

# No-constraints innovation

**Dan Gleeson looks at some of the conventional – and unconventional – ways metals and minerals can be extracted from narrow vein and low-profile mines**

**T**he development of narrow vein and low-profile mines has proven to be a major technology catalyst within the underground mining industry.

The need to remove people from confined, unsupported and potentially risky areas underground led to the introduction of teleremote, line-of-sight loading: a precursor for full machine automation.

The difficulties and cost associated with installing and maintaining fans for adequate mine ventilation could also be seen as another contributing factor to the automation trend. This also had an impact on the onset of electrical-powered production and development machines.

And, of course, as more miners looked to develop and mine narrower and more compact orebodies in an effort to reduce dilution and cut operating costs, original equipment manufacturers (OEMs) were forced to make equipment that delivers the same performance as conventional machines within a much smaller footprint. This is another development the wider underground mining industry is thankful for.

## Engines for the environment

Aramine has ended up specialising in building equipment tailored to these cramped conditions, with several machines in its range designed for narrow-vein applications.

Marc Melkonian, President of the company, says one of the biggest issues that has plagued the underground mining industry for decades is the air pollution that affects worker health.

“To respond to this issue, we have always equipped our diesel miniLoader® with an exhaust purifier,” he told *IM*.

Aramine’s second step to decarbonise the environment was developing an electric machine with a cable – “the battery-powered machine was already in our mind, but this technology was not reliable enough at that time and very expensive”, he explained.

Today, after two years of R&D, the company has a reliable and competitive battery-powered product for the narrow-vein mining sector in its miniLoader L140B.

An optimised and advanced version of the L120B, the miniLoader L140B can carry a 1.4 t payload, has a 0.6-0.8 cu.m bucket, and comes with a length of 5.3 m and width of 1.1 m, making it suitable for narrow-vein operations.

“Compared to the diesel-powered alternative, the Aramine miniLoader L140B clearly enhances the quality of the work environment for the operators and employees working around the machine,” Melkonian said.

It is also very quiet when operating and the battery drive technology offers not only improved air quality, but also significant savings on mine ventilation, he added.

The miniLoader L140B is now operating in mines in Europe, Russia, and even at high altitudes in South America, according to Melkonian.

“The true challenge for the users is to change their habits (to get the most out of the machine), but our machine reliability and ease of use have immediately pleased the users,” he said.

“The battery-powered machines offer the same, or even more breakout force than the diesel equivalent. As our battery-powered machines are using an electric transmission, this allows adjustment of the torque depending on the mine ground to provide just enough power

*GHH’s low-profile loaders have excellent weight distribution, resulting in better loading characteristics and increased component and tyre life, according to the company*

and avoid tyre spinning,” he said.

“Plus, Aramine has reduced the maximum number of components in the hydraulic system to increase the maintenance intervals to 2,000 hours (apart from daily checks and lubrication).”

While improving the working environment for miners and reducing the maintenance requirements are both valuable benefits, any new electrified machine will have to match up to its diesel equivalent to find widespread appeal in all markets.

“The solution is successful because our clients can keep the same productivity compared to working with a diesel-powered machine, and even increase it on some days,” Melkonian said.

The miniLoader L140B has been aided in this productivity quest by the ability to carry out four hours of continuous operation without re-charging – enough to muck three to four faces in one shift. After this point, an on-board charging system, requiring only 7 kW of power, is plugged into a wall socket to charge the battery.

For those requiring even more productivity, the Quick Replacement System (QRS) has been designed.

This allows the battery in the miniLoader L140B to be changed in just a few minutes. A stationary changing bench that can hold up to three battery packs with a crane to assist and facilitate the battery replacement has been designed by Aramine, and the company is also testing a mobile station to enhance the QRS flexibility.



*The Aramine miniLoader L140B is now operating in mines in Europe, Russia, and even at high altitudes in South America, Marc Melkonian says*

Melkonian explained: “Depending on the mine layout, it (the mobile station) can be useful when the changing bench can follow to the face to muck and stay close to the miniLoader to reduce the running distance.

