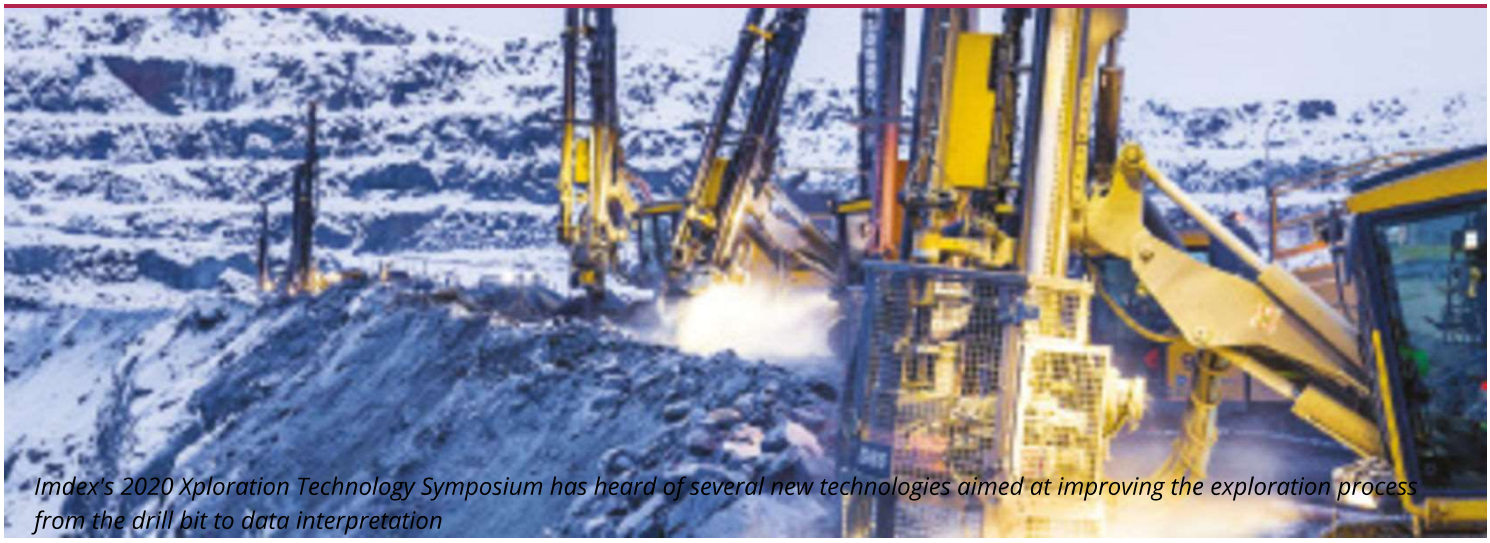
Edition

Exploration innovators offer view of the future

Vancouver's high-density mineral exploration scene got a tantalising glimpse at the industry's future at a technology symposium Friday.



Imdex's 2020 Xploration Technology Symposium has heard of several new technologies aimed at improving the exploration process from the drill bit to data interpretation

Exploration / Development > Events-coverage

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Henry Lazenby In Vancouver

Key themes from the Imdex-hosted Xploration Technology Symposium centred on improving exploration efficiency and effectiveness, using big data for machine learning and automating traditionally manual processes to enable geologists to maximise time spent on value-building interpretation and analysis.

Imdex is an Australia-based mineral drilling technology and services company listed on the ASX.

Much was said in Vancouver about the advent of machine learning and how artificial intelligence could help take the guesswork out of data acquisition at a dramatically faster rate, delivering more consistent multidisciplinary data that would help stretch exploration budgets further.

One development that might help "futureproof exploration" was the use of infrared spectra combined with machine learning, said Bureau Veritas managing director, Dr John Carter.

He said infrared spectroscopy exploited chemical composition variations and mineral lattice structures to produce characteristic mineralogical responses from samples.

