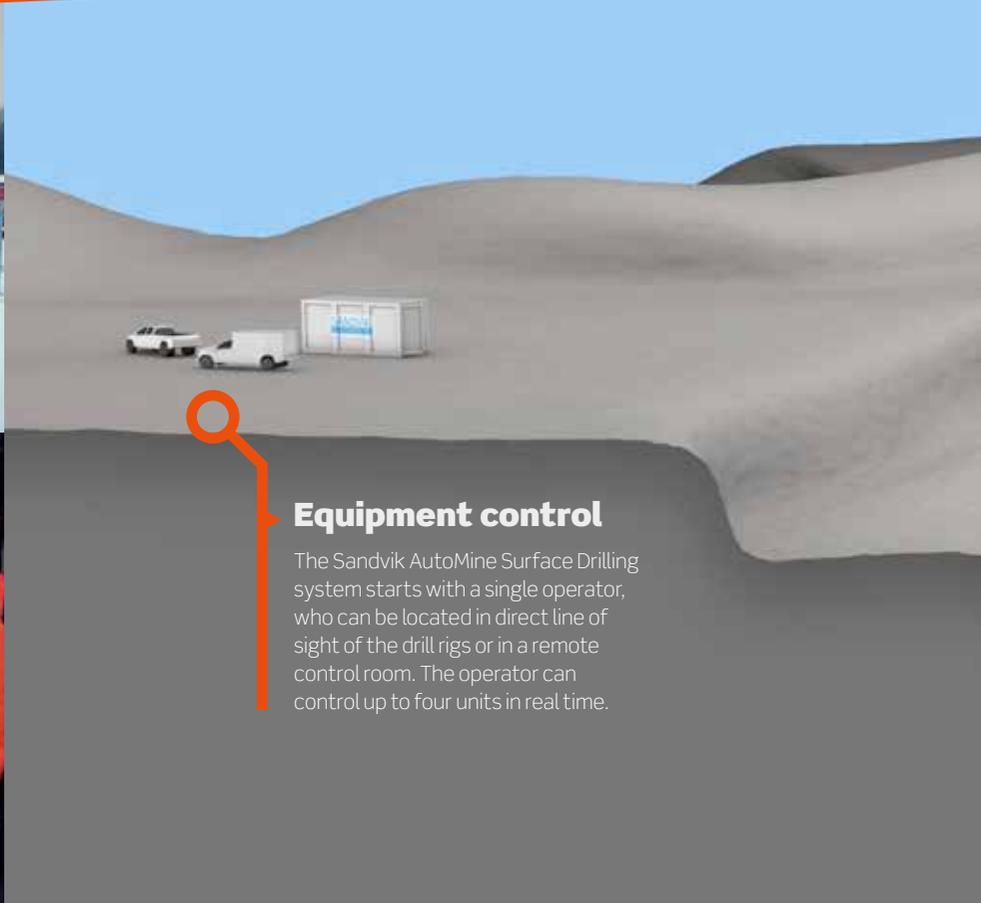
and finally fleet automation of semi- or fully-automated equipment (level 4).

FROM A FLEET management standpoint, teleremote control offers significant savings in operating costs. In addition, the system will cover real-time production management. The Drill Site Control system will provide real-time visualization inside the rock utilizing Measurement While Drilling (MWD) technology and a mine-wide communication network. The system collects data continuously during operation to determine the rock type

SANDVIK AUTOMINE IN A NUTSHELL



Remotely controlled cameras onboard the equipment enable 360-degree visibility for operators.



Equipment control

The Sandvik AutoMine Surface Drilling system starts with a single operator, who can be located in direct line of sight of the drill rigs or in a remote control room. The operator can control up to four units in real time.

and stratigraphy in real time as drilling proceeds.

ON THE BASIS of continuous data logging, the production team can make informed, proactive operational decisions. The system also helps to reduce production costs and continuously improve the efficiency of production. The technology provides insight into rock mass and forms the basis for drill and blast optimization available in real time for mine managers, geologists and chargers. Together with 3D hole navigation, the system enables accurate hole positioning and parallel holes and ensures that toe levels are accurate, translating into better fragmentation.