“Moreover, the mobile changing bench will also be equipped with a crane, which can be useful within the mine. The system will be able to be used as a trailer to move the battery packs from one place to another, but also move any other heavy objects.”

Considering the miniLoader L140B has been successfully deployed across the globe, it is hardly surprising Aramine is looking to electrify other machines.

“The next step is to be always more productive, so our R&D department is currently working on a new battery-powered mining loader,” Melkonian said.

The L350B, with an incomparable “size to capacity” ratio to carry more payload in smaller gallery sections, will come with a tramming capacity of 3.5 t and a width of 1.5 m, compared with 1.4 t and 1.1 m, respectively, for the miniLoader L140B, he explained.

This will be based on the design for the diesel-powered L350D, which is already operating in mines across the globe, with plans to launch the L350B at the MINExpo event in Las Vegas in September 2021.

### The full scope

The GHH Group has a large, competitive low profile and narrow-vein offering through its investments in GHH, Mine Master and JH Fletcher, and tie-ups with Canada’s MacLean Engineering and Peru’s Overprime.

This covers applications from load and haul, to

drilling and bolting, to utility vehicles, supporting both hard-rock and soft-rock mining operations in both development and production applications around the world.

The GHH low-profile LHDs – the SLP-5 and SLP-6 – are built on simple, reliable and proven technology with extremely low operating costs and a robust frame to cater for harsh underground hard-rock mining conditions, according to the company.

The SLP-8, meanwhile, boasts a digital platform that provides operators and shift bosses with machine analytics potential. It also comes with an ergonomic operator compartment, GHH said. “The SLP-8 is the only true 8 t loader in its size class with excellent performance capabilities at a low running cost,” the company added.

The 14 t SLP-14H is the highest capacity low profile LHD in the world, according to the

company. It comes with an ergonomically-designed, air-conditioned, closed operator compartment, which boasts ample legroom and is equipped with a swivel seat ( $\pm 15^\circ$ ) making it comfortable for the operator to drive in both directions. The loader is equipped with an articulated swivel hinge, effectively reducing the height, and improving performance, while the hydrostatic drivetrain allows for a further height reduction due to the removal of conventional drivetrain components.

The maximum height of the SLP-14H is in line with the tyre diameter – even the canopy is positioned lower than the tyres to reduce the “envelope of rupture”. The loader also has low maintenance costs per operating hour, GHH says.

Looking towards operating intelligence, the SLP-14H is fitted with TIMO (tip mode), semi-autonomous bucket filling mode, a bucket shaker for emptying the bucket in low-profile sections of the mine, bucket weighing system, camera system (rear and side) for improved visibility, and digital analytics. It is also automation ready, GHH says.

“The SLP-14H is a 100% customised loader for highly productive mines with heights of less than 2,000 mm,” the company said.

GHH’s low-profile loaders have excellent weight distribution, resulting in better loading characteristics and increased component and tyre life, according to the company. Improved torque helps up-dip loading performance, while the bucket design configurations ensure improved loading cycle times and bucket and boom life.

GHH has local production and aftermarket service support based in southern Africa where the largest global footprint of underground hard-rock low profile mines exists. “This provides not only for an excellent understanding of the



*One of the more recent pieces of equipment to arrive at Pure Gold Mining’s Madsen gold project in Red Lake, Ontario, is a 26 t capacity DT-26N articulated dump truck from DUX Machinery. This underground four-wheel drive truck is well suited for hauling ore, waste and backfill on level and steep grades, according to DUX. It also has the highest power to weight ratio in its class, the company said, adding that it permits efficient chute, side and end loading in narrow drifts with low headings*



customer needs – being right on the doorstep of the relevant mining industry – but also allows for far quicker deliveries and quick customer support,” it says.

When it comes to narrow-vein load and haul applications, GHH’s LF-3 can be used at not only deep level gold mines but also high-altitude operations.