Key to the technology's successful adoption was interpretation methodology, Carter said. He said specific spectral features were associated with limited properties but with the power of machine learning, predictions for a wealth of elemental, mineralogical and physical characteristics, and metallurgical responses, could be unveiled.

He emphasised that machine learning in routine analysis could add significant value to exploration programmes.

"There is a gap between the knowledge we need and the knowledge we have. Analysis cost tends to increase the closer one gets to process and mine development; we're trying to reduce the cost here," Carter said.

Traditionally, geologists would compare spectra to known samples using a comparison library, learned trends in spectral data, depth profiles, background and qualitative descriptive data. "Now we can train a computer to predict outcomes to discover and capture association patterns that might have otherwise been more difficult to explain and generate relationships between variables that are difficult to describe," Carter said.

"We're moving away from the manual interpretation of data. We're also moving away from just getting data, to getting knowledge," he said.

Mira Geoscience director of global consulting Jean-Philippe Paiement said supervised machine learning was opening the door to streamlined data extraction from geochemical datasets.

"Machine learning will never be a blind answer - you have to know what you are looking for and the environment you are dealing with before one can expect to arrive at a prediction," he said.

Paiement said it was now possible to analyse alteration domains with limited knowledge. Technology was allowing clustering algorithms to quantify alterations in blind domains.

He said hierarchical clustering was of interest since there was no need to define the number of classes during initialisation and it was adaptable in terms of the granularity of the interpretation.

The caveat is that machine learning only works if the data is of good quality and does not present 'levelling' problems - such as when exploration campaigns used different methods.

However, Paiement said, traditional geological knowledge was still essential in the application of machine learning, since identification of the starting domains of the rocks to be altered was essential. Basic geochemical knowledge must also be used to choose variables to be employed, as well as for interpretation of results.

Vincent Dube-Bourgeois, co-founder of Goldspot Discoveries Corp, said the use of machine learning in greenfield exploration was "state of the art". He described AI as a multidisciplinary field pulling insights from other sciences and machine learning was the toolbox of algorithms and techniques it depended on to work.

"It can help to streamline field activities, it is a tool to help with traverse planning, and can accomplish automated outcrop and lake detection from satellite images," he said.

Dube-Bourgeois said manually tracing polygons from satellite images took a great deal of work: AI cut the time it took geologists to do this. A proprietary segmentation algorithm helped correctly identify outcrops and lakes, and created automatic shape files more precisely and consistently than manual interpretation ever could.

"Fabric modelling" made an automated unbiased geometric evaluation of new data, he said.

In one case an exploration team used a historical map with 1,800 structural measurements in the creation of a large-scale trend map, incorporating new measurements, to streamline and highlight potential flexures compatible with mineralisation.

Machine learning was also helping to speed integration of different datasets.

It helped to refine historical data that were unreliable due to limited mapped outcropping. Dube-Bourgeois said GoldSpot's approach helped validate data in the field, using statistical techniques to reduce "carriable clustering" and drawing on domain expertise. It could "fuse historical maps" and incorporated geotechnical surveys such as VTEM and other classes of data from field validation.

"In short, it has successfully reduced the time and cost of exploration," Dube-Bourgeois said.

Another application was in lithology prediction, based on collation of known bedrock geology, multispectral data, magnet data and radiometric data.

Looking deeper

Principal geophysicist at HiSeis Greg Turner explained how seismic reflection could be used, literally, to shine new light on mineral systems at depth.

He said because mineral deposits were three-dimensional the depth dimension was critical to understanding scale.

Turner said minerals systems theory highlighted the need to understand the geological environment at multiple scales. Most of the information used to generate geological models was based largely on data sets that had limited depth extent or limited resolution at depth. As a result, geometries in the third dimension were often inferred.

Seismic reflection was useful in mapping crustal, camp and deposit scales, which ultimately assisted in better direct and indirect targeting of mineralisation.

Turner said the use of seismic reflection was providing continuous, high-resolution images to better constrain mineral system understanding and target new mineralisation.

