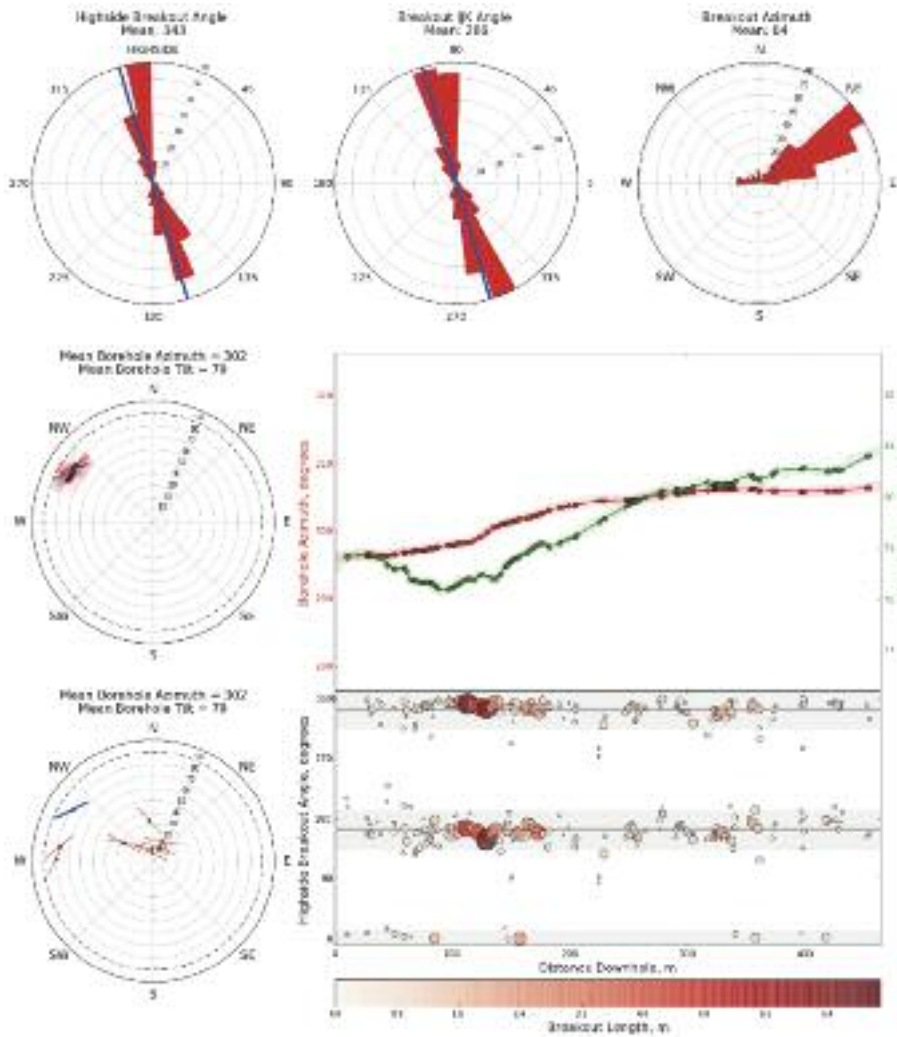




The Canadian edge



KORE's stress inversion technology extracts information about stress orientation and relative magnitude from borehole breakout data collected in multiple deviated boreholes using Acoustic Televiewer borehole logging technology. This means a borehole drilled for any reason (exploration, definition, geotechnical etc.) can be used to measure stress orientation, quickly and inexpensively

#DisruptMining finalist, **Kore Geosystems Inc** notes the true power of machine learning and artificial intelligence can only be unleashed with robust, high quality data inputs. Kore plans to install instruments onto the drill rig that can provide real-time, automated data accelerating timelines for multiple mining stages and decision-making intelligence. The team, Vince Gerrie, Aaron Maher, Sebastian D. Goodfellow, Chris Drielsma, Patrick Hooker and Chris Lane, bring together years of expertise in geology, geophysics, software engineering, and technology development.

Kore notes that "the industry is challenged by having to make critical engineering, operational and planning decisions with insufficient information. As a result, [it] suffers financially from production delays, engineering setbacks, and unforeseen capital expenditures. Many of these 'harsh realities' could be avoided if decision makers had early access to accurate, timely knowledge about the true complexities and variabilities of mineral deposits."

Kore develops technologies that combine real time quantitative measures and robust data analytics to deliver critical decision making intelligence at an unprecedented speed and resolution. It influences "large scale process improvements leading to substantial cost savings, significant risk reduction, and improved speed to market."

"There is a lot of expensive data in the mining industry and most companies do not extract the full value from it. Kore's cluster analysis process rapidly improves deposit understanding by efficiently identifying, investigating, and exploiting trends in complex multivariate data." Accelerated and increased understanding of complex datasets are achieved through a combination of data validation, machine learning, cluster analysis, traditional statistics and advanced data visualisations. Key outputs of the process include robust, unbiased, quantitative classification schemes, and the development of proxy relationships between traditionally isolated datasets.

This cluster analysis classifies the rock into

John Chadwick reports on #DisruptMining and the impressive Canadian technologies represented there, and other news from Canadian suppliers

The #DisruptMining competition was sponsored by Goldcorp Inc and Integra Gold Corp during the PDAC. #DisruptMining showcased individuals, groups and companies that are using exponential technology and disruptive concepts to tackle the vast challenges faced by mining, from exploration and discovery to production and automation to financing and corporate social responsibility. The final was a Shark Tank/Dragons Den type presentation event.

The judges were Todd White, Executive Vice President and COO, Goldcorp; Rob McEwen, Founder of Goldcorp and McEwen Mining, launched Goldcorp Challenge; David Harquail, President, CEO, Franco-Nevada Corp; Bernadette Wightman, President, Cisco Canada; and Robert Herjavec, CEO Herjavec Group, founder of BRAK

Systems, judge on CBC's Dragons Den and ABC's Shark Tank.

At the time of writing, deals are currently still being negotiated. All five finalists walked away with deals with Cementation (see *Tomorrow's underground mine article, this issue*) and Kore getting invites to Goldcorp's deal room to negotiate for the C\$1 million.