The LF-3 is relatively new, only recently entering the Australia, Turkey, Latin American and, most recently, Zimbabwe markets. It has proven to be extremely robust, reliable, and cost effective to run, the company says.

The soon to be launched LF-7, meanwhile, will be the largest narrow vein loader within the GHH portfolio, with 3.6 cu.m bucket, best-in-class power of 164 kW and an ability to operate at 25% grade, the company said.

GHH also has a partnership with Overprime, in Peru, which allows for a further extension of its narrow-vein offering with the XLH05D and XLH12D, 1 and 2 t narrow-vein loaders, and the XLD30D, a 5 t truck suitable for narrow-vein operations.

This narrow-vein load and haul offering is complemented by Overprime’s Mini Scaler XSC517, which is specifically designed to scale off rocks in applications where existing machines cannot operate due to size and manoeuvrability constraints.

GHH Group also provides **Mine Master** drills and bolters for the low profile and narrow-vein market. The Face Master 1.4 is a mechanised drill rig for ultra-low seams, while the Face Master 1.7 comes in different configurations depending on market demand.

Mine Master, together with **JH Fletcher**, provides roof bolters with a rotary dry drilling system with dust collection, for ultra-low and low seam mining.

The Roof Master 1.4 mechanised roof bolter is designed for bolting hanging and side walls at a minimum height of 1.6 m, with a maximum reach of 3 m and a bolt length of 1.6 m.

For narrow-vein applications, Mine Master has the Face Master 2.5NVDR and its modified version Face Master 2.1.

The FM 2.1 is successfully working in Uzbekistan, at Navoi Mining and Metallurgical Combinat (NMMC), having improved the rate of advance and raw material extraction at NMMC’s Karakutan gold mine by around 20%, according to the company.

The machine is characterised by the reliability and performance of the drifter, having separate hydraulic tanks, an electric compressor drive and, overall, extreme versatility, the company says.

Both the FM2.5 and FM2.1 are used for development drilling (coverage of 5.6 m width x 5.1 m height), production drilling of veins, as well as long hole drilling.

A simple change of the boom feeder configuration uses ‘snap on’ hydraulic couplings

and the loosening of 16 bolts gives a flexibility no other rig in this class can provide, Mine Master claims.

“The FM 2.5 has a powerful, 72.5 kW tramming system with excellent off-road traction and excellent stability due to a lower centre of gravity and lockable central oscillating bearing, making it a unique solution to the market,” the company said. It also has a FOPS- and ROPS-certified canopy.

“This machine is simple to use and easy to maintain with extended maintenance periods, long lifetime and excellent reliability with higher vibration resistance,” Mine Master said. “For narrow-vein mining, this reliable, powerful and versatile rig, with larger coverage compared to competitors of the same class, is definitely a game changer.”

Battery technology design in the drilling and bolting product offering is also underway within the GHH group: a battery-driven single boom drilling rig FM 1.7LE and a single-boom bolting rig RM 1.8KE are undergoing testing, the company says.

The battery on board these prototype Master Mine vehicles can be recharged by using the existing mine power network in the 500-1,000 V range and an on-board battery charger. These units also have the capability of regenerative battery charging while tramming downhill.

The machines still have the lowest height clearance in their class with a tramming height of 1.65 m and have been adapted for heavy-duty mining excavation in room and pillar operations, traversing slopes of up to 15°, Mine Master says. In addition, the operator’s air-conditioned closed cabins come with a filtration system for hydrogen sulphide gases and derivatives.

Through a recently signed partnership with **MacLean Engineering**, GHH is also able to extend its offering in certain geographical areas and provide a number of vehicles including the Cassette System, Scissor Lift, Crane Truck, Personnel Carrier, Fuel Lube, Deck Truck, and other custom designs to the industry.

MacLean has been manufacturing purpose-designed production support vehicles for the potash mining industry in Canada’s Saskatchewan province for over a decade and has more recently leveraged the partnership with GHH to expand its global footprint.

