CASE STUDY

Pillar recovery delivers US$1.59M in customer benefit using WebGen™ 100 wireless technology

Nexa Resources Vazante - Brazil

Site Profile

Vazante is a zinc/lead mine located in the northwest of Minas Gerais state, Brazil, and owned by Nexa Resources, a company formed from the merger between the Brazilian Votorantim Metais and Peruvian Milpo. The mine currently stands for 28% of the company's equivalent zinc production, delivering and beneficiating 374 and 35kt in Zn and Pb concentrate, respectively. All the ore production is concentrated at the mine site and transported to Três Marias, where the metallurgical concentration takes place in a smelter.

Vazante is inserted in a karstic context associated with high rates of hydric circulation and its relationship with the terrain's morphology (high outflow rates associated with geological structures, presence of sinkholes and caves), which brings extra concerns to mine operation.

The mine operation started in 1969 as an open pit mine and developed to an underground operation in 1982, with *Vertical Retreat Mining* (VRM) and *Long Hole Open Stope* being used as main methods for ore extraction. The method of choice is dictated by the ore block geometry, and continuity and angle.

The VRM is a variant of Sub-Level Stoping, consisting of opening two parallel galleries (drifts) at the base of the ore panel, the first is developed in the orebody and the second in waste, which is used for access and transport. Both lower galleries are connected approximately every 60m by a crosscut. On top of the orebody panel, another tunnel is developed.

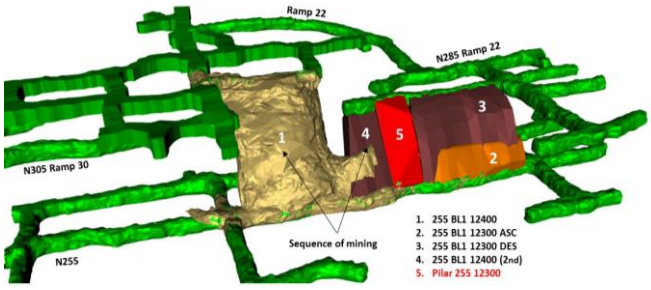
The deposit is controlled by a large shear zone, from where the Willemite mineral (zinc silicate) is extracted from hydrothermal veins embedded in a breccia main body. This shear zone has a main NE / SW direction, with dips ranging from 30 to 85° to NW and veins width of approximately 4.5m.

Situation

Where the VRM method is used, a roughly 15m wide pillar is kept between each designed stope to enhance the stability of the rock mass and maintain operational dilution at a controllable level. The recovery of the ore contained in these pillars is dependent on several discrete operations required after the entire stope is blasted and mined out, which involve resources and time that could have been used for primary production. Most importantly, it requires exposure of people to areas that have already suffered great damage due to very close blast cycles performed during the mining of the stope. The re-entry for blasting the pillar is accomplished by implementing several roof-supporting steps, such as shotcrete, rock bolting and cable bolting after completing backfill.

To control dilution, the site performs individual stope stability analysis under the methodology introduced by *Potvin, 1998* and *ELOS* (equivalent linear overbreak/slough). The analysis results indicated the necessity of introducing an *island pillar* into the mine sequence to reduce stopes *hydraulic radius* and *standup time*.

The figure below shows the layout and mine sequence from the stopes *255 BL1 12300* and *255 BL1 12400* (numbers 1 to 4) which was mined using the current blasting technology (Bulk emulsion and i-kon™ III electronic detonators), and the *island [rib] pillar* (number 5) mined using WebGen™ 100.



255 BL1 12300 island [rib] pillar recovery using wired detonators would be dependent on rock filling the adjacent open stope, reinstalling ground control where needed, scaling, and managing the risks associated with personnel exposure to previously blasted rock mass. This incurs additional costs and time delays. All these operations aim to allow the safe re-entry to the upper level to load 110mm downholes, program the electronic detonators and fire the shot.

Pillar recovery delivers US$1.59M in customer benefit using WebGen™ 100 wireless technology

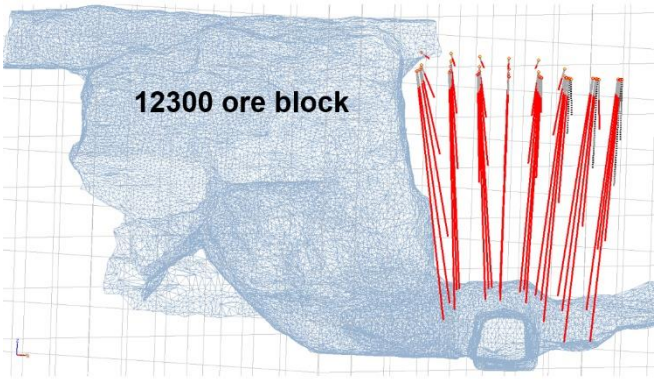
Nexa Resources Vazante - Brazil

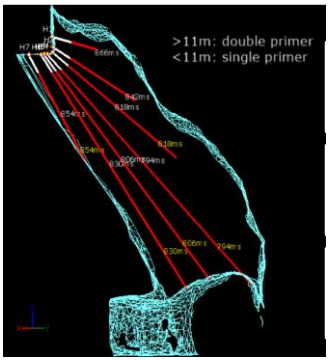
The ore is then extracted from the lower level with 60% expected recovery, as well as dilution caused by the contact with the backfill material.