With tablets, laptops or smartphones, the information can be made available anywhere, in the pit or in the office. Sandvik AutoMine Surface Drilling will deliver users value,

enabling not only real-time visibility of the operation and rigorous reporting of production data, but also opening new or elusive areas to production. The system offers confidence for continuing production safely and efficiently above voids, close to dangerous heights or under high walls, for example.

The optimized and automated fleet of drill rigs reduces operating costs and provides real-time visualization of the status of the production area.

The system will drill the holes according to the plan, in the right place and at the right depth and angle, all of which will improve the outcome of the blasting by reducing the required amount of explosives, optimizing fragmentation and facilitating the separation of ore and waste.

Sandvik AutoMine Surface Drilling will be available for all intelligent top hammer, down-the-hole and rotary drill rigs. ■

TECH SPECS

Available for Sandvik DP900i/1100i/1500i

- Offered as factory option, with retrofit possibility for rigs with onboard automation capability
- **Up to four drill rigs controlled remotely by a single operator**
- Compliant with EU Machine Directive and related safety requirements
- **Multi-satellite RTK GNSS navigation, compatible with GPS and GLONASS**
- IREDES standard format for drilling plans
- **Interfacing with third-party fleet management systems for logging real-time production, operator performance, drilling data and equipment KPI and health data**
- Four automation levels:
 - 1 - Intelligent equipment control
 - 2 - Information management
 - 3 - Teleremote control
 - 4 - Fleet automation

Continuous data logging

The Drill Site Control system offers real-time visualization inside the rock using Measurement While Drilling technology. The system continuously collects data during drilling to identify the rock type and stratigraphy in real time.

Multi-level automation

Sandvik AutoMine is scalable across four different levels of automation including intelligent equipment control, information and production management, teleremote control and fleet automation of semi- or fully automated equipment.

THE WHIFF OF SUCCESS

■ The Gold Sniffer's journey from innovative idea to revolutionary product was a long one for inventor Jim Kendall, but his unwavering belief has him poised to change the world of gold mining and mineral exploration.

Text: **JEAN-PAUL SMALL** Photos: **SILKE FISCHER**



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HE LIGHT BULB went on for a sweaty Jim Kendall on 19 January 2011 at 6:50 pm. The Canadian inventor who holds four degrees in engineering was at his gym in Ajax, Ontario, when he finally figured out a way to turn photographic images into gold – or more accurately, to form images of gold particles using his revolutionary creation, the Gold Sniffer.

“At its core, the Gold Sniffer is a technology that combines spectral (i.e., light) and spatial information,” Kendall says from his lab at Conestoga College in Kitchener, Ontario. “The two issued and five pending patents are based on combining those two techniques. No one has ever patented that before.”

55K
Retail price of the
Gold Sniffer in
CAD.

LIKE A GEIGER counter that detects radiation to locate uranium, Kendall’s invention is a portable device that can quickly detect gold and electrum particles as small as three microns. It uses a high-resolution macro lens and a sophisticated CMOS sensor, like those in digital cameras, to shoot images of a mineral sample. Using complex algorithms the Gold Sniffer executes a pixel-by-pixel interpretation of the photo to find the gold particles in the sample.

“Gold has a unique colour, and there is some very deep physics as to why that is,” Kendall says. “So what the Gold Sniffer is really doing is looking for that unique colour in the digital image it takes. Combined with spatial data, it determines the gold grade and the number and shape of the gold particles in the rock.”

Currently, assays are the most common way to determine whether

there is gold in a sample. An assay can take from days up to a month, “during which time,” Kendall says, “decisions need to be made, and decision makers can lack necessary information. The Gold Sniffer provides results in minutes.

“Also, during the assay process, spatial information is lost when the sample is ground into a powder. The Gold Sniffer detects gold using a non-destructive optical method, which leaves the sample, and the spatial information, intact.”

Kendall hopes to start selling his invention this year. The path to commercialization, however, has been a long one for the descendant of miners from Cobalt, Ontario, the site of a silver mining boom in the early 20th century.

