



**Paul Moore spoke to the global rock tool majors about their take on bit changes & life in autonomous drilling applications plus the latest on new products and technologies**

**A**utonomous drills are gaining traction all the time – and that means fully autonomous multi-pass surface drilling, not just remotely operated. Underground autonomous production drilling is also evolving fast, with development drilling not far behind. This begs the question – if a principal upside of autonomy is equipment having to stop working far less often, then what are the implications for the top hammer & DTH bits that are doing the work?

Pejman Eghdami, Executive Vice President, Rockmore International told *IM*: “Since Rockmore is primarily a drill tool designer and manufacturer, we as a company have to understand drilling equipment technology and how our products interface with such equipment. In the past, the drilling equipment did not particularly depend highly on the drilling tool design with integration between equipment and tooling as a necessary functional constraint. A wide variety of tooling quality and design characteristics could be installed on the drilling equipment. Certainly, drilling efficiency and total drilling cost will vary across different quality and brands of drilling tools for various rock formations and drill settings. But by large, current drill rigs will generally perform with industry standard tooling and be subject to downtime for tooling changes that will be more frequent and time consuming with lower quality tools, leading to higher drilling costs. The newly emerging drill rigs, however, that are classified as autonomous drill rigs demand tooling that will have to exhibit longer lifetime and reduced wear rates in order to minimise tool changes that would be counterproductive for autonomous settings.”

He adds: “Since it is desired to minimise the operator interaction with the drill rig for at least a full drill shift, the drill tooling is required to either maintain its integrity or efficiency during the entire drill shift or be changed automatically with a robotic system. The

lifetime of the drill tooling for the bits and drill rods can certainly be extended by utilising new materials and design features in the future. These gains, however, will be incremental and not cost effective for every drilling environment or rock condition.”

Pejman also argues that it is the drill rigs that also need further technological development to sense when the drilling tools require a change due to wear or abuse. “The feedback systems in current rigs today rely on pressure settings to discern for worn tooling, especially for the drill bit. But such systems often fail in their functions and instruct the operator to change the drill bit when in fact the bit is still adequately usable. In other instances, the feedback system fails to instruct the operator that the drill bit or drill rod is past discard limits due to fatigue wear or other parameters.”

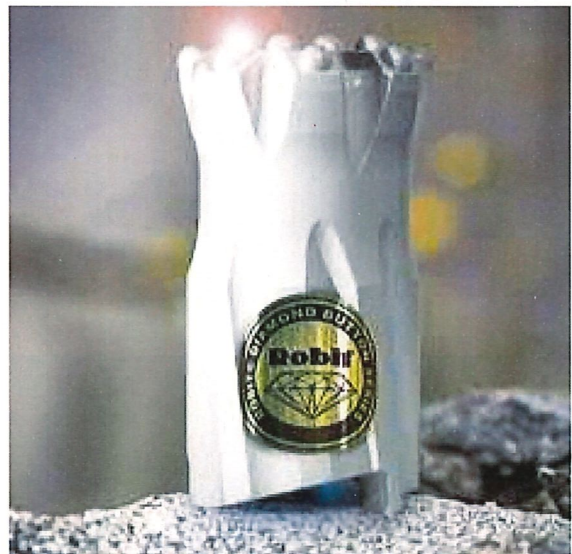
Rockmore sees drill rigs in the future needing secondary feedback systems such as automated measuring of the drill bit diameter or wear indicators to properly inform the operator regarding the drill tool status. “In addition, automated robotic arms and systems should be incorporated in underground drill rigs to perform bit and rod changes if the drill rig is required to work autonomously with zero or minimal operator interaction. Autonomous drilling, therefore, is still in its early development stages regarding the interaction between the drill rig and the drill tool requirements necessary to offer a drilling operation underground with zero or minimal operator involvement.”

Jose Rodriguez Callao, Robit PLC Sales Manager

*Epiroc says its new Epsilon<sup>2</sup> premium tricone drill bit will see surface mine blasthole drilling customers enjoy up to 100% longer distance drilled before bit discard*

comments: “It is clear to everyone that the trend in mining as in other activities is oriented towards automation, but in a mine drilling is only part of the process, so stopping all work to change bits, even if you have auto pulling, for safety still means stopping all work while refilling or changing bits with a human presence, which means high operating costs, so the longer the interval for these changes, the more savings for the mine.”