The other four judges combined to award C\$400,000 in deals:

- Rob McEwen awarded C\$50,000 each to Cementation and KORE Geosystems
- David Harquail awarded C\$50,000 each to Bio-Mine and TradeWinds
- Bernadette Wightman awarded C\$100,000 to Goldspot Discoveries
- Robert Herjavec awarded C\$50,000 each to Cementation and KORE Geosystems.



unbiased domains based on validated quantitative data, including petrophysics and multi-element geochemistry. The domains are visualised (3-D), and iterations, interrogations and comparisons to various classification schemes can be performed rapidly. The ability to generate multiple iterations of project scale petrophysical and geochemical domains and interactively compare them in spatial context to known lithology, alteration, structure and mineralization can lead to valuable insights and better geologic models.

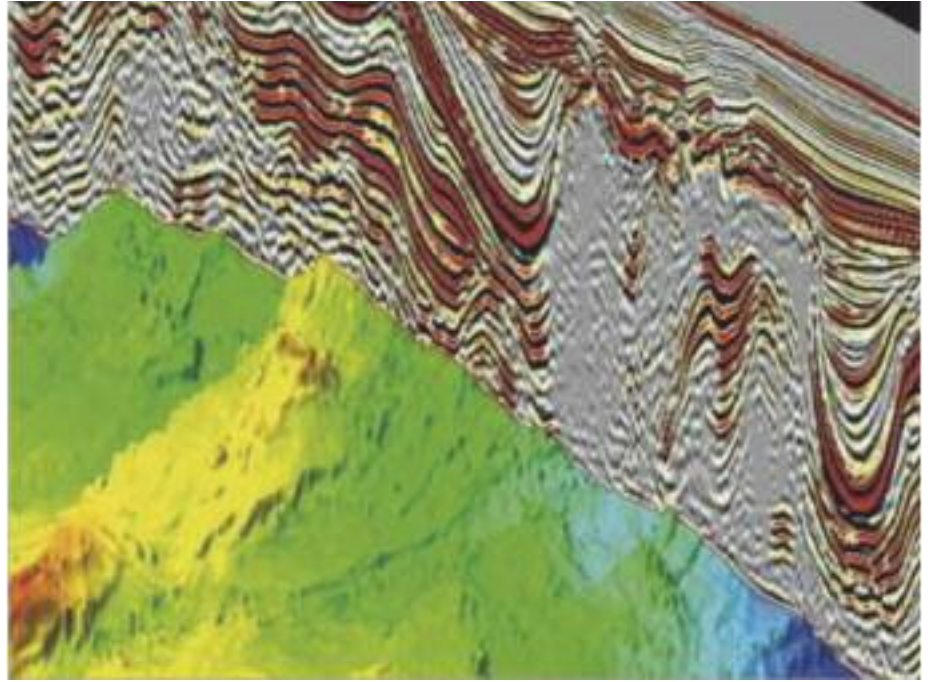
Integrating multi-disciplinary data enables the development of predictive relationships between traditionally isolated datasets. Modern data science techniques applied to in situ data can provide robust real time estimates for traditionally expensive, slow, and sparsely sampled laboratory analyses. Kore has accurately predicted recoverable grade and key assay and geotechnical parameters directly from petrophysical data. This permitted the client to have real-time estimates of recoverable grade from individual boreholes, without requiring additional expensive and time consuming metallurgical tests.

Goldspot Discoveries is revolutionising mineral exploration by using machine learning to target on a regional and localised scale. The Goldspot Algorithm significantly decreases risk, while increasing the efficiency and success rate of mineral exploration. This in turn will completely disrupt the investment decision model by using the Goldspot Algorithm to stake acreage, acquire projects and royalties, and invest in public vehicles to create a portfolio of assets with the greatest reward to risk ratio.

Acoustic Zoom (AZ) was a #DisruptMining semi-finalist. It is an advanced geophysics company established to develop new processes for mapping the character of complex geological formations at a finer scale than previously possible. AZ's innovative seismic method comprises a key advance in imaging the Earth's microstructure and one that has important application to mineral deposit delineation. The AZ method can produce high-resolution 3D images of a mining property's subtle geological structure, making it possible to differentiate ore-bearing features from the barren host rock, including under areas overlain by bog and thick glacial till. The specific advance achieved is the ability to identify detail beyond that possible with state-of-the-art long offset, wide-azimuth seismic, even when very high source location density and multi-fold data are acquired.

AZ proposes to utilise its method to survey and image the deposit at an operating gold mine to delineate and extend the resource.

The AZ's unique and game-changing aspect is the capture of subtle reflectors and diffractors,



which have the potential to unmask finer internal structure consistent with ore-bearing veins. The value proposition is to deliver very high resolution seismic images to targeted depths through the placement of fixed, custom-designed, receiver array patterns that can be used as antennas, supporting beam-forming and focused listening in post-processing to deliver high-resolution subsurface imagery.

Also a semi-finalist, **Objectivity.ca** is a data analytics consultancy using simulation and data mining to develop niche products and services addressing challenges in exploration/MineEx geology, mine ventilation financial analytics, 4D visualization software and large scale visualization and collaboration systems.

It evolved from providing the design and implementation of large scale visualisation systems, and research associated to understanding how human's work with complex data.

The visualisation systems were used for the analysis of complex geological and engineering data sets. These datasets included both 3 D and 4 DI (time varying data). When using these systems it became quickly apparent that the existing software was great for process driven mine design, but that there was a gap between the generation of data and the acquisition of knowledge and development of know-how.

