

Wireless initiation – enabling new mining methods at Musselwhite

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The mining industry is being reimagined. Robotics, automation, big data and the Internet-of-Things are transforming every element of the value chain – from exploration, mining and processing to transport. New technologies and solutions are delivering significant advances in safety, productivity and environmental outcomes.

As the industry continues to advance in automated technologies to drive greater productivity and safety across the mining value chain, the drill and blast element remains largely manual due to the complexities involved

in the intricate process. It carries the potential to unlock billions of dollars for the industry by granting access to ore reserves and reducing waste and operational delays in a safer working environment.

Orica's automation driven technology is leading the market through stepped changes in safety, productivity and efficiency for their customers, but forms the critical building blocks of their vision of automated blasting in the future.

Orica Chief Commercial Officer, Angus Melbourne, said: "Orica is uniquely positioned to unlock the value that digitally enabled and automated blasting can deliver to the global mining industry. Building on more than 140 years of experience and innovation in blasting, we have enhanced our ability to deliver value for customers by adding world-class digital expertise and solutions to our existing suite of market-leading products and services".



Looking back at the loaded wireless blast from the conventional wired mass blast. The red lighting indicates the position of the TRP loaded with WebGen™ primers

“As the industry moves rapidly towards an automated future, the introduction of the world’s first WebGen™ wireless initiation system signifies that we, Orica, are serious about being a big part of this automated future.”

INTRODUCING WEBGEN™

As a truly wireless blasting system Orica is revolutionising conventional blasting practices with their new Wireless Electronic Blasting System – WebGen™. The world’s-first truly wireless initiation technology represents a significant step in the evolution of blast initiation and is one of the most exciting initiation technologies developed in the last 35 years.

The system provides for groups of in-hole primers to be wirelessly initiated by a firing command that communicates through rock, water and air. This removes constraints often imposed by the requirement of a physical connection to each primer in a blast.

Orica is the first company in the world to develop an integrated initiation system that unlocks countless safety and productivity benefits for customers by completely eliminating the need for down-wires and surface connecting wires. This step change in blasting technology fundamentally changes the industry approach to blasting and mining.

Melbourne described the technology as being a game-changer for the industry, saying: “WebGen™ is a world-first technology and is something we are very proud of. The WebGen™ wireless blasting system not only improves safety by removing people from harm’s way, it improves productivity by removing the constraints imposed by wired connections and importantly is a critical pre-cursor to automating the charging process.

CASE STUDY: ENABLING NEW MINING METHODS WITH WEBGEN™ AT MUSSELWHITE CANADA

Site Profile Musselwhite Mine is located on the southern shore of Opapimiskan Lake, approximately 480 km north of Thunder Bay, Ontario, Canada. The mine is 100% owned and operated by Goldcorp Inc. (Goldcorp) and produces 265,000 ounces of gold per annum.

The Situation:

The majority of the mining at Musselwhite is completed using a modified Avoca mining method. With this method, each blast is backfilled and waste is removed from the backfilled stope (void pull) to create a void for the next blast.

As Musselwhite follows the ore body down, the increasing depth, the strike length, and number of lifts have contributed to high levels of stope dilution. Some of this dilution is separable during the mucking cycle, but the net effect is a reduction in productivity and profit. Orica identified an opportunity to use WebGen™ 100 wireless through the earth initiation technology (WebGen™). A project was initiated in late 2016 to leave temporary rib pillars (TRP’s) that could be recovered using WebGen™.

The TRP concept aimed to improve two key aspects; Safety and Productivity:

- Reduce hazard exposure of operators working adjacent to open holes
- Improve fragmentation through mass blasting
- Reduce mucking and remote bogging time
- Eliminate void pulls (re-handling)
- Reduce dilution

At Musselwhite, ore pillars that previously could not be recovered in underground operations can now be extracted using Orica’s WebGen™ technology combined with a new mining method using temporary rib pillars (TRP). Using this new method, the main ore of the panel can now be blasted and extracted while the TRP hold back the waste rock backfill. The inaccessible ore pillars can then be blasted, delivering reduced dilution, increased truck fill factors and improved overall productivity.

Goldcorp Musselwhite Mine, Chief Engineer, Billy Grace said: “Since starting the TRP trials with WebGen™ in 2016, our level of comfort with the technology has reached a point that discussing possible wireless applications is an integral part of our mine planning process. The entire team is excited by the possibilities that WebGen™ has opened up, and the new opportunities they are allowing for us to increase our productivity.

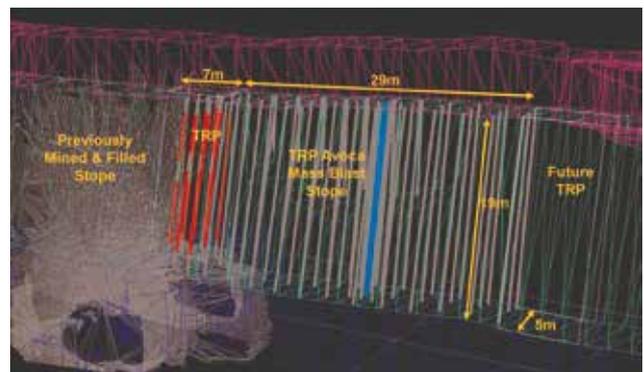


Figure 2 The novel mining method purposely leaves a section of the orebody stranded, in the form of a temporary pillar, charged with WebGen™ primers.