Robit’s Director Global Sales, Jorge Leal adds: “Until drill rig manufacturers invent an automatic way to change the drill bits, there will be a need for more resistant drill bits so they can keep running the machines without interruption. Depending on ground conditions, a drill bit can drill between 50-80 m before it needs to be taken out to be re-sharpened. A drill rig can drill 250-300 m in a shift (depending on many



*Robit sees its new diamond coated button bits as part of the solution to enable autonomous drill rigs to drill for longer without interruption*



variables) so it is not productive to take out those bits. That is why for example Robit has diamond coated button bits to provide the solution to drill with ease that amount of meters, and even more.”

Brunner & Lay Marketing Director, Shane Jimison commented: “The autonomous drills either underground or surface will produce better results on drill string life and efficiency. These drills can be set up based on the current environment with the proper settings and the end result will allow for life improvements along with better production numbers for the mining operations. This will eliminate setting changes, poor drilling habits and many other factors that not only reduce the life of the drill string but overall efficiency.”

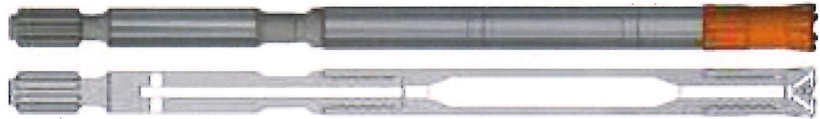
### Rockmore unveils Retrac

In new product developments, Rockmore recently introduced a new drill bit design specifically used in tunnelling applications. Reaming type bits in underground drilling and blasting operations are used to enlarge selected existing blast holes to bigger diameters for effective blasting and rock fragmentation. This is typically performed in tunnelling, mining, and underground construction drilling operations. The larger reamed holes are not loaded with blasting agents and therefore allow the rock formation to implode during the explosion phase. The empty voids in these reamed holes promote better rock fragmentation and more efficient blasting patterns.

After blast holes are drilled in the drift or tunnel face with hole diameters ranging from 43-51 mm, certain holes in the pattern are enlarged with a typical reaming bit to 76-102 mm, depending on the blast and rock formation requirements. Standard reaming bits feature face designs with dome or narrow nose fronts and are intended to effectively enlarge a predrilled hole. When



Rockmore Retrac bit designed to ream from 41 mm to 102 mm holes and configured with a R32 thread connection to the tunnelling rod



they are retrieved out of the hole, however, at the end of the target hole depth, they often seize up due to the loose rock debris inside the hole formation.

Rockmore engineers addressed the challenge of retrieving these style bits by developing a new model that features retract style cutting fins in the rear section to promote better retraction out of the hole. The fins effectively push out any rock chips trapped behind the bit when the drill string is pulled from the blast hole resulting in more efficient reaming operations in underground drilling operations. The particular model shown in the attached image is designed to ream from 41 mm to 102 mm holes and configured with a R32 thread connection to the tunnelling rod.

### Brunner & Lay points the Arrow

The new Arrow drilling system from Brunner & Lay it says was developed to enhance the ability of modern, high powered rock drills in both surface and underground applications to produce more precise holes necessary for production in the modern mine & quarry site. Jimison comments: “Blast holes that are straighter improve several aspects of the drill/blast operation with overall time savings having most impact to the operational bottom line. Straight holes improve drilling by providing less bending stress on the drill string and reduced hole deviation to improve the service life of the string. Typically requiring less energy to produce the holes, thus saving on fuel and wear-and-tear on the drill itself. Straight holes improve blasting operations by reducing fly-rock, back-break and deliver intended fragmentation to reduce the need for secondary drilling and breaking.” The system is currently available for its T38, T45, T51 and B60 applications.

The company adds: “Straight holes mean easier and faster drilling and charging. Less bending stress throughout the drill string yields less fatigue induced drill string failures extending service life. Brunner & Lay is now offering a variety of straight hole drilling tools in the form of guide rods, guide/pilot tubes, and shoulder driven drill tubes to meet a wide array of applications. Utilisation of this system along with the proper bit design for the rock type can produce significant improvements in the operation's bottom line.”