“Growing up, we used to get mining magazines delivered directly to our door, like the newspaper, and our family still has mineral claims in the area,” he

“It’s taken a lot of time, effort and funding to develop this project”

At its core, the Gold Sniffer is technology that combines spectral and spatial information



says. “But when I went to university I studied engineering physics at McMaster University before getting a master’s and PhD in electrical engineering at Carleton University specializing in microelectronics.”

With his degrees in hand, Kendall worked in the microelectronics industry for 20 years, designing everything from transistor structures to entire design systems for microchips.

BY 2007, KENDALL felt it was time for a change. The electronics industry was mired in a downturn, so he decided to enrol at Queen’s University to study mining engineering and get back to his roots. It didn’t take long for the 40-something freshman with 20 years of experience in electronics to start attracting the attention of his peers. With his background, Kendall was a captivating candidate for research projects, and within a few months he began working on the one that would change his life forever.

“In 2008 and 2009, I took a job in Toronto with the mining company that was involved with the research project,” Kendall says. “That’s where the idea behind the Gold Sniffer was born. I worked with them for two years, but they cut eventually R&D spending, leaving me and the team without jobs.”

ALL WAS NOT lost for Kendall, though. He became the CEO of Excalibur Resources in 2010 and got the dormant mineral exploration company going again, starting exploration projects in British Columbia and Ontario and a gold mine in Mexico. It was shortly after leaving Excalibur, working off the stress of another day at the gym, that he had his Eureka moment. Today he and his wife and business partner, Catherine Campbell, own Kendall Technology and its unique product, which will sell for 55,000 Canadian dollars (36,000 euros).

“It’s taken a lot of time, effort and funding to develop this product,” he says. “We’ve received government grants, invested substantial amounts of our own money and spent a lot of sleepless nights to get the commercial version ready, but it’s all been worth it.”

Kendall stresses that his invention will not replace assays completely, and that there is room for both the Gold Sniffer and traditional methods of exploration within gold mining.

“Assays won’t go away, as they’re typically built into legal structures,” he says. “And anyway, I believe the Gold Sniffer will spur on more assays because it encourages gold exploration.”

It smells like Kendall may be on to something. ■

How it works

1 Photograph the orebody on site

Using a high-resolution camera and CMOS sensor, it shoots images of any potential sample.



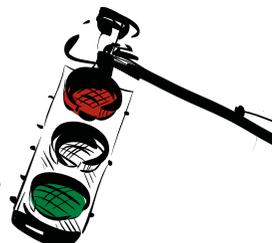
2 Analyze the image

A complex algorithm interprets the photo to determine if there is gold within the sample.



3 Decisions can be made quickly

Minutes after the images are taken, the results are available, showing whether there is gold or not.



SHAKE, RATTLE AND ROLL

■ It's no secret that miners work in tough environments, and large equipment operators can be subject to heavy vibrations for up to 12 hours a day. Reducing these vibrations is a key objective for Sandvik Mining.

Text: **ALANNAH EAMES** Photo: **SANDVIK**

OCCUPATIONAL HEALTH therapist Barbara McPhee, author of *Bad Vibrations: A Handbook on*

Whole Body Vibration Exposure in Mining, has long questioned whether the mining industry is doing enough to tackle the issue of "whole body vibrations". She argues that miners are particularly vulnerable because they often have to work on rough roads in equipment that sometimes lacks adequate protection. Sometimes, the industry underestimates the seriousness of the impact of vibrations on workers' health. "It's very hard sometimes to make the call if you're not aware of it or if you don't understand it very well," she says.

