USING **BIG DATA** AND **AI** FOR SMARTER MINERAL EXPLORATION

Roundtable: How big data solutions will lead to new mineral discoveries
Using Big Data and AI for Smarter Mineral Exploration is based on the exploration roundtable: How big data can lead to big new discoveries which took place at the Progressive Mine Forum in Toronto, Canada. The one-day mining and exploration innovation event was organized by The Northern Miner, with the support of IBM and other sponsors. This whitepaper contains selected edited highlights from the discussion, as well as additional editorial on technology and innovation in mining exploration.

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Natural resource businesses are facing disruption due to volatile commodity prices and low reserves replenishment, while exploration and development costs remain high. Companies are shifting toward innovation and technology to cut costs while trying to increase the productivity of existing exploration and production operations.

How is the mining industry wrestling with big data and how have advanced technologies like artificial intelligence (AI), machine-learning and cloud computing helped drive efficiencies in geological workflows and productivity?

**80/20**

"The time spent by exploration geologists at our Red Lake mines searching for and manipulating data versus analyzing data."  
— ROBIN LEE FELL, DIRECTOR, STRATEGIC TECHNOLOGY SOLUTIONS, GOLDCORP INC.

**Goldcorp’s Red Lake Mine Employing IBM’s Watson**

As part of IBM Watson for Natural Resources Cognitive/Al industry platform, IBM has been working with Goldcorp since 2017 in the area of subsurface analytics. To augment our geoscientists, IBM is creating a data-driven modelling workflow for predicting gold mineralization in a specified location within the boundaries of a mine. The workflow will result in models that input known and inferred geological information (lithology, veining, mineralization, alterations and structure information, such as faults and folds) available from multiple sources (drill-hole data, chip data, maps and geological models) in and around the location of interest and output a predicted value for the expected gold content in that location. IBM’s subsurface analytics work for the mining industry will help reduce drilling costs, improve predictions where there is sparse data and accelerate geological insights.
IBM Watson for Natural Resources Cognitive/ AI platform for the oil, gas and mining industries delivers improved operational, exploration and market performance in the areas of; subsurface analytics, equipment reliability, operational effectiveness and health and safety. As the oil and gas industry forges ahead in digital transformation, the mining industry has an opportunity to implement proven solutions already in play.

**INTRODUCTION**

With prices for most mined commodities strengthening over the past year, the mining industry is emerging from the downturn that lasted from 2012 to 2016. As mining’s overall prospects brighten, however, two chronic problems remain: the declining rate of new mineral discoveries and the rising cost for each new ounce or tonne of metal or mineral added to reserves.

The modern era of mineral exploration was launched after World War II, and after seven decades of prospectors and geologists scouring the globe, almost all the “easy” deposits at surface have been found and mined out. As today’s mineral explorers seek out increasingly difficult deposits, they are becoming reliant on expensive deep-drilling and data-heavy surveying.

The good news for miners is that the rate of improvement in information technology over the same time period has been revolutionary, and a new suite of powerful analytical tools for mineral exploration is becoming available for the first time.

Big data, artificial intelligence, and the Internet of things are some of the new phrases that today’s mineral explorers are bringing into their workday vocabulary as they seek new ways to achieve accelerated exploration, discovery and production through improved accuracy in deposit-modelling capacity – ultimately leading to new revenue streams that are achieved sooner.

Another benefit for miners is the fact that the oil and gas industry is already several steps ahead in experiencing the disruption of the big data revolution. Miners are able to look across at their resource-industry cousins for inspiration and examples of best practices in bringing big data into exploration applications.

In the following pages, our roundtable of experts and thought leaders delve into these topics and serve up their unique insights on this emerging field.

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**LESLEY STOKES** ▶ IBM is on the cutting edge of developing big data solutions for the mineral exploration and mining industry. Pavel, can you give us an idea of what IBM is working on and how you became interested in this sector?

**PAVEL ABDUR-RAHMAN** ▶ We are focused on creating vertical industry specific enterprise AI solutions — what we call Watson — by taking advantage of big data, high performance cloud computing, advanced geo-spatial 3D data research and proprietary predictive models. We are analyzing both structured and unstructured data, which represents the four Vs of big data: volume, variety, velocity and veracity. For example, drill database, block models, geochem, geological shape files, metallurgy, XRF data and core photos. To simplify it, think about a two-by-two matrix with internal data, external data, structured data and unstructured data.