Fewer drilled holes means an optimised drilling pattern with increased burden and spacing, less possibility of drill string jamming, improved safety with better blast control and reduced consumption of explosives, which makes up for 40-50% of the total cost of drilling and blasting.

Drill tubes are more rigid than conventional drill strings of extension or MF drill rods. It is this increased rigidity that ensures far less hole deviation and a more cost-effective drill and blast cycle. Additional rigidity provided by pilot/guide and drill tubes enable thick

*The new Arrow drilling system from Brunner & Lay it says was developed to enhance the ability of modern, high powered rock drills in both surface and underground applications to produce more precise holes*

layers of overburden and broken rock to be drilled through without appreciable hole deviation. Tubes also limit the potential for jamming while retracting the drill string through overburden.

Jimison told *IM* that customers that have used the system have experienced less hole deviation when compared to traditional systems in both underground long-hole applications and top-hammer surface use.

### Sandvik digitalisation & Guide Adapters

Back in June 2020, Sandvik Rock Tools launched what it says is an entirely new digital solution: My Rock Tools – Analyze. It is a mobile application designed to help customers improve their rock tool performance through analysing failure and discard reasons.

The new solution is an application specifically designed to conduct failure and discard analysis and provide advice and guidance in a customer report – all remotely. The aim is to determine the root cause of the failure or discard reason of the rock tool, prevent it from happening again and to help improve future performance.

“Sandvik Rock Tools suite of digital solutions serves our customers in a number of ways, and we are now very happy to be able to add My Rock Tools Analyze in order to offer easy-to-use remote support for failure and discard analysis. With it, customers can ultimately increase productivity and profitability by using the analysis results to improve their drilling operations” says Charles Macfadyen, Digital Solutions, Rock Tools Division, Sandvik Mining and Rock Technology.

The application is very easy to use: customers receive an invitation from Sandvik to log in, download the app (available both for IOS and Android), provide some key product information, take a few photos of their worn out tool and then send it to Sandvik for analysis and feedback.

“A big part of Sandvik's DNA is continuous improvement in close collaboration with our customers, and My Rock Tools Analyze does precisely that, in a user friendly, fast and remote way. We truly believe that this will help our customers and us both in the short and long term,” says Macfadyen. The My Rock Tools Analyze application is available for all Sandvik Rock Tools customers and can now be downloaded in App Store and Google Play Store.

Sandvik Rock Tools is also launching an entirely new product for its bench drilling Top Hammer customers: the Guide Adapter. It says that the solution enables customers to reduce hole deviation in challenging conditions by up to 50% and achieve considerable cost savings.





*Sandvik's My Rock Tools - Analyze is a new mobile application designed to help customers improve their rock tool performance through analysing failure and discard reasons*

Significant hole deviation (>8%) can pose problems for many bench drilling companies that operate in challenging ground conditions such as bad and soft rock, as well as deep overburden. This often results in reduced productivity, safety risks and increased tool wear.

"We are very happy to be able to offer the Guide Adapter to customers facing deviation problems in their day-to-day bench drilling operations. The Guide Adapter helps them to increase the service life of their drill string and also reduce the number of drilled holes, as well as the amount of blasting needed," says Fredrik Björk, Product Manager Top Hammer Surface Tools, Rock Tools Division, Sandvik Mining and Rock Technology.

Sandvik says the new Guide Adapter enables customers to achieve greater productivity, longer tool service life and improved safety. Ultimately, this can also lead to lower total operational costs.

"We have conducted in-depth testing with our customers around the world and the results really do speak for themselves. By using the Sandvik Guide Adapter, our customers achieved a hole deviation between 3% to 5% - a reduction by up to 50% - and also increased the service life of their rock tools by up to 40%. This truly has an effect on both productivity and in turn, profitability", says Fredrik Björk. The Guide Adapter is now available for T51 and GT60 Top Hammer threads in different diameters.