Technical Solutions

Using WebGen™ 100 wireless technology, Orica presented the possibility of recovering *255 BL1 12300 island [rib] pillar* minimizing people's exposure and allowing the mine to improve operational productivity safely and efficiently by keeping two mucking accesses to the main stope.

The pillar was preloaded with WebGen™ 100 wireless detonators before losing the access to the upper level due to the blast events on the main *255 BL1 12300* ore stope. After the ore from the block was extracted and the pillar had completed its requirement to provide regional stability and dilution control, the *island [rib] pillar* was remotely initiated.





49 holes	110mm diameter
88 WebGen	8.2t of emulsion
Bulk density 1.15 g/cc	Stopping/ stemming control

This way it was possible to recover the ore contained in *255 BL1 12300 island pillar* without the need to complete all the steps described in the *Situation*, minimising crew exposure, and improving mine productivity.

Results

While there was still access to the top of the *island pillar*, Orica and Nexa conducted extensive site signal surveying and followed the best practices to ensure all the drill pattern in the pillar was correctly loaded and all 88 WebGen™ 100 units were encoded and positioned as planned. This blast was kept sleeping for 33 days. In the meantime, several ore blasts took place beside the preloaded pillar to release ore to be mucked from the main *255 BL1 12300 stope*. The lower level had shotcrete applied to eliminate the risk of slumping blastholes interacting with bogging operations, and as an additional safety precaution for all operations and people working under the sleeping shot. Without this safe spot, the tele-remote operated mucking process would have to be done over 90m due to the size of the open stope, resulting in significantly lower productivity, however, this situation is avoided by using WebGen™.

After all the ore material from *255 BL1 12300* main stope was mined, the wireless primers were safely fired using a magnetic inducted signal travelling through the rock.

A special blast sequence was also used for this specific application with the intent to lower blast vibration levels. A seismograph was installed to verify the initiation of the charges.

CASE STUDY

Pillar recovery delivers US$1.59M in customer benefit using WebGen™ 100 wireless technology

Nexa Resources Vazante - Brazil

The preloaded pillar had dimensions of approximately 25x30x6m, generating 18.8kt of ore accounting for 12% of zinc production for the month, achieving an overall average Zn content of 9.19%.

Applying WebGen™ 100 enhanced pillar recovery enabled the mine to improve its productivity without exposing people to areas previously damaged due to prior blast cycles. The process was completed with no misfires, adequate fragmentation, allowing 88% recovery of the pillar with operational dilution kept under desired levels, resulting in a net benefit of US$1.59M for Nexa Resources Vazante.

The following outcomes were achieved using WebGen 100 for pillar extraction:
- Increased expected ore recovery from 80 to 88% for the pillar
- Cycle time reduction of approximately 70% achieved for the extraction of the pillar (from 90 to 20 days)
- Reduced dilution of *255 BL1 12300* main stope from 27% to 20% due to hydraulic radius reduction and less standup time

A second application currently being studied will allow to preload an entire stope, which will reduce operational risk and number of cycles, resulting in further increases in ore production and therefore profitability.

Testimonial

“I would like to thank the partnership established between Nexa and Orica. This is an important moment for the history of mining, and especially a milestone for the rock blasting history. We went through a series of improvements in the evolution of blasting technology, from the first detonators until nowadays using 100% wireless detonators.

“The blast happened 2 levels below us, so we are 400m away, above the shot. All encoded signals were sent through the rock with the safety protocols to fire the blast being followed.

“Thanks to this technology and this partnership, today we recovered a so called island [rib] pillar, which is a pillar kept in the open stope for dilution control. After all ore from the block was extracted and the pillar had completed its requirement, the preloaded holes were successfully initiated remotely.”

Mateus Ribeiro,
Chief Mining Engineer,
Nexa Resources Vazante

Acknowledgements

Orica appreciates the opportunity to partner with Nexa Resources to develop this case study. We thank all Vazante crew for the trust and partnership during the tests and application of Orica’s newest technology WebGen™ 100 wireless detonator.

CASE STUDY

Pillar recovery delivers US$1.59M in customer benefit using WebGen™ 100 wireless technology

Nexa Resources Vazante - Brazil

Blast crew responsible for the blast. Left to right: Italo Jeferson, Luciano Santos, Fabricio Santos, Francisco Biulchi, Mateus Gomes and Wesley Andrade

Authors: Wesley Andrade[1] and Francisco Biulchi[2] (Orica), Mateus Ribeiro[3], Celso Lima[4] and Fabricio Santos[5] (Nexa)

1. *WebGen product Specialist, Orica, Brazil*
2. *Mining Engineer consultant, Orica, Brazil*
3. *Chief mining engineer, Nexa, Brazil*
4. *Mine manager, Nexa, Brazil*
5. *Production mine foreman, Nexa, Brazil*

Date: May 2020

Disclaimer