The Economic Benefits of RHINO™
A Logging-While-Drilling Sensor for the Mining Industry

By Thor Kallestad
Chief Executive Officer
DataCloud International, Inc.

and

Ayman Tawadrous
Senior Research Fellow
Orica Mining Services, Ltd.
Know the Rock™: Improve Productivity and Margins

Optimizing a mining operation requires comprehensive knowledge of the entire orebody. Since drilling out an orebody is quite expensive, these expenditures are typically kept to a minimum, and the uncertainties that remain are considered a cost of doing business.

The ideal solution is to continually obtain high-resolution, accurate subsurface data at a tolerable cost, during the development, and production stages. Doing so leads to a significant increase in the quality of accumulated data that is used during iterative decision-making processes which occur during a mine’s life cycle.

While drilling, sampling and assaying is the most common approach to accumulating knowledge about an orebody during the production cycle. This approach is quite costly, time consuming, and in some cases, may not provide enough granularity about the rock mass being mined.

A ground-breaking technology that provides such granular information in real-time, and at significantly less cost than the status quo, is DataCloud’s RHINO™ geoscience sensor. RHINO™ is an Internet-of-Things (IoT) enabled, high-resolution, real-time geophysical Logging-While-Drilling (LWD) tool. It is supported by DataCloud’s MinePortal™ Platform, a unique cloud-hosted earth model built specifically for the mining industry.

RHINO™ and MinePortal™ can also connect seamlessly with Orica’s BlastIQ™ Platform. Together, these innovations provide the subsurface insights, as well as blast design, planning, and implementation tools required to optimize blast outcomes and deliver sustainable margin growth and productivity gains.

High-resolution geoscience information provided by DataCloud’s RHINO™ LWD sensor improves mine site productivity and financial returns

Short-term advantages:
Streamlines operations, lowers costs, reduces dilution, and improves mill throughput

Long-term advantages:
Produces durable efficiency gains and sustainable margin growth independent of industry cycles, which increases asset values
Minimally Invasive Technology
Maximum Subsurface Information

RHINO™ IoT sensors are mounted on production drills at mining operations. The LWD sensors are designed to be “set and forget” with no additional work required from drill and blast personnel. The sensors measure subsurface rock mechanical and acoustic properties while drilling production blastholes. Wireless communication equipment that streams the downhole data to the cloud via Wi-Fi or mobile networks is included as part of the RHINO™ IoT sensor package. Once data is measured, these high-resolution rock properties are available to the engineer in real-time via web browsers and mobile devices. The sensors do not interfere with existing drill-based systems such as Measurement-While-Drilling (MWD) systems. An illustration of the main components of a RHINO™ package is shown in Figure 1.

![Figure 1. Components of RHINO™ including wireless streaming and communication equipment](image)

Examples of RHINO™ subsurface information from recently logged blastholes at an iron ore mine are shown in Figure 2. The identity of the mine has been anonymized to maintain confidentiality. In this case, it was concluded that density (leftmost track on each of the five blastholes shown) is a great proxy for ore-waste boundary detection. As can be seen clearly, the thin bands of iron ore prevalent in this part of the mine are easily distinguished from the host rock. Uniaxial compressive strength, elastic modulus, and compressional velocity were also measured. Logs shown are uncalibrated but can be correlated to core, or reverse circulation data. This unprecedented technology has never been available to mining operations until now.
Figure 2. RHINOTM IoT geoscience blasthole data from an anonymized iron ore mine

MinePortal™ – Making Sense of It All

While RHINOTM is the DataCloud hardware solution that lives on drills, MinePortal™ is DataCloud’s software solution that brings the RHINOTM subsurface information to life. It uses advanced cloud computing and machine learning techniques to amplify the value of these high-resolution measurements. In conjunction with RHINOTM, MinePortal™ delivers the orebody knowledge required to significantly improve the productivity of mine site operations. Once in MinePortal™, the high-resolution subsurface information that RHINOTM provides can be used for a variety of applications such as enhanced visualization, mine planning, slope stability, ground support, and fracture detection. An example of an open pit mine logged with RHINOTM sensors is shown in
Figure 3. All the information in MinePortal™ is auto-populated from RHINO™ and is available to the user in real-time.

Figure 3. MinePortal™ high-resolution imaging. Top: aerial open pit view, Bottom: bench terraces
Compatibility with Orica’s next generation BlastIQ™

RHINO™ LWD data can move instantly via API to Orica’s next generation BlastIQ™ Platform, where it can also be used to optimize blast design, implementation, and measurements to achieve desired blast outcomes.

BlastIQ™ is Orica’s cloud-based digital platform that encompasses several components. The components of the platform include a design tool; namely SHOTPlus™, which provides advanced blast design capabilities, sophisticated explosive loading rules, electronic timing design as well as unique predictive modeling tools to help the engineer predict and optimize the outcomes of a blast design.