The company fundamentally believes that teams of individuals have "incredible capabilities to synthesize information into knowledge and that our role is to provide tools that make this process easier. To this end we use advanced data mining techniques to identify niche value drivers and then develop software tools to help make better decisions

"These tools are not designed to be black boxes but rather to complement the thinking

Acoustic Zoom Seismic is a novel seismic exploration/exploitation technique adapted from sonar applications. The method is complementary to 3D seismic imaging, enabling high resolution imaging of geological structures within the seismic volume using beam-forming and beam-steering techniques. The approach utilizes purpose-designed steerable phased arrays, analogous to the arrays used in radio astronomy, for both the source and receiver arrays

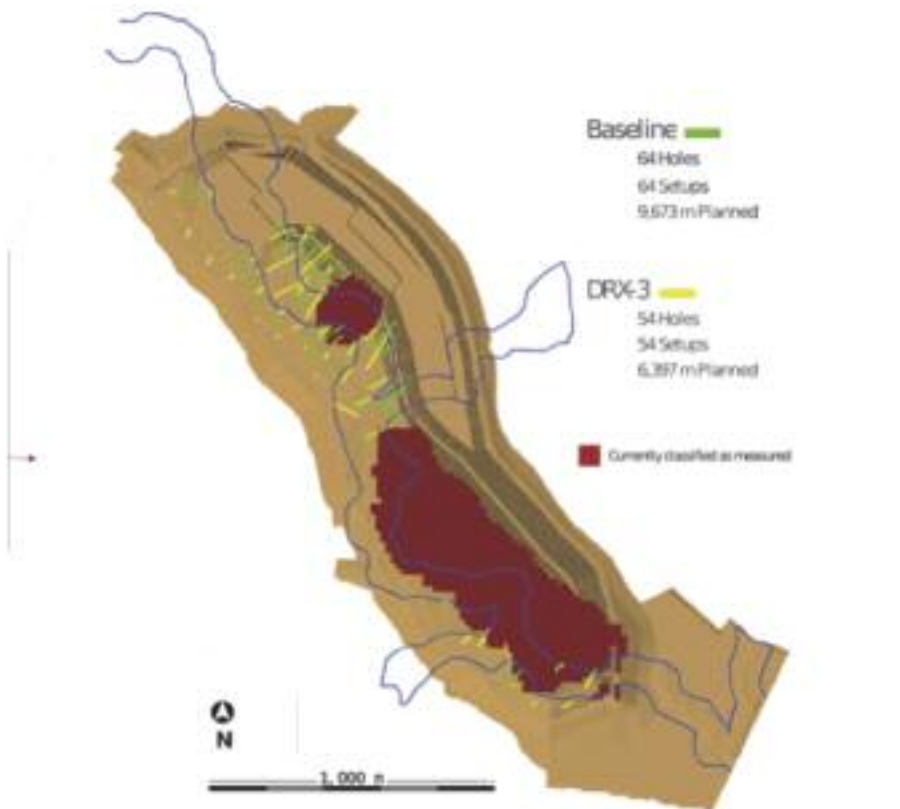
and expert analytical process by providing a means of generating options, respecting constraints and creating clear visualisations of KPIs to allow decisions to be made. This is accomplished by incorporating innovative in-house developed algorithms within specialised services.

Royal Nickel Corp, interested in evaluating emerging technologies, applied Objectivity's DRX to its Dumont open pit project. The goal of the assessment was to determine if DRX could improve the conversion efficiency of a volume of ground from the Indicated, to the Measured category

Of particular interest to the company was DRX's capability of producing a number of drilling plans based on varying budgets. Each of the drilling plans had to meet all project constraints while maximizing the indicated to measured conversion rates.

Creating a number of valid options enabled the company to select the appropriate plan that best aligned with its strategic goals and budgets.

When compared to the manual layout, the DRX solutions provide a means of drastically improving conversion rates. This increase in resource conversion efficiency has the potential to save money but more importantly it saves



Run	Holes	Meters	Conversion Rate m/min	% Conversion Rate Increase	Budgeted Drilling Savings \$
Manual	64	9,673	2,975	-	-
DRX-3	54	6,397	4,394	+48%	\$458,640
DRX-4	83	9,495	3,483	+17%	\$24,920

time, both in drilling and setup. The DRX-3 solution not only decreases the total number of drill holes, but also improves drilling times.

If environmental footprint has to be reduced, or if the drilling setups are expensive, then DRX can find solutions that trade off metres drilled for fewer setups. The DRX-2 solution decreases the drilling campaigns' footprint by eliminating 22 drill setups.

Deployed as a Microsoft Excel add-in, **ThreeDify** Excel CoreBlock (XLCoreBlock) is a Microsoft Excel based drill hole visualiser and quick resource estimator. The company says that “by leveraging the popularity and ease-of-use of Microsoft Excel, XLCoreBlock has significantly lowered the learning curve and total cost of ownership for mining knowledge workers. It has become the go-to tool for field geologists, mining executives, investment banks and property owners
“XLCoreBlock provides mining professionals with a quick, easy and cost-effective way to visualise, validate and analyse drill hole data in 3D directly within Microsoft Excel.”

The CoreViz Module allows its users to visualise and validate assays, lithology and attributes (both continuous and categorical), making XLCoreBlock a potent Excel-based QA/QC DDH validation tool.

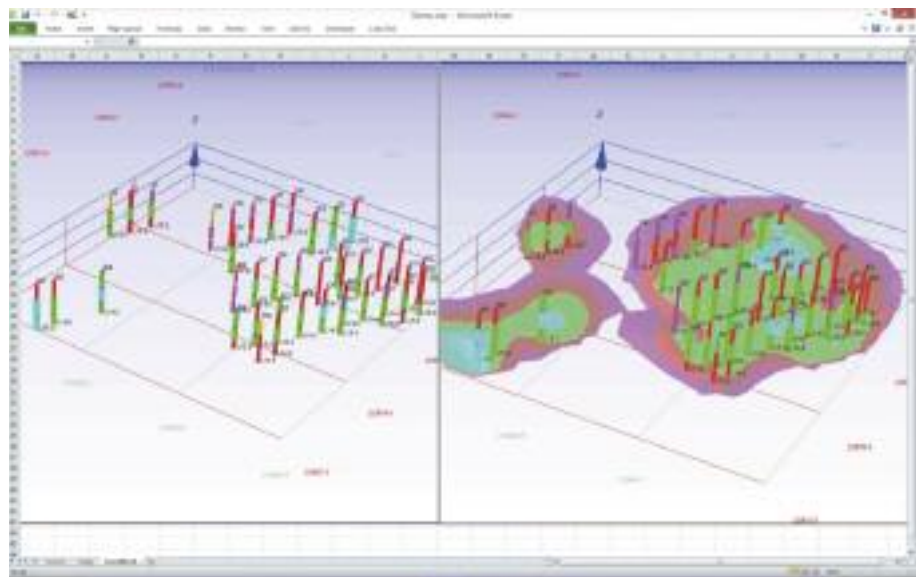
The BlockModel Module features implicit modelling based on a very fast implementation of anisotropic Radial Basis Function (RBF) interpolation. It allows the user to quickly create and export 3D block models and iso-grade surfaces or solids. The RBF interpolator is a global, automatic resource estimator with no need for tedious variogram modelling.