The latest unit to come off the production line at MacLean’s main manufacturing facility in Collingwood, Ontario, is a service lube truck, destined for Saskatchewan. This specialty mining vehicle meets the specifications set by potash miners in the province through a custom-engineered design that has a maximum height of 2 m and a bi-directional cabin. This means the vehicle can navigate low-profile mine designs in which continuous miners tend to tunnel and

excavate in multi-kilometre linear grids where the turning radius is either limited or non-existent.

These tailored MacLean machines provide customer-specific tank sizes and configurations, as well as hose reels, nozzles, pumps and powerpacks. The machines boast on-board suspension systems designed for reducing whole body vibrations by up to 30% while travelling at high speeds.

“All these models are designed and manufactured with the signature Maclean-quality ruggedness and reliability to ensure application requirements are met with ease, providing high speeds, safety, and comfort in low-heading mines,” the company said.

## A light load

Still within Canada, **RDH-Scharf**, a member of the SMT Scharf Group, has recently added a new unit to its range of Muckmaster LHDs.

The 1.5 cu.yd (1.4 cu.m) Muckmaster 150D is equipped with a 129 HP (96 kW) engine and a spacious operator compartment for comfort.

Built for narrow-vein mines, the company has already recorded several Muckmaster 150D sales since launch, with six units having been sold to customers in Latin America, among others. The most recent sale saw a unit equipped with a remote-control system and quick-attach forks dispatched, according to the company.

Turkey’s **Talpa Maden** has been designing load and haul equipment for the Turkish narrow-vein mining industry since the early 2000s.

Its first machine – a LH217 LHD – was sold to a chrome mine in Turkey, and the series became smaller still with the introduction of the LH112 loader suitable for very narrow galleries.

Talpa told **IM**: “Turkish mine sites offer a wide variety of mineral deposits, and thus designs and cross-sectional areas of underground openings differ greatly. Usually the most common ones are narrow-vein mines, which have diameters of about 2 x 2 m to 3 x 3 m.”

The latest addition to the company’s lineup is a lithium battery LHD LE110, which comes with a 1.25 m width (length 4.9 m, height 1.67 m) and a tramming capacity of 1 t (*featured in more detail in IM June 2020’s Load and Haul feature*).

## Narrowing down the drills

Since **IM** heard from Peru-based **Resemin** in this same feature last year, the company has secured another two orders for its 1.15 m MUKI Bolter suitable for narrow-vein mining applications, CEO James Valenzuela said.

Like the organisers and exhibitors of **MINExpo 2020**, the company has been affected by the lockdowns and travel restrictions tied to the onset of COVID-19.

It has been working on electrifying its fleet of narrow-vein mining equipment for some time and,

prior to the onset of COVID-19, was making headway with its Troidon 55 battery-powered drill rig.

Valenzuela told **IM** that the lockdowns that came into force in Peru on March 15 stopped progress on electrifying this single boom front face rig.

“Now we expect to end construction of the machine at the end of this month, so a trial will be planned around mid-July,” he said.

Despite this setback, the company has been making progress on its other area of technology focus: automation.

Having previously sold three MUKI LHBP-25 long hole drills equipped with CAN BUS system for tethered teleremote control to India last year, the company recently offloaded some small long hole drill rigs with these capabilities.

Fully autonomous machine requests have been seen by the company in tenders for projects, but Valenzuela felt the need to clarify the realities of deploying such technology underground.

“Digitalisation on drilling rigs is good, but it has some challenges because more automation means less confident machines,” he said. “I say this because electromagnetic sensors are very vulnerable to the tough environment of underground mines; they fail very often.”

This makes fully automated drilling, for example, very hard to carry out. “It is a well published technology that doesn’t work basically,” he said. “It is a fact.”

**Sandvik Mining and Rock Technology** has made automation leaps in the field of underground development drilling, yet it has also developed products specifically for narrow-vein mines and other confined areas.