Other components of the BlastIQ™ Platform include a secure cloud hosted blast-reporting system, an on-bench mobile system for collecting actual (as-drilled and as-loaded) pattern information and a module to communicate with Orica’s Mobile Manufacturing Units (MMU™s) delivery systems, in particular the recently released Bulkmaster™ 7 unit for accurate explosive loading. The platform is also designed to allow for third-party data integration for blast outcome measurements. Figure 4 illustrates the main architecture of Orica’s BlastIQ™ Platform and how it can communicate seamlessly with DataCloud’s MinePortal™ Platform.

![Figure 4. Components of BlastIQ™ Platform and how it communicates with MinePortal™](image)

An example illustrating the use of the RHINO™ subsurface information in BlastIQ™ for generating the explosive loading design based on high-resolution rock hardness in an iron ore mine is shown in Figure 5. Once an explosive loading design has been determined for a particular pattern, electronic delay timing can be employed to optimize the firing sequence to achieve a desired outcome. While preparations are being
made to fire a drilled pattern, additional patterns can be drilled and logged with RHINO\textsuperscript{TM} sensors. An example of such simultaneous operations, is shown below in Figure 6.

Figure 5. RHINO\textsuperscript{TM} measurements used in BlastIQ\textsuperscript{TM} to determine loading rules that match explosive energy to rock hardness

Figure 6. An example of simultaneous operations taking place on a bench
Cut Costs, Increase Profits Own Your Economic Future

DataCloud’s solutions are focused on improving the economics of an operation in two primary ways:

1. **Improving Throughput**: This goal is achieved by improving fragmentation, via better blast outcomes, that are possible only with an accurate, high-resolution understanding of patterns before explosive loading and timing decisions are made.

2. **Reducing Ore Dilution**: This goal is achieved by delineating ore-waste boundaries within drilled patterns. This allows for proper timing design to minimize movement within the blast; and consequently, reducing dilution during blasting and loading.

To demonstrate the value created by improving throughput and reducing ore dilution, a sensitivity analysis for a hypothetical iron ore mine; with a fixed annual production of approximately 40 million tons, was carried out. The estimated head grade of the feed is about 62%. Table 1 shows the annual incremental revenue gained from different permutations of increased mill throughput and reduced ore dilution. The sensitivity analysis assumes a recovery rate of 85%, sellable iron concentrate of 62%, and a sale price of iron of 60 US Dollars (USD) per ton. The highlighted cell shows that a 1.5% increase in throughput (better blast outcomes) combined with a 1.5% reduction in dilution (knowing ore/waste contacts), creates 100 million USD of annual incremental revenue. Figure 7 shows a cross plot of the sensitivity analyses data presented in Table 1. The figure illustrates how small improvements in throughput, and grade delivered to the processing plant, can generate profound revenue gains.

![Figure 7. Incremental annual revenue growth due to improved head grade and mill throughput](image-url)
When utilized in iron ore mines, DataCloud’s RHINO™ and MinePortal™ technology also allows operators to maximize the benefits of the structural price divergence between grades that has developed in recent years. By reducing the contaminating effects of inadvertently sending waste rock to processing plants (dilution reduction), a higher commodity price can also be realized by the operation. This compounding effect also enhances the value of DataCloud’s real-time geoscience technology, allowing market driven price trends to combine with productivity improvements and increase margins even further.

An example of this price disparity for different grade concentrations is shown in Figure 8.

![Figure 8. Iron ore price discount that has developed in recent years based on iron content](image)

With respect to other ore types such as copper, gold, nickel, lithium, etc., mines will experience similar benefits from DataCloud’s technology to those shown in Table 1 and Figure 7. In these orebodies, deployment of DataCloud’s RHINO™ and MinePortal™ technology, will produce more profound effects on throughput than it will on dilution reduction. The net effect will still be significant revenue growth and margin expansion, in addition to a corresponding improvement in asset productivity.
The Unique DataCloud Business Model

DataCloud creates alignment with mining operations by providing its RHINO™ sensors via an Infrastructure as a Service (IaaS) business model. DataCloud also offers its MinePortal™ Platform via a Software as a Service (SaaS) business model. Cost of the services is expended in line with the scale of the activities at a mine. No capital expenditure is required by the customer, and the risk of delivering services is borne by DataCloud. Such pricing and structural features are typical of SaaS and IaaS models in other industries. They have also proven popular as mining customers look for a business model that provides financial flexibility to trial the services, and then lock in pricing, while realizing the benefits of this transformative new technology.

### Table 1. Annual incremental revenue gains realized as a function of improved mill throughput and reduced ore dilution in an iron ore

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<th>Dilution Reduction</th>
<th>0.10%</th>
<th>0.25%</th>
<th>0.50%</th>
<th>0.75%</th>
<th>1.00%</th>
<th>1.25%</th>
<th>1.50%</th>
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