XLCoreBlock Key Benefits

- **Easy-to-use:** visualise and analyse your drill hole data in 3D, and conduct quick resource estimation within your familiar Microsoft Excel interface
- **Automatic:** automated interpolation of block model grades and attributes for both single and multi-mineral deposits using 3D anisotropic RBF interpolators that support a user-defined search ellipsoid. No complex variogram modelling is needed. Ideal for investors, fund managers and field geologists who need quick estimates for their deposits
- **Flexible:** you specify where data are in your worksheet(s). Supported data types include lithology, assay grades, continuous and categorical attributes
- **Efficient:** there are no additional files or file formats to manage as generated 3D drill hole plots and block models are directly saved as part of the Excel file from which the plots and models are created
- **Convenient:** you can also easily create AVI video animations for your 3D drill hole data and block models.

Over 2,000 multi-disciplinary geoscience datasets have been downloaded free-of-charge from the Botswana Geoscience Portal since its launch in 2016. Mineral explorers, government and academic researchers, and other key stakeholders from more than 35 countries have visited the public repository to access the 10 gigabytes of pre-competitive geoscience data stored online. The portal, developed to promote and stimulate exploration activity in the Ngamiland region in northwest Botswana, is a collaborative partnership between the Botswana Geoscience Institute (BGI), the mineral resource industry and **Geosoft**, who developed and hosts the portal.

“The response from the geoscience community



XLCoreBlock consists of two modules that can be licensed separately



in Botswana has been very positive,” says Tiyapo Hudson Ngwisanyi, Chief Executive Officer at the BGI, “Raw geoscientific data is critical in the mineral industry because people can manipulate it in such a way that it brings out features that they need.”

Ngwisanyi hopes that as the technology used to integrate and visualise exploration data evolves, data archived in the portal can be reprocessed in new ways to uncover previously hidden features, and attract new investment to Botswana from around the world.

“It is important for our government to safeguard all data that has been collected so that it can be used by others,” explains Ngwisanyi, “To have comprehensive data in one place eliminates the need to re-do certain surveys and reduces the cost to those companies.”

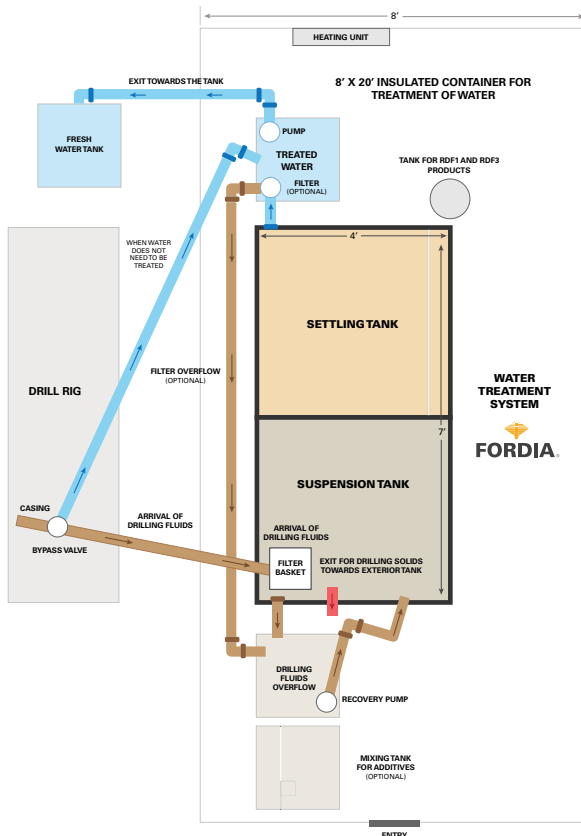
Geosoft developed and deployed the user-friendly Botswana Geoscience Portal using its experience with data services, portal development and geoscience data servers to catalogue, verify and deliver BGI’s geoscience data.

“We have been monitoring the use of the portal on behalf of the BGI,” says Troy Wilson, Senior Director of Strategy and Business Development with Geosoft. “The top five countries downloading data are Australia, Botswana, South Africa, the UK, and Canada, along with a significant number of resource companies. It was great to see that the second-largest number of data consumers came from Botswana.”

To date, the most popular downloads are the raw geophysical and geochemical datasets, but the release of the IGS prospectivity maps in August and Ngamiland magnetic inversion results in November saw large spikes in the number of downloads. New datasets are regularly being added to the portal.

Building on the success of this portal, Geosoft’s Government Segment Team is actively engaging with international government agencies seeking to improve access to their data repositories. “Geosoft is developing new ways to empower governments to curate their geoscientific data and collaborate openly with other government agencies and industry stakeholders,” said Wilson. “There’s an urgent industry need for more jurisdictions to make pre-competitive data available to stimulate exploration, and we’re excited to play a role in meeting that need.”

Geosoft presented on the benefits of publishing open geoscience datasets on spatially-enabled web portals during the 2017 PDAC conference.



Fordia water treatment system installation schematic

Exploration drilling

Fordia, a provider of drilling solutions that include diamond tools, equipment and accessories, has been serving customers in the mineral exploration, geotechnical and environmental industries since 1977. The company found that its customers—drilling and mining companies alike—were struggling to find ways to reduce their water consumption. “Many municipalities have restrictions on how much water can be used, often forcing mining and drilling companies to stop operations because limits have been surpassed. Customers were looking for ways to recycle their water so it could be re-used, but solutions were hard to find.”

Until recently, water treatment systems for the

industry were very expensive, very large machines with limited efficiency and functionality. Fordia looked at developing an affordable water treatment system (WTS) that was easy to transport even to remote sites and that would be easy to operate. The first generation model of the system is now available.

The WTS is a small, lightweight system whose primary function is to separate drill cuttings from water so that the same water can be re-used. This is an excellent solution for underground drilling as well as surface mining where water is scarce or distant, or for drilling in fragile environments that need to be protected, such as desert ecosystems, wetlands and northern regions. Once these cuttings are isolated, they can be disposed of in environmentally approved ways, eliminating the need for site remediation. In the case of underground drilling, the recuperated cuttings can be used to backfill the boreholes.