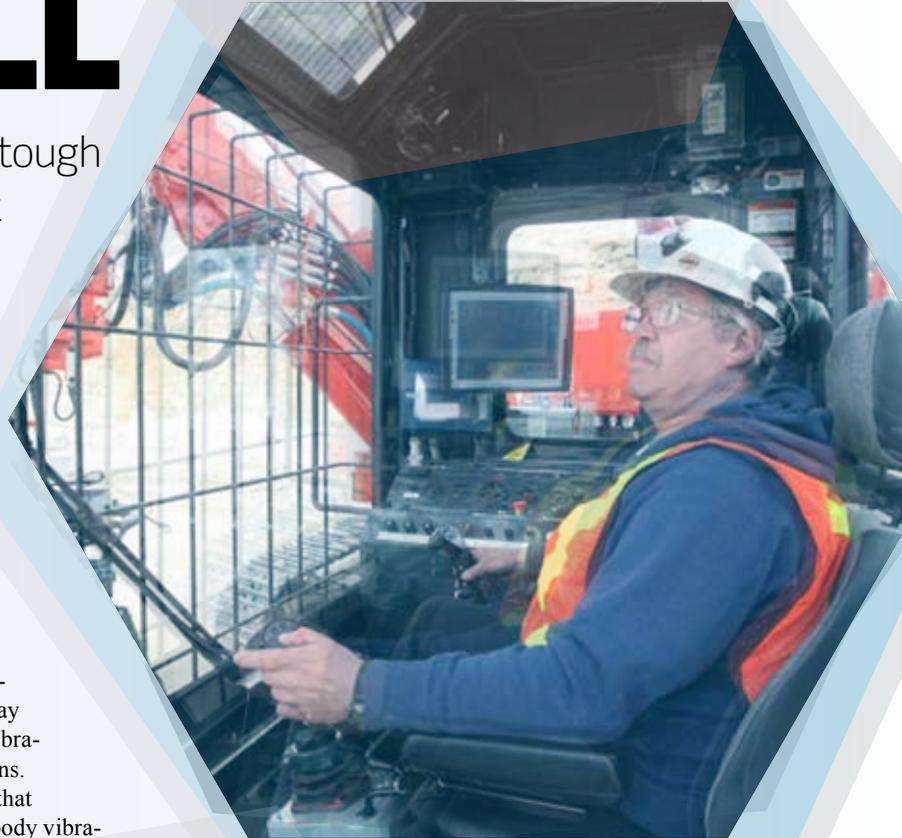
Over time, exposure to loud noise can lead to serious complications such as loss of balance, permanent hearing loss, stress, tinnitus and chronic fatigue. Constant vibrations can cause operator discomfort, spinal issues and neurological and vascular disorders.

"It seems that the spine fatigues with this constant vibration, but there are

other types of disorders like gut disorders and circulatory disorders that may occur as a result of vibration," McPhee explains.

The good news is that awareness of whole body vibrations is improving as both regulatory authorities and mining companies and suppliers step up their efforts to reduce the impact of noise and vibrations on mine workers. For example, Australia's Department of Natural Resources and Mines for Queensland includes whole body vibrations in its health and safety priorities, recognizing the importance of the issue. Academic institutes are teaming up with mining companies to research the long-term impact and come up with tools such as whole body vibration measurement devices to reduce vibrational exposure.

Other companies, like Sandvik, have long been focusing on reducing the noise and vibration levels for operators using its equipment. Environment, Health and Safety (EHS) issues are part of the company's DNA.



15

Reduction, in decibels, of sound using rubber liners alone.

SOLID GROUND EXAMINES the development of four products from Sandvik and the work that's gone into them to make them as noise- and vibration-friendly as possible for operators. Besides making life more comfortable for operators, these features often have additional benefits for the mine. Sometimes they can lengthen the lifespan of the equipment or deliver fuel savings. And most importantly, a healthier and happier worker can mean fewer lost time incidents, which makes for more efficient mining operations at the end of the day.



Rubber liners on the truck box

OFTEN, THE ROADS in mines are rough and drivers are shaken around, not to mention the noise level when manoeuvring heavy underground trucks. Using rubber liners on the bottom of the truck can reduce the strength of the vibrations and noise for the driver, as rubber absorbs much more energy than a steel liner. For example, if a rock hits a truck box with a steel lining, all the energy will hit the chassis, resulting in a loud bang and strong vibrations. If the truck has a rubber lining the impact is much quieter.