The very latest product news from Sandvik is that it will soon launch its Top Hammer XL, "a new groundbreaking, comprehensive drilling system for large hole size top hammer drilling in surface mining applications." It says the system has been proven in several field tests around the world by drilling more than 100 km in difficult rock conditions. "The test results show 50% reduction in fuel consumption, 25% reduction in total drilling costs and 15% increase in

productivity compared to down-the-hole (DTH) drilling method." Sandvik says it is the first to introduce this kind of new top hammer drilling technology that can achieve cost effective drilling results in large mining hole sizes. The new system will be launched in more detail during the first half of 2021.

### **Epiroc squares up Epsilon rotary bits**

Thanks to smart patented features, Epiroc says that its new Epsilon2 rotary bits will greatly improve drilling productivity through extended bit life and a faster rate of penetration (ROP). The new air bearing bit has been

tested thoroughly in the field by selected customers in highly diverse operating conditions in North America, South America and Asia. The tests show an average of more than 60% longer distance drilled before bit discard compared to the previous Epsilon generation – peaking at over 100% in some cases.

"The name Epsilon 'to-the-power-of-2' is no coincidence. It's more than an upgrade, it's a new generation," says Bahadır Ergener, Product Line Manager – Rotary. "Degrading of the bearings was long a common cause of bit failure, forcing customers to accept a slower ROP and a shorter service life than

### **JSI – China's premium tools supplier**

Paul Moore spoke to Joe Shen, Overseas Business Development Manager at leading Chinese rock tools player, JSI Rock Tools Co Ltd, based in Guiyang, Guizhou, about its market offering and position

#### **Q How successful has JSI been in the global market for mining rock tools in recent years versus other global players and what regions outside China?**

**A** We come up against the well-known global drill bit suppliers on many projects, as an example we have had a number of trials against products from Epiroc and Sandvik, and some customers have chosen us, simply because we offered a better overall cost per metre performance. The South American market particularly has been a big success for us. We have set up a branch company in Chile called JSI LA which opened in Rancagua in 2019 headed by Juan Carlos our Director and we also have an exclusive distributor in Peru. And we have been cooperating with customers at some Argentinian and Brazilian projects for years. Our product quality and performance have been proven in that region. By setting of the branch in Chile in particular, JSI Rock Tools can provide better services to local mining customers. Juan Carlos has 20 years of experience in the application of rock drilling tools in mining and has a team of experienced Chilean staff. JSI LA can provide economic and practical solutions to help drop total drilling costs, as well as they will also providing effective and quick services to meet customer demands more efficiently.

#### **Q Is it fair to say that out of the Chinese rock tools suppliers that you are considered one of the premium players? Are there any particular tools you are known for?**

**A** Among Chinese manufacturers, our quality is ranked at the top. We have strict raw materials checks and acceptance processes with our production quality checked which ensure only premium and consistent quality products are supplied to customers. Our bit type B45R32-G633A is a very typical product for underground tunnelling and drifting. Also, our MF rods (T38, T45 and T51) for underground production and open pit mines are very competitive. And unlike some Chinese suppliers we are not supplying copies - JSI has its own patents and will develop more of our own innovations in the future. Also, unlike some, we accepted long ago that hand drills are old technology and most mining companies even in China now use mechanised drill rigs which have much better safety and efficiency. We foresaw this change so our factory is designed to produce high quality threaded rock drilling tools including drill bits, rods, shank adapters and couplings from sizes R25, R28, R32, R35, T38, T45, T51, ST58, ST68 to G60 threads.

#### **Q Can you supply any customer feedback on performance of JSI tools?**

**A** Leading African contract miner, African Underground Mining Services (AUMS) is a 50:50 Barmenco/Ausdrill JC and is one of our well-known customers. Several years ago, they ran trials at a new underground mine in Tanzania on our bits with the result that on metres drilled and bit wear they were comparable to one of the major Scandinavian bit suppliers. They went on to order first our 45 mm bits and then other products.



*JSI recently set up a branch company in Chile called JSI LA which opened in Rancagua in 2019*



## Mincon sets new RC records in Northern Cape

Mincon South Africa recently supported Torque Africa Exploration at a mineral greenfield exploration drill site in the Northern Cape province of South Africa. Torque Africa is a long-time Mincon customer and has extensive experience in deep-hole RC drilling. For the project in the Northern Cape, a new Mincon reverse-circulation (RC) system was used, successfully drilling to 1,019 m in just nine days. With this new benchmark, the world of exploration drilling can now match diamond coring systems to a 1 km depth, with all the advantages of air-powered RC systems.