LATEST TECHNICAL INNOVATIONS

"This new mining method has led to significant safety improvements as the operators do not have to work adjacent to the open stope. The mine also saw a significant increase in productivity as re-handling of waste is no longer required. With the improvement in the conditions of the stope walls, the mine is also seeing better ore recovery from reduction of waste dilution.

The selected stope for the trial case was not conventional for the mine. Dilution recorded was well above historical averages. The metrics selected to measure performance were:

1. The overall stope cycle time in days
2. The daily scoop productivity, in tonnes per day (TPD)
3. Overall stope dilution.

Musselwhite TRP Case Study Blast	
Days mucked	33% Reduction
Avg. TPD	27% Improvement
Dilution	93% Reduction

Table 1: Summary of key production metrics for the case study blast.

Since the case study blast, Musselwhite has implemented the TRP method in several areas of the mine where excessive dilution is being experienced. On average, a 34% reduction in dilution has been observed in these TRP mining fronts.

The key benefits of WebGen™, validated by Goldcorp include:

- 1) **Improved Safety** – The new mining method has led to significant safety improvements as the operators do not have to work adjacent to the open stope.
- 2) **Increased Productivity** – Prior to this new method, the mine would fill the previous open stope with waste rock prior to blasting the next block. This re-handling of waste consumed valuable assets and resources that could be moving ore to the mill.
- 3) **Improved Ore Recovery** – A measurable improvement in the conditions of the stope walls has also been achieved leading to the reduction of waste dilution.

The WebGen™ system has proven itself as a technology critical to implementing new mining methods at Musselwhite and providing significant safety, productivity and cost reduction benefits. As a result, Goldcorp signed a long term commercial WebGen™ service agreement with Orica in North America.

Additionally, based on the success of the TRP method, two other revolutionary mining methods have been successfully evaluated, including a Temporary Uphole Rib Pillar to improve recovery; and a Reverse Throw Retreat to improve ore recovery. Enhancements to other drill and blast geometries and mining methods utilised at Musselwhite are currently being explored, enabled by the wireless initiation technology.

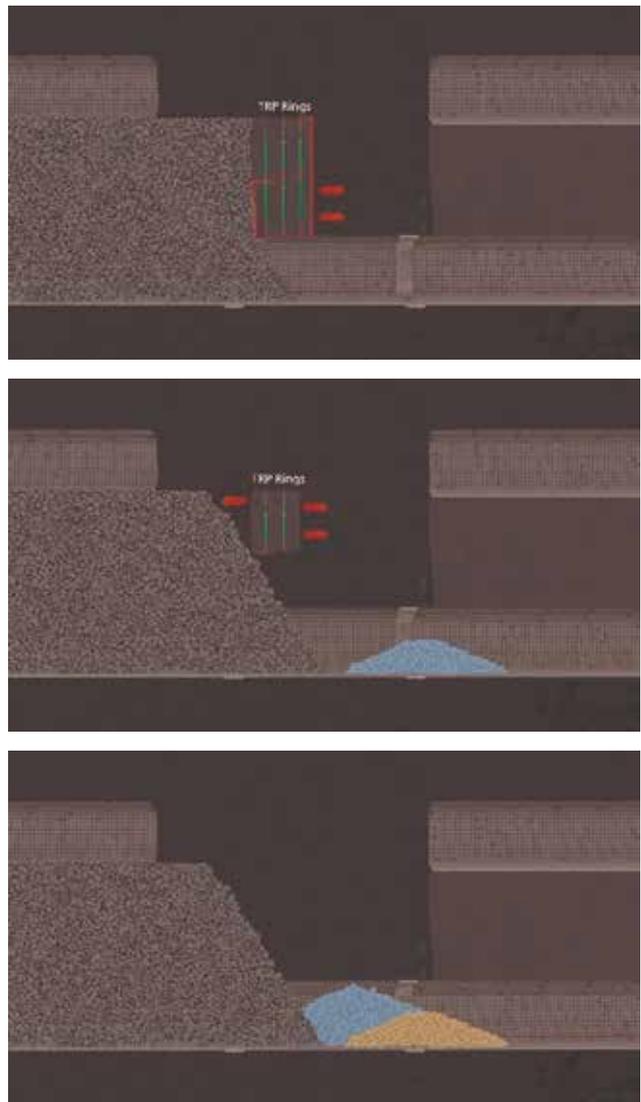


Figure 3 Firing sequence of the TRP rings occurring in one single event



Orica Senior Underground Blasting Specialist and Team leader at Musselwhite, Steve Piercey discussed the step-change in traditional thinking enabled by WebGen™ technology, saying: "For all of the wonderful things we were able to do with electronic blasting, we were still

WIRELESS BLASTING SOLUTIONS



WORLD'S FIRST TRULY WIRELESS INITIATING SYSTEM



Improved ore
recovery



Increased
productivity



Improved safety



Reduced operating
costs

A wireless blast service enabled through WebGen™ completely eliminates the need for down-wires and surface connecting wires.