Its new 2711 class of drills are simple and safe to operate, with robust components, and provide an excellent performance to ownership cost ratio, according to the company.

Sandvik explained: “Selective mining methods and small tunnel developments have proved to be a good way to extract ore economically, and control the dilution when ore is distributed in narrow veins typically less than 2-3 m in width. Sandvik’s narrow size underground drills are thus designed specifically with the requirements of drilling narrow vein drifts and that of small tunnels projects in mind.”

The drills are also equipped with Sandvik’s Fleet Data Monitoring systems, enabling mines to improve fleet performance and management, it says.

The 2711 series consists of three drill types using a common platform covering different applications: namely development drilling, DD2711, rock support bolting, DS2711, and long hole production drilling, DL2711 and DL2721.

The DD2711 is a compact and flexible single boom electro-hydraulic jumbo with a minimum



cross section of 2.7 m x 2.7 m. The versatile boom delivers large coverage and fully-automatic parallelism for fast and accurate face drilling, while 20 kW of drilling percussion power is provided through Sandvik’s HXL5 rock drill, it said.

The rig is designed for underground hard-rock applications that require high capacity and reliability in development blast holes ranging from 3.7-4.3 m in length.

The DS2711, meanwhile, is a one-man operated electro-hydraulic, fully mechanised bolter for rock reinforcement in underground hard-rock mines. The operator works from supported ground while protected under a FOPS-certified canopy structure. “Mechanisation of the bolting process ensures efficient, constant and durable rock bolt integrity,” Sandvik said.

The DS2711 provides “excellent” bolting performance to cost ratio for small and medium size tunnels with a minimum cross section of 2.7 m (width) x 3 m (height), according to Sandvik.

“Designed with proven and reliable components, the DS2711 provides high reach, and is able to install all types of mechanised rock bolts ranging in length from 1.5 m to 2.4 m,” Sandvik said. “It is in effect a small premium bolter, compact, mobile, and designed for global needs.”

The next addition to the range will happen later this year with Sandvik DL2711 and DL2721 long hole drills.

### How low can you go?

When low-profile mining becomes extra low profile (XLP) mining, the number of companies miners can turn to for new equipment decreases.

Epiroc, Sandvik and **Rham** have both come up with XLP offerings – aimed at the popular South Africa market – but specialists such as **DOK-ING** have been gaining market share of late and realised the future of XLP mining looks to be electric.

In electric developments, Sandvik’s LZ101LE battery-powered dozer is currently still being

*Sandvik’s 2711 narrow size underground drill range has been designed with the requirements of drilling narrow-vein drifts and that of small tunnel projects in mind*

trialled, according to the original equipment manufacturer.

It featuring a push capacity of up to 4 t and designed for cleaning stopes as low as 1.1 m. This makes it an ideal machine for tabular orebodies, such as platinum and chrome mines, the company says.

A Sandvik spokesperson said the results from the LZ101LE trial the company had collected to date are still being reviewed and it hoped to provide more information in the future.

Epiroc, meanwhile, is facing potential upheaval at the Anglo American Platinum-owned Tumela 15E underground platinum mine, part of the Amandelbult Complex in Limpopo province.

In Anglo American Platinum’s 2019 report, it said it was planning to trial electric narrow reef mechanised equipment at Tumela. These new narrow reef machines use lithium-ion batteries, which can achieve up to 2,000 charging cycles, and will eventually replace the current fleet of diesel-powered Epiroc XLP units in the future, it said.

**IM** understands that Tumela will initially use the existing diesel refurbished Epiroc XLP fleet for the first phase of the 15E work, with the intention to progressively phase the units out with electric DOK-ING Narrow Reef Equipment (NRE) in its final production trial stage, later in 2020.

If the NRE equipment performs to expectations, the mine will then utilise the NRE units as it opens the scale of the 15E project.

The potential NRE benefits are numerous, according to the company. Foremost is safety, as remote-controlled equipment keeps workers away from the mine face. It allows for lower panel widths (0.9-1.7 m), resulting in less dilution of ore with waste, as well as faster extraction and

improved labour efficiencies, Anglo Platinum said.