When we got the opportunity to work with Goldcorp, it sparked a keen interest at IBM to expand our work in Watson for Natural Resources specific to subsurface analytics in oil and gas to the mining industry and to Red Lake’s specific complex geology. In general geo-spatial-temporal (3D/4D), sub-surface analytics, IBM research and data science consulting is part of the expertise and experience we bring through our Watson for Natural Resources industry offering.

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“As part of the Watson for Natural Resources Cognitive/ AI platform offering, IBM is bringing our work in oil and gas sub-surface analytics to hard rock mining.”

—PAVEL ABDUR-RAHMAN
LESLEY STOKES ▶ Robin, can you explain how Goldcorp is using big data and how it’s going right now?

ROBIN LEE FELL ▶ In exploration, we’re focused on Red Lake, which has more than 80 years’ worth of data. We’re assessing all these data sets and pulling them into IBM’s Watson platform to try to improve exploration geology and efficiency in drilling.

The really exciting stuff is once we have this data in place and it is somewhat clean, then we can fire some really clever technologies at this data, such as cognitive computing and machine learning, which is basically pattern recognition. Human beings are very, very good at this. We can take in vast amounts of information — or what we think is vast — and use our experience and knowledge to produce an output that contains elements of creativity and pattern recognition. This is something that machines haven’t been able to do until the last five years or so.

What we’re hoping is to leverage the power of cloud computing, cognitive analytics and machine learning. The goal is to make geologists more productive. It’s a tool for them. You’re not going to replace geologists ever but we can get them thinking more, asking questions and getting quick answers. These are problems we’re trying to solve underground, with sparse information. It’s difficult work, so we’re trying to use all of this technology and IBM’s experience to build something new in mining to do this.

MICHAEL DEHN ▶ Is this building something new or rebooting what was developed 10 years ago? Because a lot of this was tried 10 years ago, even at Goldcorp, and it was unsuccessful because the computing power did not support the data. The data sets were so big the computers couldn’t crunch it. And you may have been able to do something in two dimensions, but doing anything in three dimensions was difficult.

ROBIN LEE FELL ▶ In the past 10 years the required advancement has happened in cloud computing. Graphical processing is no problem — there’s no limit. It’s not like you have physical servers now, where you have to buy some more and cost it in. It’s all in the cloud.

“Using Watson, we’ve harmonized all of our 140 block models into one database in one place. Previously, we could load two or three block models at a time. Now we can query the whole harmonized lot. And it’s not just block models; it’s drill logs, geological shapes, unstructured data, etc.”

—ROBIN LEE FELL
Part of the challenge in exploration is that we rely on desktop tools to model and assess our data. These tools are limited by a physical computer on your desk. Even if they have a centralized database, the compute is still happening on your computer as opposed to in the cloud where the power of compute is limitless.

Here’s one example of something we’re doing with Watson: we’ve harmonized all of our 140 block models into one database in one place. Previously, you could load two or three block models at a time. Now, with Watson we can query the whole harmonized lot. And it’s not just block models; it’s drill logs, geological shapes, unstructured data, etc. So, if someone put together a relevant PowerPoint in 2002 and it’s hidden on a drive somewhere, now Watson has access to that, knows what it is and can point it out. And it helps you stitch these structured and unstructured data sets together. If you do this manually it takes hours and hours and hours.

PAVEL ABDUR-RAHMAN ➤ I’m not really familiar with what happened 10 years ago, but what happened in the last 10 years and what we’re expecting in the next five to seven is mind boggling, especially some of the advancements in quantum computing. There’s a joke that the only profession that will matter is change management because of the rapid exponential growth and improvement in technology. For an example in mineralogy, in 2017 a study from the Deep Carbon Observatory found there are about 1,500 “missing minerals” on Earth based on the vast amount of information on Earth’s more than 5,200 known mineral species (databases containing details of where each mineral was discovered, essential information on chemical compositions and a host of physical properties, including hardness, colour, atomic structure, and more). Abellaite and parisite-(La) are examples of new-to-science carbon-bearing minerals predicted before they were found, thanks in part to big data analysis.