“Structural vibrations are around five times less compared to a steel lining,” says Oskar Larsson, product manager for wear protection at Sandvik. “The noise is cut by at least 15 decibels. The rubber liners reduce the noise from 95 decibels to less than 80 in the cabin, and from 100 decibels to around 80 when measured 30 metres away from the truck.”

During the development process, Sandvik conducts material tests to select the best rubber compound and thickness to minimize the level of noise and vibrations. “It’s a challenge to find the best balance between making sure the rubber reduces the impact of noise and vibrations as much as possible, and ensuring it can withstand abrasive wear and tear,” Larsson says.

Using a rubber lining on the truck box instead of a steel one also has benefits for mining companies. A Sandvik rubber lining lasts around five times longer than a steel lining, which means lower operating costs over time.

The new Sandvik DR461i drill rig cabins

LAUNCHED IN EARLY 2015, the cabins on the new Sandvik DR461i drill rigs are insulated to dampen the noise level. As these drill rigs are engineered to operate in the harshest conditions, Sandvik used a company that specializes in noise and vibration reduction to design the cabin, and employed a third party to test the noise and vibration levels. All cabins are certified with the falling object protection system (FOPS).

The cabin is mounted on vibration isolators, which limit the strength of the vibration reaching the operator’s seat; the seat itself has its own air suspension system.

To make the operator’s shift more pleasant and less tiring, there are more ergonomic controls in the armrest with automated functions. The Sandvik Compressor Management System isolates the compressor, eliminating the need to maintain pressure when not drilling. This option also has a benefit for the mine: it can deliver fuel savings of 20 to 35 percent. Less fuel also means less engine noise.

“This newly designed cabin is quieter than its predecessor because it has an improved airtight enclosure,” says Tab Siegrist, product line manager for surface drills at Sandvik Mining. “It also has top-grade insulation and a canopy-style roof. This canopy along with the windows helps to reduce heat inside the cabin. Our goal is to have these kinds of cabins on all our drills to ensure consistent quality and standards.”

Darlene Dutcher, product safety manager for surface drills at Sandvik Mining, adds, “Our standards are for noise to be less than 80 decibels. Vibration levels are also under acceptable levels according to ISO regulations. The next step will be to limit noise from the engines and compressors.”



Load and haul cabins

UNLIKE OTHER EQUIPMENT that is stationary or moves slowly, underground loaders and haul trucks play a major role in mining operations – their efficiency directly influences the mine’s output. Equipment working underground operates in even tougher conditions – roofs on tunnels and roadways are often low, and because visibility and space are limited it’s inevitable that sometimes a vehicle will collide with the rock walls.

Making life comfortable for machine operators means they will be more relaxed and focused during their work-shift, which can reduce the risk of accidents. Reducing the impact of noise and vibrations for the operator is an important part of this.

“This means we have to develop products that can tackle tough tasks but at the same time offer the best possible safety features for the operators and other people in the mine,” says Jani Tapanainen, load and haul project engineer.

Sandvik haul trucks have an extensive suspension system – including rubber tyres, machine axle suspension and operator seat suspension – to reduce vibrations for the operator. The cabin fixing method and damping system are also part of the suspension system. Each suspension system is tested and fine-tuned in the best way so that it can work on different road conditions and cope with light to heavier vibrations.

The cabin installation method reduces noise entering the cabin through the machine’s frame, and sound insulation provides an extra layer of protection.

“We test the interior acoustics in the cabin during development,” Tapanainen says. “The materials we use on the interior and the layout of the cabin play a major role in soundproofing the inside of the cabin. The slightest gaps or small openings in the cabin’s frame can ruin the good sound insulation, so every door sealing, cable inlet and the like needs to be designed to fit as seamlessly as possible.”

Dust extractors on bolter miners

CUTTING THROUGH ROCK creates dust. Therefore, it’s important to make sure that the air containing suspended dust is fed into an appropriate exhaust system or dust extractor system to keep the air in the workplace as pollution-free as possible. Many Sandvik products have integrated onboard dust extractor systems. This is especially useful in areas where space is limited for external systems. For example, nearly all bolter miner orders for China are equipped with such filtering units.