This first model has been tested at select customer sites with excellent results. Fordia’s WTS represents a more economical option compared to existing systems and current customers are finding that up to 80% of their water can be recuperated. More importantly, they are able to respect all environmental restrictions and municipal regulations.

“Customers who tested our system onsite have told us they are really pleased with their results,” said Denis Landry, Fordia’s Executive Vice President and General Director. “Fordia is known for its onsite technical support and we have been working closely with our customers to make sure they leverage as many benefits as possible from the system.”

VersaDrill Canada officially launched its new legacy drill at last month’s PDAC: the VersaMobile KmN.8UM underground drill. It is a powerful and safe telecontrol drill. Because the



VersaDrill Canada’s new VersaMobile KmN.8UM, track-mounted underground drill weighs 7,120 kg



VersaDrill Canada team wanted to build this machine to address the many challenges encountered by drillers, it offers three unique characteristics that are not found on other drills. In addition to being mobile, it features a built-in working platform, which considerably reduces the time required to move between bays. The drill is also equipped with the Zero Energy security system, which allows driller assistants to work safely. Finally, a great feature of the VersaMobile KmN.8UM is that it can easily fit into a shipping container.

- Depth Capacity 800 m
- Fabrication steel
- Total weight 6,474 kg
- Pull and push capacity 8,300 kg
- Possible angle (underground) -90 to 90°
- Pull speed 67 m/min
- Speed of descent 113 m/min
- Single line pull capacity 4,500 kg
- Rod pull length 3 m
- Maximum torque 2,840 Nm.

VersaDrill Canada builds multi-purpose diamond drills. Its equipment is robust, safe and flexible to use and can be adapted to many types of surface and underground environment. VersaDrill says it aims “to offer reliable and performing products that meet its clients' expectations.” The company is part of the Rouillier Group, an Abitibi-based leader of the mining industry in diamond drilling and in the manufacturing of high-performance equipment.

New, better mining

While the mining industry is large, the contract mining industry is relatively small and often requires the use of unique practices conceived by highly specialised people. For this reason, most systems are developed for the larger market, requiring contract work to be done with solutions designed specifically to fit its purpose. While this specialised equipment certainly suits the needs of the contract work being performed, occasionally these innovations can enable new possibilities for permanent installations. This has been the case with some of the components of the shaft sinking control system developed by Redpath.

As discussed in the September of 2015 magazine edition of International Mining, new networking solutions have been successfully implemented by **Redpath** in a number of shaft sinking and rehabilitation projects. This was motivated by the following major factors:

1. To reduce the number of shaft cables required for shaft sinking: The leaky feeder cable must be carried down as the shaft progresses; a wireless solution (WiFi) eliminates the need to manage this overhead cable
2. To provide a reliable communication link to the workers beyond the reaches of leaky feeder at shaft bottom: During sinking, the leaky feeder

cable must be kept on a spool to facilitate the progressive deepening of the shaft. This spool must reside on the work stage, which is too far from the shaft bottom to provide a reliable signal to the workers and devices on the bench. Using WiFi has even allowed for video conferences involving people on the bench!

3. To reduce the amount of risky work done mid-shaft: Leaky feeder requires amplifiers to be installed on the shaft wall. This type of work can put workers at risk (working at heights, falling objects, etc.) and also consumes valuable hoisting time
4. To provide a solution that would not interfere with existing mine infrastructure: Since leaky feeder is used in permanent mining, frequency selection must be coordinated by any contractor services coming onto site. Using WiFi means that Redpath can implement a solution without the need for additional licensing and minimal frequency conflicts
5. To visually monitor under-slung equipment during shaft travel: The bandwidth provided by WiFi makes IP cameras easy to install on the conveyance. This allows the hoist operator to monitor the equipment visually and audibly for any issues as the equipment is lowered
6. To use this equipment to provide guide vibration reports. After building a mine shaft and hoisting plant, the shaft guides can be benchmarked by relating hoist position to the input of a multi-axis accelerometer. With the hoisting system connected to the conveyance in real-time, plotting vibration graphs is simple and low-cost
7. To simplify the removal of equipment after shaft construction is complete: Most often the client will want to install a compatible system and integrate it with the permanent mine infrastructure. This means that all equipment

used for contracting must be removed. With minimal WiFi access points in the shaft to remove (often only two: under the collar doors, and at the top of headframe), this makes demobilizing easy.

Since implementing this solution, the last point has become less important – some clients are requesting that Redpath leaves the communication equipment in for permanent hoist interlocks. With many hoisting plants requiring real-time slack rope monitoring and shaft signalling (also known as hoist bells), the PLC and communication system can provide this in the form of load links and limit switches for a very effective and – with the WiFi-system already installed – very low-cost solution.

Taking Redpath's vibration monitoring to the next level, clients can monitor guide vibration in real-time during every hoisting cycle. This means that the hoisting conditions can be compared to the original benchmark and alert the operator of upcoming guide problems before excessive wear or damage takes place. The system will alert the operator of a high vibration spot and provide the precise hoist position at which it occurred.

On the heels of showcasing a battery powered 975 Omnia Scaler-Bolter at MINExpo 2016 in Las Vegas, **MacLean Engineering** shone the R&D spotlight on full-fleet electrification at this year's PDAC Convention in Toronto with the commercial rollout of the MacLean EV Series, as well as the launch of a new, ultra-versatile utility vehicle – the Maclean LR3 Boom Lift.

The MacLean EV Series delivers diesel-free propulsion by incorporating leading edge battery and electric motor technology along with sophisticated battery management and monitoring safeguards, to ensure a high-performing, data-rich EV fleet solution for mining companies looking to reduce ventilation and



MacLean LR3 Boom Lift



maintenance costs, while improving underground air quality.

“Since 2015 we have devoted significant R&D resources towards advancing our fleet electrification program to the point that we can now offer EV solutions across our ground support, ore flow, and utility vehicle product lines,” remarks company President Kevin MacLean. “A mobile fleet propulsion system that can significantly reduce cubic feet per minute (CFM) to diesel engine horsepower requirements, remove diesel fine particulate matter and reduce heat in the underground environment, as well as help companies secure the financial and reputational benefits of GHG reductions - this is the compelling business case for the new era of battery power in underground mining, one that we’re fully engaged in for our global customer base.”