MICHAEL DEHN ➤ It’s going to take some time for the industry to buy in. After the first artificially-discovered deposit there will be a little bit of a rush to that technology. But until we have that first discovery or you can show an incremental reduction in your cost-per-ounce of discovery, there’s not going to be a huge buy-in to these systems because, as you know, it’s the big companies that are doing it — not the juniors. And the juniors are the ones who are making the discoveries.

MOHAN SRIVASTAVA ➤ The juniors are tackling it in a slightly different way. We’re not into Watson and 140 block models all in one system. I don’t think it’s the availability of technology that’s made data management better, it’s the lack of money.

At the project I’m working on in Brazil, the reason we’re using Optical Televiewer, with its big data implications, is that we had a limited budget and it made sense to drill reverse-circulation (RC) holes. You could drill them fast. You lost the core, and so you needed something to replace that. The combination of RC drilling with Optical Televiewer was cheaper than diamond drilling, it gave us bigger volume samples and the Optical Televiewer provides such a startlingly good image, that you can get very close to core logging off of it. And when a single hole is 200 megabytes of data and you’ve got 100...
holes, you’re easily into gigabytes and terabytes of data. But what drove us was lack of money. We had a limited budget. And that’s where good technology can step in.

ROCIN LEE FELL ▶ You’re absolutely right. Part of the challenge is for people to have access to the right data. I don’t think these kinds of systems will replace people but we can give them a lot of power. If you imagine being able to read 2,000 journals and provide some kind of result. Not a Google result searching for words, but if the system actually understands your language and has a background in geology with expertise in certain deposits, then really you’re giving the power of 10,000 geologists to one geologist at a computer. That’s the idea.

Right now we’re looking at where we have low ounces per tonne in the block model but also visible gold indicated in a drill database. That makes no sense. But we can run that query quickly between data sets.

RICHARD SPENCER ▶ The quality of the data being collected today is a problem. If five of us were logging core, each of us would log differently. Until we’re using some consistent logging system, there’s going to be a lot of bad data that we’re battling to distinguish from the good data. That is a massive problem. The only way of getting through that is to go back to the original core or chips, if they still exist, and use the modern techniques on them. In that respect, we’re probably not going to be terribly efficient at using the big data. But going forward we will become more and more efficient at it.

ROCIN LEE FELL ▶ We now actually have the ability to address the data quality issue. Maybe there’s a certain geologist who had a certain preference for logging core a certain way, and since then we’ve decided that way is not the way we like. We can go in and actually modify or add factors to that data to normalize them. Absolutely, the quality of the data has to be great. But now we have the ability to improve the quality.

PAVEL ABDUR-RAHMAN ▶ There’s a professor from the London School of Economics who said we need robots to make us more human, talking about robotic process automation, but I think it still applies to this conversation. And I’m listening to the concerns of these geologists around the table and I’d like to say that we actually would like the geologists to do more geology and let machines do the data manipulation, information extraction and even some prediction. Professor Ajay Agrawal, from the University of Toronto, framed AI in a very simple way. He said if all human activities could be categorized in five buckets — data collection, information retrieval, prediction, judgment and action — let the machines do the first three. And let humans — the geologists, doctors, lawyers, investment bankers, etc. — make the judgment calls and take the actions necessary. Given AI is poised to be one of history’s greatest platform technologies (e.g. steam engines, railways, electricity grids, telephone, internet), we should embrace it as part of the 4th Industrial Revolution.

In the past 10 years the required advancement has happened in cloud computing. The power that we have access to in IBM’s platform is limitless, really.

—ROCIN LEE FELL

Poll responses were gathered from attendees and live stream viewers at the Progressive Mine Forum.

For exploration, big data is best for:

- Detecting/predicting patterns: 72%
- Reducing operational costs: 19%
- Generating targets: 19%
- Organizing/storing data: 17%

For exploration, big data is best for:

Click to watch the full video of this discussion at the Progressive Mine Forum.
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