Between 10 and 15 February, 2020, work began on setting up a site for exploration drilling at a remote greenfield site in the Northern Cape province of South Africa. Nardus Bezuidenhout, Director of Torque Africa Exploration, moved in on site with one of his company's Thor 8000 RC truck-mount drill rigs – a proven powerhouse for his chosen method of deep-hole drilling. Joining the main rig on site were a fleet of support vehicles, including rod carrier trucks, compressors, water and fuel tankers, and medical service vehicles – as well as a full team of staff to support the operation.

With the nearest town more than 120 km away – along drifting dirt roads – it's no small undertaking to set up camp in the middle of nowhere. Even with extensive planning and logistics, fuel and water are precious resources that cannot be wasted. Time is money, and the longer these resources are on site, the higher the total cost of the project would be. When drilling exploration holes to 1,000 m or more, it's not uncommon to be on site for up to three months. That's a lot of time, money, and careful management of scarce resources.

This estimated drilling timeline is based on using diamond coring systems – known for their reliability in deep-hole drilling, albeit at a great cost. Additionally, diamond coring requires the use of expensive muds for stabilising the hole during drilling. When encountering underground cavities these muds are then wasted, and when encountering aquifers the muds can potentially contaminate a supply of drinking water.

However, for this project Torque Africa elected to use the latest products in the Mincon MR range of exploration tools. These reverse-circulation (RC) tools use a variation of the familiar air-powered down-the-hole (DTH) hammer, but designed to flush cuttings through an inner tube. Until recently, such airpowered RC systems were only used for exploration drilling up to 500 or 600 m – but changes to Mincon's newest RC hammers meant that Nardus and his team could expect reliable performance to drill much deeper.

Drilling commenced on the afternoon of 17 February 2020, using a Mincon MR120 RC hammer and a 143 mm drill bit. Slow, methodical progress was made to ensure everything was safe and functioning as intended. After reaching a depth of 114 m the team retrieved the drill string from the hole, after which the first four metres of the hole was reamed and widened to install a temporary casing. This was done to stabilise the soft ground near the surface, thus preventing hole collapse. When drilling resumed the team used a new, 140 mm RC drill bit, equipped with polycrystalline diamond-impregnated carbide buttons.

"When we chose drill string components, we opted for Mincon's bits with PCD carbides. Since we were drilling into granite we wanted extreme durability and reduced downtime associated with bit changes or bit sharpening," says Bezuidenhout. Over the next four days, drilling operations took place during daylight hours. Average progress was approximately 120 m per day, which included retrieving the drill string at 637 m in order to change sample tubes and swapping to a new, 137mm RC drill bit – both being wear components.

The process of retrieving a drill string is straightforward, but time-consuming. After lifting each pipe out of the hole it needs to be unscrewed, removed, and the remaining pipes reattached. This is repeated, six metres at a time, for the entire length of the drill string – more than 600 m at this point. Deep-hole drilling projects can become incredibly expensive if multiple drill-string retrievals are

necessary. Either the bearings would corrode due to moisture from water injection for dust suppression, or overheat by friction."

Two patented Epiroc features combine to solve the problem: Tornado, which channels cooling air over the hotter load side of the bearing, and Torrent, which

removes moisture from the cooling air and therefore reduces corrosion.

"Epsilon<sup>2</sup> outperforms other air bearing bits on



For a recent project in South Africa's Northern Cape, a new Mincon reverse-circulation (RC) system was used, successfully drilling to 1,019 m in just nine days

required, but this can be offset by using durable, reliable equipment that consistently delivers high levels of performance.

The Mincon MR120 hammer used for this project offered exactly that. As part of the newest generation of Mincon hammers, it incorporates changes informed by decades of customer feedback. Thanks to Mincon's engineering processes it's possible to quickly respond to customer needs and improve products based on real-world experiences. Additionally, all Mincon products are manufactured at its own factories, which includes full control of its proprietary, in-house heat treatment processes that ensure all products are of the highest quality. "It's clear that Mincon's engineers have listened to drillers and designed a product that has major benefits for deep-hole RC drilling, without the higher cost of alternative approaches," added Bezuidenhout.