WebGen™ communicates through rock, air and water to initiate blasts reliably and safely, removing people from harm's way. This industry-changing technology enables new mining methods and blasting techniques to increase productivity and reduce operating costs.

Orica achieved **34% reduction in waste dilution for improved ore recovery** and **20% improvement in mucking productivity** based on WebGen™ application at Musselwhite, Goldcorp in 2018.

To learn more about WebGen™ and how it can better enable your operation today, please contact your local Orica representative or visit orica.com/wireless

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encumbered by wires. Now we have a truly commercial system that is 100 per cent wireless, we are only limited by our imaginations and sound engineering principles.” Orica is now working to produce a wireless primer specifically for surface mining applications that will deliver greater flexibility to the open cut mining sector in coming years. This is a critical first step towards full automation of the drill and blast process across the underground and surface mining sectors, a long-term goal shared by both the mining industry and Orica.

Updated TRP Results Since the case study blast, Musselwhite has implemented the TRP method in several areas of the mine where excessive dilution is being experienced. On average a 34% reduction in dilution has been observed in these TRP mining fronts.

The WebGen™ system has proven itself as an enabler to modify an existing mining method utilized at Musselwhite and provide substantial improvements in safety, productivity and cost reduction.

Based on the success of the TRP method, two other mining methods have been successfully evaluated, including a Temporary Uphole Rib Pillar to improve recovery; and a Reverse Throw Retreat to improve ore recovery. Enhancements to other drill and blast geometries and mining methods utilized at Musselwhite are currently being explored.

Acknowledgements Orica would like to recognize Steve Piercey, Orica’s Senior Underground Blasting Specialist along with Bill Grace, Holly Robinson and the entire Musselwhite team for their relentless drive towards excellence. This achievement would not have been possible without collaboration and support from the customer, led by Musselwhite Mine General Manager, Peter Gula.

MEDIA CONTACT Andrew Valler Senior Manager, Global Marketing Communications
Mobile: +65 9233 0062
Email: andrew.valler@orica.com
Website: www.orica.com

NEWS, PLANT AND EQUIPMENT

Exploring for conglomerate gold in The Pilbara

Conglomerate-hosted gold and alluvial gold draining conglomerate sequences have been discovered by multiple explorers over an extensive area of the Pilbara region of Western Australia. Most of the conglomerate-hosted gold in the region has been recognised in the conglomerates of the Hardey Formation at the base of the Mount Roe Basalt in the lower part of the Fortescue Group.

Like the Witwatersrand gold deposit to which they have been compared, the conglomerate contained in the Pilbara was deposited prior to the Great Oxygenation Event, where low levels of oxygen in the atmosphere allowed detrital gold to be co-deposited with pyrite, graphitic carbon and uraninite.

Understanding sedimentary features and controls on gold distribution are key tools for exploration. Numerous researchers and explorers have suggested a sedimentary or paleoplacer deposition model for the Pilbara conglomerate-hosted gold deposits, a different style of gold mineralisation

than traditionally mined in Australia. The paleoplacer model refers to gold deposited within coarse sediments, where distribution and grade can be directly related to sedimentary controls.

Gold discovered in the Pilbara appears to have a relatively high nugget. ‘High nugget’ refers to the large statistical differences between closely spaced samples of the same material in the mineral system, making a resource difficult to estimate.

High nugget is a common problem in gold deposits and may be exacerbated in the Pilbara deposits by the relative immaturity of the host conglomerates, but this

has not been extensively tested. Early indications are that the Pilbara conglomerate-hosted gold is typically coarse, producing watermelon seed-sized gold grains. How these gold nuggets are formed remains a contentious topic, and a lot more work is needed to fully understand this phenomenon and the implications for sample assay statistics.

Results from conglomerate-hosted gold at the similarly challenging Pardo deposit in Ontario highlight the variability in sample grade in this style of mineralisation. A recent 985 tonne bulk sample of exposed pyritic conglomerate returned a head grade of 4.2 g/t gold

in a pilot plant program. The volume of rock excavated had an estimated average grade of 1.3 g/t gold from 11 diamond drill holes. The variability in grade from drill core to bulk sample is typical of high nugget gold deposits and creates a challenge when estimating a Measured or Indicated Resource required for preliminary economic assessment.

Because high-nugget mineralisation requires customised sampling to address the statistical variance, more work is required to determine exactly how the nugget effect will influence the accuracy of resource estimation of Pilbara conglomerate-hosted gold deposits.