The MacLean LR3 Boom Lift’s innovative solution for elevated work platform needs in high-back mines is the result of engineered design that integrates heavy-load/high-reach capabilities and is versatile enough to perform a wide range of mine support functions while providing coverage from ground level up to a height of 8 m. The unit has a lifting capacity of up to 4 t (8,000 lb and is certified to 10,000 lb in Australia), a 6-m deck, and +/-150 boom swing and +/- 300 deck swing ranges, along with multiple, quick-change deck configurations to suit the application.

“In our almost half century of introducing mobile equipment solutions to the hard rock mining industry, we have always proceeded with a singular focus - solve a specific problem with a safety and productivity improving design that is as practical as it is innovative,” notes company Founder and Chairman, Don MacLean. “The LR3 solution to the original problem of safely installing 4.5 t twin fans in the larger heading mines of Australia has now evolved to being the newest member of the MacLean utility vehicle product line, one that can respond to a wide range of mine services needs that are relevant to mining operations across the hard rock mining globe.”

Motion Metrics is coming off another successful year, with record breaking revenues and a major presence at September’s MINExpo exhibition. The maker of LoaderMetrics™ and PortaMetrics™ continues to leverage the latest in camera and sensor-based technologies to help its clients achieve long-term safety, productivity, and predictive maintenance goals. The company hopes to continue its growth in 2017 by capitalizing on its latest technological breakthroughs and expanding the market for PortaMetrics - a 3D imaging fragmentation analysis solution - by offering affordable subscription pricing.



Before incident:
2016-11-19 05:30:45
(healthy teeth)



After incident:
2016-11-19 05:32:51
About 2 minutes passed from a grab with healthy teeth, and then incident has happened during past 2 minutes



After Tooth replacement:
2016-11-19 09:32:08
About 4 hours passed to replace the tooth

The latest iteration of LoaderMetrics uses Deep Learning algorithms and a thermal camera to achieve optimal accuracy in missing tooth detection. LoaderMetrics 2.2 has been trained to recognise when the tooth line is in its normal state and to send out an automatic alert when it detects a missing tooth. With Deep Learning and thermal imaging, the system can now detect missing teeth faster and more accurately than ever before. Combined with surveillance views and an innovative Lens Cleaning Solution, it is the company’s most advanced system to date.

The new LoaderMetrics system has already been installed on LeTourneau (Joy Global) L1850 and L2350 as well as CAT 993 and CAT 994 wheel loaders around the world, and detected its first missing tooth in November 2016 at a copper mine in Chile. Every missing tooth detected can prevent potential crusher jams that can cause lengthy periods of costly downtime, and require a dangerous tooth retrieval process. Also, because loader teeth tend to be smaller than shovel teeth, missing teeth from loaders can pass through the crusher and cause serious damage to conveyor belts and other downstream equipment.

Motion Metrics hopes to improve safety and efficiency in operations of all types and sizes, so it recently introduced subscription pricing for their popular PortaMetrics fragmentation analysis tablet. The new subscription model allows users to lease the patented 3D imaging device for an affordable price, a perfect solution for quarries and smaller scale mines. PortaMetrics subscriptions also come with a basic warranty and support from Motion Metrics’ team of in-house fragmentation experts. With the click of a button, PortaMetrics uses 3D imaging to provide actionable information such as particle size distribution and slope, without the need to place a reference object. This data is critical for mines and quarries looking to optimize their digging efficiency and explosives use.

PortaMetrics has been receiving a lot of attention lately. Motion Metrics’ paper, *Fast Rock Segmentation Using Artificial Intelligence to Approach Human-Level Accuracy*, was recently presented at the 2017 ISEE Annual Conference on Explosives and Blasting Technique in Orlando.

The paper explains how the device uses 3D imaging and artificial intelligence to delineate rock boundaries and accurately calculate rock fragmentation from a safe distance. Motion Metrics reports “the presentation attracted a record-breaking audience and the paper received a prestigious honourable mention award.”

LoaderMetrics and PortaMetrics, as well as ShovelMetrics, the company’s pioneering missing tooth detection and all around shovel monitoring solution, are all designed to integrate with the Metrics Manager™ Pro data management platform. Metrics Manager Pro unites information from every Motion Metrics system at the mine, providing a one-stop online platform for mine management to access critical information. Personnel can access data summaries and system status reports, as well as receive equipment activity logs, in-depth performance reports, and rock fragmentation data.

#DisruptMining semi-finalist **Minrail** has developed a unique and innovative mining system for shallow-angle mining operations (S.A.M.S.™). Quite simply, S.A.M.S. is revolutionary because it enables a new and completely mechanised approach for the extraction of ore from underground operations. In a nutshell, the system solves the long-standing problem of ore extraction at sloping surfaces between 100 and 450 which do not allow for mechanised rubber-tyred operations to assist in such tasks.

Minrail has solved this historical problem of the industry by developing an overhead double rail system that can be adapted to any underground mining operation.

S.A.M.S. is a fully integrated mining method: from development, to production, to backfilling. It is modular in design, its ‘spine’ being the overhead double rail system which can be customised to the requirements of specific ore extraction processes. The hydraulic system is powered electrically (600 V).

The rack and pinion double rail system, with electrically-powered hydraulic motorised capability, is equipped with a modular girder trolley. The telescopic working platform accommodates two workers, but can be operated



This wholly mechanised patent-pending rail-based system from Minrail brings with it several opportunities for innovation in any underground mining operations

by a single worker. Most modules are remotely-operated through wireless commands.

Using S.A.M.S., the orebody can be extracted along vein lines with significantly more precision than traditional methods, Minrail says.

The modular design adapts easily to other applications such as construction of underground infrastructure, material handling and design.

ESG Solutions, a leader in microseismic solutions is working with the Ultra-Deep Mining Network (UDMN) to improve safety and productivity in mines through the development of innovative methods focusing on rock stress risk reduction. The UDMN, managed through the Centre for Excellence in Mining Innovation (CEMI), aims to become the leading organisation in ultra-deep (below 2.5 km) research and innovation and to solve resource extraction difficulties.