Even though these air-filtering systems are important to improve air quality for workers, they can create additional noise.

“To isolate the vibrations of the extractor fan from the scrubber box, Sandvik has applied an elastic-mounted fan, and we also developed a new kind of rear silencer,” says Egmont Lammer, product manager EHS underground coal and minerals. “These features are unique in our industry, and we have filed two patent applications.”

The new filtering systems have reduced noise levels by eight to 10 decibels, depending on the operator’s proximity to the machine.

“Our customers appreciate not only the benefits of suppressing and extracting dust, but also of keeping noise to a minimum level for their operators’ health and productivity,” Lammer says.



GENIUS GROTTO

For centuries, Fingal's Cave has moved many who have glimpsed its geometric intricacies and heard its uncommon cry to create timeless works of art.

Text: JEAN-PAUL SMALL Photo: JIM RICHARDSON

TO SAY THAT BASALT is a common rock would be an understatement. The volcanic rock has been found on land, the ocean floor and even on Mars and Venus. While used in a variety of applications, today basalt is used most as aggregate in construction. So how could a cave filled with something so commonplace inspire anyone to anything?

Step into the mouth of the Isle of Staffa's Fingal's Cave in the Inner Hebrides in Scotland and you have your answer.

First discovered in 1772 by naturalist Sir Joseph Banks, Fingal's Cave has evoked strong sentiment for hundreds of years in those who dare to enter. The cave, which is made up entirely of hexagonal columns, was created when cooling on the upper and lower surfaces of solidified lava resulted in contraction and fracturing. The hexagonally joined basalt columns are unique in themselves, but the sound of the waves echoing off their symmetrical surfaces gives the place an otherworldly quality. A naturally occurring, water-level walkway invites visitors to challenge their fears and explore its darkened depths. Those that do tend to come away changed.

When German composer Felix Mendelssohn visited Fingal's Cave in 1829, he was so inspired by the echoing sound emitted by the waves he wrote the now famous "Hebrides, Op. 26" (which is also known as "Fingal's Cave Overture") upon his return. Mendelssohn's composition so stirred the public at the time that it drove other artists to see what could have influenced the German so. Romantic poets William Wordsworth and John Keats visited, as did Poet Laureate Alfred, Lord Tennyson. Early science fiction writer Jules Verne used the site in three of his books: *The Green Ray*, *Journey to the Centre of the Earth* and *The Mysterious Island*. Swedish playwright August Strindberg used the cave as a setting for a scene in *A Dream Play*. In more modern times, British rock band Pink Floyd has a song with the cave's name in the title and Scottish rock band Wolfstone recorded "Fingal's Cave" on their album *Seven*.

But perhaps the most apt description comes from Scottish historical novelist and poet Sir Walter Scott, who upon visiting the cave exclaimed, "It is one of the most extraordinary places I ever beheld. It exceeded, in my mind, every description I had heard of it." ■



“ It is one of the most extraordinary places I ever beheld. It exceeded, in my mind, every description I had heard of it

SIR WALTER SCOTT

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ENVIRONMENT, HEALTH AND SAFETY (EHS)

Stay safe. Our objective is zero 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 on a range of equipment, our products are designed to improve the environment and reduce health and safety risks in our customers' operations.



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 metre 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

Reliable LHDs 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.



CONTINUOUS MINING AND TUNNELLING

Always advancing. 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

Ready to roll.

Our complete components offering supports modern conveying practices in mining and includes rollers and frames, idlers, pulleys and belt cleaners, condition monitoring and safety control devices and loading sections. With an emphasis on performance and reliability, products 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 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.



SERVICES

Peace of mind.

Our technicians are highly skilled in best practices to safely maintain and optimize your equipment, ensuring you get the most out of your capital investment. Our primary focus is to provide support and keep you operating and more productive. By signing up with Sandvik, you get the capabilities of a global industry and service leader delivered directly to your site, providing peace of mind and enabling you to focus on your core business.



MINE AUTOMATION

Complete control.

The Sandvik 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 machines raise productivity sharply.





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