The machines have sensors and cameras allowing production data to be monitored in real time from the surface. Ultimately, it will be possible to also operate the units from surface.

In Australia, a DOK-ING XLP dozer is also set for a trial at a small underground gold mine in the Goldfields region of Western Australia. The mine in question, which uses the long hole open stoping method, has been unable to recover ore from a flat dipping area of the orebody.

Facilitated through DOK-ING's Australia distributor, **Mine Tech Australia**, the trial could take place over a one- to two-month-period and involve an XLP dozer recovering gold the mine owner had previously written off, Brendan Tritton, Director – Operations Manager at Mine Tech Australia, told **IM**.

"The client has a couple of areas they are looking to utilise the DOK-ING XLP dozer in," he said. "It could help reclaim lost ore that has been left behind due to it being a horizontal flat-dipping orebody that doesn't suit their standard operating procedure."

The trial, which will involve a diesel-powered unit, was yet to start when **IM** spoke with Tritton in June, but he said the Mine Tech Australia team were now well equipped to handle the teleremote unit having trained on it for some two to three weeks.

He is excited about the prospects for these machines in Australia, saying the incorporation of battery technology will open the number of applications.

"It will be a real turning point for this equipment in Australia," he said. "With smaller orebodies, ventilation costs are huge. If you can operate off a smaller size fan through using battery-electric equipment, it can suddenly change the mine economics."

### The unconventional approach

As OEMs continue to come up with new designs for narrow-vein mines, others in the space are looking to turn conventions on their head.

**Bauer Technologies** is a company usually associated with civil engineering, yet the trench cutting technology it initially developed for this industry appears to have applications in various bulk sampling and mining contexts.

Among these is narrow-vein mining, with the company's Vertical Cutter Mining System having previously been tested on dykes and veins below surface at Koidu Limited's kimberlite mining leases in Sierra Leone.

Looking to mine dykes for kimberlites to a greater depth, Koidu and Bauer agreed to trial the BC 33 cutter at the mine in 2010. The cutter width chosen was 800 mm, based on Koidu's assumption of a dyke width of between 800 and 1,000 mm.

While the test appeared to be a success, Bauer has not trialled this system in a narrow-vein mining context since. Still, it sees plenty of prospects ahead.

"We see a lot of opportunities not only in kimberlites, but also in other commodities like gold, metallurgical coal and uranium, as well as for deep sea SMS deposits," the company told **IM**.

To try and entice the industry into testing this technology, Bauer is working on extending the application of the standard cutter system towards the mining of much harder rocks at much higher production rates, it said.

"Secondly, based on the very positive experience on our FalCon kimberlite bulk sampling project in Canada, now our system, proven in the mining industry, can reach a depth of 250 m from a working elevation," the company said.

"Both systems are key elements to make the cutter system more attractive to the mining industry."

Bauer spelt out some advantages to using this cutter technology:

- Mining of veins and dykes and 'uneconomic' small orebodies is viable;
- The technology comes with an almost one to zero strip ratio, providing minimum dilution of ore;
- Increases mine life after open-pit mining ends without added infrastructure;
- No underground development is required, leading to a much lower installation cost;
- The time to mine is extremely short;
- Primary crushing is incorporated into the system;
- Equipment can be used on several orebodies or mine sites;
- Comes with low or no additional environmental impact;
- Mines with reduced energy consumption;
- A fully electric Vertical Cutter Mining system optional is available;
- There is minimal trucking/re-handling required; and
- No additional road and bench construction is needed.

Anaconda Mining spin off **Novamera** is also plotting its entry into the underground narrow-vein mining market from surface.

The company thinks a combination of drilling



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and imaging techniques already proven in the oil & gas industry could provide the technical and economical means to mine steeply dipping narrow-vein orebodies.