“As mining in Canada occurs at greater depths, geotechnical risks are increasing significantly, particularly as they relate to stress within the rock mass,” says Damien Duff, UDMN Rock Stress Risk Reduction theme leader and Vice President, Geoscience and Geotechnical R&D at the CEMI. “Failing to address the challenges associated with increasing rock stress introduces unacceptable project risks.” ESG Solutions is examining an innovative approach to estimate rock stress using microseismic data collected during mine operations. Specifically, stress tensor determination from microseismic source mechanisms provides a relatively inexpensive

Roy Hill is a A\$10 billion capital cost project located in the Pilbara region of Western Australia that includes an iron ore mine with a capacity of 55 Mt/y, a mine process plant, a 344-km heavy haul railway system from mine to port and new port facilities at Port Hedland. WSP Global is the project management consultant, drawing on global resources, systems, and project management expertise to efficiently manage contracts throughout the execution phase

way to assist in the evaluation of induced stress and mine hazard and acquire numerous stress measurements throughout wider volumes of a mine.

“Using microseismic data, mines will also have better opportunities for numerical model calibration and enhanced model forecasting by being able to obtain more accurate stress information from seismic data at remote locations in the mine,” says Dr Dave Collins, Manager of ESG's Mining and Geotechnical Consulting Services Group. “Using seismic stress inversion analysis may also help mines increase understanding of failure processes. This can result in improved mine design and safety procedures, contributing to greater operational efficiencies and productivity,” says Collins.

ESG Solutions is confident this project will contribute beneficial tools to assist in the safe and effective operation of ultra-deep mines. “We’re pleased to contribute to such a groundbreaking initiative as the Rock Stress Risk Reduction theme, and join efforts with a diverse group of solution-providers within the UDMN to create the tools and technologies this industry

needs,” says Zara Anderson, General Manager of ESG's Mining and Geotechnical Services Group.

Safety

The ultimate safety goal for mining companies is achieving a zero-incident work environment. One issue that consistently ranks as a major risk is the potential for collisions between underground mobile equipment and pedestrians. Using sub-GHz RF technology to form a peer-to-peer network of miners and vehicles, **Newtrax Technologies** has developed a proven technology to detect pedestrians around corners, and in blind spots that cannot be covered with other technologies.

Consistently and accurately distinguishing passengers from pedestrians is a common problem in proximity warning systems. Due to the pervasive nature of RF, these systems typically cannot differentiate between a passenger inside the vehicle and a pedestrian standing just beside it. The patent-pending solution to this problem that Newtrax has devised can reduce the noise from these nuisance alarms by 90-95% for a more accurate and reliable system that ensures the safety of miners working underground.

A case study presented at this year's SME Annual Meeting in Denver in February *Proximity Detection with Reduced Nuisance Alarms, Purpose-Built for Underground Hard Rock Mines* by Alexandre Cervinka and Cynthia Younes, examined how Fresnillo's Juancipio Project, a silver mine in Mexico, reduced the number of near-miss incidents as well as lost time with this system.

Newtrax Technologies is now partnering with the Montreal-based Institute for Data Valorisation (IVADO). Together, they aim to create new value for existing customers with the big-data





generated from Newtrax systems installed around the world.

Jean-Marc Rousseau, Director of Technology Transfer for IVADO, said “the customer problems Newtrax is trying to solve and the datasets they have are a perfect fit for the expertise of our deep learning and operational research hubs”. Deep learning, the subset of artificial intelligence (AI) focused on teaching machines to find and classify patterns in mass quantities of data, is now the cornerstone of growth for Google, Facebook, Microsoft, Amazon and a host of other Silicon Valley companies.

Cervinka, CEO of Newtrax, said “since our HQ is in the middle of what is becoming the Silicon Valley of AI (Montreal) with the world’s largest number of independent data scientists a stone’s throw away from our R&D centre, we are well positioned to leverage locally what globally is a very scarce talent pool”.

Breakthroughs in AI have historically been constrained by the absence of high-quality training datasets, not by algorithmic advances. Rapid progress in machine vision, language translation, and games only occurred after relevant and specialised big data became available.

In this context, Newtrax and IVADO are confident the combination of high-quality datasets with world-class AI expertise will deliver powerful decision-making tools for the underground hard rock mines of the future.

Safety is one of the core drivers of **Wenco** technology, best known for fleet management. A current focus is on integrating collision avoidance systems with fleet management data. Equipment status, destination, route network, bench elevation, and other parameters collected by a real-time fleet management system (FMS) have the potential to affect the severity of hazards found through a collision avoidance system.

Devon Wells and Wenco colleague Jason Clarke in *Mining Safer Together: Stronger Collision Avoidance Through Integrating Contextual FMS Data*, presented at the SME note that “many collision avoidance systems already send their data to FMSs to analyse and store for safety reporting. Using this integration to pull FMS data into collision detection and avoidance calculations presents an opportunity to advance operator safety while also reducing the false positives hampering the technology.

“The latest collision avoidance systems have attempted to implement EMESRT Design Philosophies guidelines in order to improve upon best practices and pursue the ultimate goal — a thoroughly safe mining operation. Yet, efforts to date still fall short.

“Even the most advanced technological solutions for collision avoidance come with substantial drawbacks that hinder their utility for



surface mining. Complex systems and high costs render many options unviable, while GNSS-based peer-to-peer technology continues to deploy excessive false alarms that force its rejection by machine operators.

“The contextual data gathered by an FMS, though, presents a real boon to these peer-to-peer collision avoidance systems. Unlike stereoscopic video or lidar, this data comes at no additional cost to sites that already use an FMS. Yet, it can greatly aid collision avoidance systems in sorting real hazards from false alarms through its ability to provide information about site parameters and equipment behaviour. FMS data adds a GNSS-supported map of the mine’s road network, which can facilitate more accurate predictions of equipment travel paths. It provides access to bench elevation data, so collision avoidance systems can nullify alerts produced by equipment operating on separate benches. It gives colour to equipment activities through status codes, allowing the system to mute alerts from equipment working under ordinary conditions.

“In total, this additional data gives collision avoidance systems the context they need to judge hazards from safe operation and cease sending nuisance alerts to operators.

“FMS data does not present the only option for enhancing the safety of collision avoidance systems to EMESRT-approved levels. Technology vendors are continually working to develop new sensors and logic that can correct for many of the issues in current generation GNSS-based peer-to-peer collision avoidance systems. These future options will undoubtedly reduce many of the current complications and raise mine safety to new heights. But, FMS data is already available to connect to collision avoidance systems to address many of the current concerns. In integrating FMS and safety systems, mines stand to significantly decrease the false positives arriving from their current collision avoidance systems and, thereby, make their systems more practicable for surface mining. This integration

A screenshot of Wenco’s new collision avoidance system, Fleet Awareness V2X

nudges the current generation of collision avoidance closer to the ideal vision for safety set out in the EMESRT Design Philosophies and offers a workable solution to enhance safety for everyone throughout the mining environment.