He said seismic reflection had been used successfully in the Tanami region of central Australia, an area about 354km wide. The technology had been used to find mineralised fluid pathways between various crust layers that helped determine sinks for mineral enrichment.

"In the Tanami region there is an astounding correlation between mineralised occurrences and antiform occurrences - it has resulted in the discovery of a series of multi-million-ounce deposits," Turner said.

University of British Columbia professor Bern Klein, a member of the International Caving Research Network (ICaRN), said new techology could play a key role in advances in cave mining, that in turn had an important part to play in future mining of British Columbia copper porphyries. ICaRN is looking at block caving using a fully integrated approach, from cave-to-mill, applying in-mine ore sorting.

"The mining industry is not known to be a fast actor and it remains to be seen how fast we can implement some of the new technologies available to us," Klein said.

Significant innovation was needed to make mining of large-tonnage, low-grade deposits feasible.

XRF Shovel and PGNAA Belt sensors, combined with automated ore sorting systems, had been successfully demonstrated to add value at large-scale copper mines in both waste rejection and ore recovery.

"Finer particles can significantly add to the NPV of a project using sensors that provide real-time data. The shovel-based sensors, for instance, provide the potential for individual shovels to operate at different cut-off grades and in combination with in-mine ore sorting, could add up to a 79% improvement to a project's NPV," Klein said.

"Bulk sorting can add significant value to operations with heterogeneity and a sensor amenable to the ore in that condition.

"If we can detect heterogeneity, we have the opportunity to implement ore sorting," he said. "Mining usually ignores medium heterogeneity, and this is where a lot of value can be added via automation."

SRK Consulting practice leader Wayne Barnett lifted the veil on virtual mixed-reality data collection and analysis. Using commercially available VR technology such as the Microsoft Hololens 2, SRK in partnership with the Simon Fraser University, is developing the EasyMap MR software application that incorporates 3D-scanning and holographic projection technology.

This could be a particularly useful tool for geologists and geotechnical engineers to use visual powers to automatically measure surface orientations and for drawing out geological interpretations directly onto a rock face using virtual tools.

"Mixed reality technology is changing best practices in data collection and analysis, not just visualisation and communication," Barnett said.

Drilling better

Imdex global product manager Nick Payne said mineral exploration drilling rates had not improved since 1958 and today still averaged about 30m a shift.

The Imdex-developed COREVIBE energy pulse drilling method used high-frequency energy pulse-assisted drilling for wireline coring that could improve drilling rates by 30%.

"If you have competent ground it works great, but brittle stuff is no good. On the Mohs scale of mineral hardness, a value less than 5 renders the innovation ineffective," Payne said.

XTRACTA, a retractable core barrel that allowed a driller to inspect and change a drill bit each time core was retrieved, obviated rod pulling to inspect drill bits, improving operator safety, Payne said. The entire core barrel was retractable with the bit and reaming shell, and retractable reamers advanced in the rods.

"You reduce the risk of a collapsed hole [by not having to pull rods], and it gives the driller a chance to be a bit more aggressive with higher cut rates and enables a drill bit change at every run. It also does not cause hole deviation and significantly reduces the risk of injury since there is no need to pull rods until hole is competed," Payne said.

He said Imdex's MAGHAMMER percussive core drilling innovation enabled coring and hammering simultaneously at 60bps. It could advance at a rate of 20m/h, the equivalent of current reverse circulation rigs, but without the need for pre-collaring.

Payne said it combined rotary diamond drilling with fluid-driven percussive drilling. "It entails a brand-new drilling technique using water. It's ideal for drilling through cover, and is only limited by the pull-back capacity of the drill rig," he said.

Imdex has been developing the new technologies in New Zealand at its own test site, which has helped fast-track prototype development. External bodies such as XGS have monitored and validated test results.

COREVIBE is being field tested on live sites in South Africa, Australia, the US and Canada and will be available to market by mid-2020. XTRACTA will be available by year-end in H & N core sizes, with trials starting in February. The MAGHAMMER is scheduled to start testing early next year.