The process, Sustainable Mining by Drilling (SMD), is divided into two campaigns: drilling the pilot holes and accurately mapping the vein, then enlarging the pilot holes to predetermined sizes to recover the ore. Using an inclined mast drilling rig, an inclined pilot hole is drilled along the centre line of the vein (equidistant between the hangingwall/footwall) with a directional drilling system.

Steering the pilot holes live with a survey tool will determine the current orientation and refine the 3D model of the vein used to plan the pilot hole enlargement, the company says. Once the pilot has been drilled, a large hole-opener can be used to open the hole's trajectory up to 2 m in a single pass.

Novamera President and CEO, Dustin Angelo, told **IM** that the company had plenty of work to carry out prior to the planned field tests of SMD in early-2022.

This includes developing a prototype near bore hole imaging tool (NBIT) to use with its ground penetrating radar unit.

"We'll be field testing the NBIT tool around the August 2020 timeframe," Angelo said. "We will also continue to refine the tools we use to filter



**Hard-Line** may have had surface operations in mind when it came up with its teleremote LP301 and LP401 low-profile (skid steer) loaders, but the ability to access restricted areas where a person-operated machine cannot manoeuvre would also prove beneficial in narrow vein and low-profile mines.

**IM** caught up with Chad Rhude, Vice President US Operations at Hard-Line, to quiz him on these low-profile – as low as 760 mm and 1,016 mm tall, respectively – machines.

**IM: When it comes to the mining industry, where does Hard-Line believe the use of teleremote-operated LP401/LP301 loaders will provide the most value?**

**CR:** They can provide value in applications where it is either too dangerous, not cost-effective, or impossible to use larger manned machines. For example, they could be an effective solution for cleaning spillage from under conveyor belts, or other equipment that currently requires manual labour or an operator in a machine like a skid steer.

The LP series of machines will allow the same job to be performed from a safe distance by removing the operator from the cab of the machine and, because there is no need for an operator's cabin, allowing the machine to access areas traditional manned machines are unable to fit into. This can offer value in that the work can be done without shutting down the conveyor and should be faster in situations where work might currently be done manually.

The machines could also provide value as support platforms or could be used to inspect or enter areas that are too dangerous to have personnel enter.

**IM: Where, regionally, have you seen demand for these units from a mining perspective?**

**CR:** Most of our focus has been in the municipal and construction markets in the USA to this point, but we have seen interest in North America, Australia, and some enquiries in South America in the mining space.

**IM: Do you see these units having applications in underground narrow vein and low-profile mines?**

**CR:** We see these machines having applications anywhere there are height and safety concerns that would restrict the use of larger machines or having personnel work in the area. Narrow vein and low-profile mines would seem to be ideal areas for a machine with a small footprint and remote-control capabilities.

The fact that the machine is remotely controlled allows it to access areas that would be too dangerous or too small for larger manned vehicles, and the ability to have multiple attachments, from various bucket configurations to rock breakers and other devices attached to the front of it, make it a very versatile piece of equipment.

In addition, the fact that these machines have been built on a skid-steer platform allows them to work at higher speeds than many track-only machines of the same size and lifting capacity allowing for faster cycle times when used to move material. An over-the-tyre track kit is also available for the LP401, which allows it to operate in low traction conditions.



the data and produce 3D images.”

With respect to the hole opening and excavation part of the SMD system, the company will be working on optimising penetration rates, carrying out testing on fatigue and cutter wear rates, and hole stability tests, he said.

“We are evaluating the possibility of doing a small field trial of the pile top drill rig,” Angelo added.

The company is also identifying and reviewing additional off-the-shelf, already commercialised equipment and components that can be used in

the SMD system development to mitigate any perceived technology risk.

He concluded: “Based on our current plans, we are targeting to have the full prototype SMD system ready by the end of June 2021. We would, then, begin validation testing and make subsequent adjustments throughout the remainder of 2021 with the intention to begin to mobilise in early 2022 for the full scale field trial at Anaconda Mining's mine site in Newfoundland in late spring/summer 2022.”