With Mines Going Deeper, Developing an All-Encompassing Passive RFID Solution can Help with Safety, Productivity, and Profitability was presented to the SME by M. Brunet of K4 Integration, noting that “many newly discovered orebodies have been found deep within existing mining infrastructure. Logistical costs to access and maintain these areas are high and any reduction in operating expenditures is crucial.”

Deploying a passive RFID in these circumstances or in new operations is beneficial. It can be used for material handling and inventory: knowing what you have and where in the mine can make inventory management easy and reliable. Proactive ordering makes sure things never run out. Expensive equipment can be tracked in order to monitor its use.

Also, personnel tracking means energy used for lighting and ventilation can be controlled depending on activity in an area of the mine; dispatching is more efficient; safety accountability time during an emergency is reduced. Data from work habits can be stored and reviewed.

Another application is the optimisation of ramps by prioritising use depending on equipment.

“Newly developed tags are being introduced every day,” Brunet says, “these only add to the breadth where a passive RFID system can be beneficial. Tags can now be embedded in steel or hammered onto a skid, they can be carried by personnel without being intrusive, or they can be installed on vehicles.”

A recent report from Persistence Market Research estimated the global dust control



market to exceed \$12.3 billion by the end of 2016. The mining industry is estimated to account for 25% of this market. This spurred the team from **Cypher Environmental** to invest the time and energy to determine the shortcomings of the current industry offerings and come up with a solution.

The most prevalently used dust control products on the market are chloride based: MgCl, CaCl or Bischofite in South America and these products have been in use around the world for many years as a low cost treatment of unpaved roads to control fugitive dust.

Cypher set out to develop a low cost/cost competitive alternative to chlorides to not only provide effective dust control for its customers but to ultimately limit the widespread application of these toxic products in sensitive environments around the world. The product had to be non-corrosive/non-toxic in composition, but also outperform chlorides in a side by side comparison making the adoption an easy choice for clients worldwide.

As a result the company has developed a product called Dust Stop Municipal Blend (DSMB), and while the name may be deceiving, the solution has significant opportunity to replace archaic forms of dust control being used in the mining industry including the chloride products discussed above. Chlorides are not only toxic but also highly corrosive, speeding up rust development and depreciation of any mining equipment / assets using the roads treated with these products. Chlorides are also hygroscopic, meaning they require ambient moisture in the atmosphere to absorb water and control the dust. The downside is that the products are not effective during long periods of dry weather, and will absorb too much water during wet weather resulting in toxic run-off or slippery and dangerous road conditions which can also have a negative impact on productivity. DSMB contains a blend of natural sugars, starches and a mineral component, which binds and hardens the road surface that will not run-off in the rain, yet is effective during long periods of dry weather.

This new product is highly concentrated to reduce shipping costs, fuel consumption and emissions caused by the shipping of water weight of less concentrated products (some chloride products are shipped, ready to use). DSMB is also applicable to any road material type and can be applied using standard road maintenance equipment (water trucks, graders, etc.).

Cypher has developed a simple spreadsheet that shows how the use of DSMB can not only save millions of litres of water (sprayed onto roads for dust suppression) but ultimately countless litres of fuel (in delivering that water), resulting in a huge cost saving, due to the long



term results (measured in months) that the product can provide. Simultaneously having a profound impact on the environment and helping to reduce operational costs on road management.

Greener processing

Back to #DisruptMining and another semi-finalist, **Dundee Sustainable Technologies (DST)** which last December announced successful extraction results on gold concentrates from Chile using its proprietary chlorination technology at its Demonstration Plant in Quebec. A gold extraction yield of 97.3% was achieved at the outlet of the chlorination reactor with full environmental controls over the sulphur and mercury content.

"These results are another important demonstration of the efficiency and effectiveness of the DST chlorination process and of its potential as a robust and environmentally friendly alternative to cyanide extraction in the gold mining industry," said Brian Howlett, President and CEO of DST. "We are partnering with a number of mining companies in an effort to advance our technology and further explore the commercialization of our patented process."

In September 2015, DST entered into an agreement with a Chilean mining company for the processing of gold concentrate at the pilot scale using the chlorination process. Excellent results at the pilot scale enabled DST to move forward on to the next stage, which involved the processing of the concentrate which contained an estimated 110 g/t Au, Cu grades of 9.0% and mercury content in excess of 700 g/t at the Demonstration Plant.

DST processed 40 t of this complex material which is difficult to process using conventional processing methods without the associated environmental liabilities and metallurgical challenges. In particular, the 700 g/t of mercury was effectively removed during processing to a

level of 99%.

Through the development of patented, proprietary processes, DST extracts precious and base metals from ores, concentrates and tailings, while stabilising contaminants such as arsenic, which could not otherwise be extracted or stabilised with conventional processes because of metallurgical issues or environmental considerations.

At present, DST's most advanced proprietary process is associated with the extraction of precious metals using a chlorination to provide a cyanide-free alternative for the exploitation of gold deposits. The primary benefits of this innovative technology are shorter processing times, a closed-loop operation eliminating the need for costly tailings pond, and reducing environmental footprint related to the inert and stable cyanide-free tailings.

The chlorination process developed by DST is a recognized 'green technology' for which it was awarded a C\$5 million grant by the Government of Canada for the construction and operation of a demonstration plant. The plant serves as a demonstration platform for the chlorination process on an industrial scale and under continuous operating conditions. The corporation has received, from Environment Canada, through the Canadian Environmental Technology Verification Program, an independent certification of the performance of its cyanide-free gold extraction process.

In addition to the chlorination process, DST operates a pilot plant designed to demonstrate its arsenic stabilisation process for the sequestration of arsenic in a stable glass form. This process involves a technique to segregate arsenic and therefore provides opportunities to process materials considered too toxic to be exploited or stabilised using conventional mining methods.

#DisruptMining semi-finalist **Scanimetrix's** wireless monitor and sensor products are