On day eight of the project, Torque Africa Exploration resumed drilling with the fresh 137 mm drill bit – only the third bit required for the project. In order to reduce time on site, a decision was also made to move to a 24-hour drilling schedule. Rapid progress was made: in just two days the team powered through 382 m of hard granite and rushing groundwater to reach a depth of 1,019 m and making this one of the deepest exploration holes drilled using air RC tools, putting the technology on par with diamond coring as a solution for deep-hole drilling.

With the target depth reached, the drill string was retrieved for its final inspection, which showed only expected wear and no failures. Once retrieved, a post-drilling survey was conducted to verify the depth and straightness of the shaft, with the survey report indicating a hole deviation of only 0.83 degrees. This exceeds the performance of competing technologies and proves yet another benefit of air RC systems.

A record-depth hole drilled in record time would be a pointless achievement if sample cuttings were unusable, though. Fortunately, this is where the air RC approach has yet another advantage: consistently returning uncontaminated sample cuttings to the surface. This is due to cuttings being flushed up through a sample tube rather than being exposed to the drilled hole.

Bezuidenhout noted that samples continued to be collected even after encountering extensive groundwater at 886 m. For every metre drilled, a sample was collected, bagged, and tagged, allowing geologists to analyse the ground conditions and mineral content.

With this remarkable achievement, Mincon believes that air RC systems are now a strong alternative to coring-based exploration solutions. The hole drilled by Torque Africa Exploration proves that it's possible for air RC systems to drill past 1,000 m while collecting samples, using significantly less time, resources, and money.



reliability, and even challenges more costly sealed bearing bits. Users of sealed bits can now turn to Epsilon<sup>2</sup> for comparable productivity at a lower cost,” explains Epiroc. “Longer bit life means improved personal safety through reduced operator interaction with the drill bit. With twice the distance drilled, there is no need to replace the bit every day, perhaps only once a week. We believe customers will value a lower climate impact when selecting their next rotary drill bit.”

Another aspect of extended bit life is that there will be fewer bits manufactured in total over time, which in turn reduces the outtake of raw material, the transportations and the ecological footprint.

### **Robit bits pass multiple tests**

Robit actively seeks out opportunities to prove the performance of its bits versus competitor options in customer tests. In February 2019, Robit's Chilean distributor Full Safety organised a drilling test at Codelco's El Teniente underground copper mining division. The head-to-head test between four different brands – Robit and three other globally well-known brands – was carried out by Astaldi, the site contractor. The test was conducted on a Sandvik DD321 jumbo with an HLX5 drifter using R32 x 45S1 bits, a HEX35 C38-R32 14' drifter rod and coupling C38-C38. The testing conditions were identical for each brand. The procedure was a simple wear test: to measure how deep each tool would be able to drill without sharpening or replacing. Several units of the selected tools were consumed; and the results were calculated as the average meterage of each tool type. Robit says its bits averaged out at 315 m while Robit's rods and couplings averaged out at 1,724 m. Given the rock quality at El Teniente this was an excellent result. Astaldi confirmed that the Robit consumables were superior to the other well-known brands' consumables in performance.

Then in July 2020, Robit's Turkish distributor Guris Is Makinalan Endustri AS organised a drilling test at Ozkoyuncu open pit iron mine. The head-to-head test was between Robit and another globally well-known brand. The test was conducted on a Sandvik DX800 Ranger with an HL700 drifter. The testing conditions were identical for each brand. The procedure again was a simple wear test. The ground conditions were quite difficult and abrasive. The rock has a lot of quartzite with a silica content of around 90%. There is also fragmented rock, water and spacing in the strata. A Robit C51-102 mm drop centre spherical bit completed its service life at 1,269 m and this result was 300 m better than the competitor bit of similar design.

Robit has grown fast in the Turkish market. It is also supplying rock drilling consumables for face drilling, long hole drilling, and ground support operations for underground mines as well as surface drilling for open pit mines for ETI Bakir AS in Turkey. The consumables are being supplied by Robit's distributor, Guris Is Makinalari Endustri AS. ETI Bakir is the biggest copper mining company in Turkey and was incorporated into Cengiz Holding in 2004. 