



# Varistem<sup>®</sup> Stemming Plugs Trial

Feedback Report

**Cast Improvement Coal  
Overburden**



## EXECUTIVE SUMMARY



- The intent of the trial was to demonstrate the energy retention capabilities of the Varistem® blast stemming plugs through conducting a split blast on one of Coal Mine X's overburden production blocks, in order to determine the difference in cast gain between Varistem® and Non-Varistem® sides of the block.
- The Varistem® side of the block had a deeper and wider power trough.
- The cast analysis showed that the portion of the block that used Varistem® cast the material, on average, 87% further than the portion that did not use Varistem®.
- The blast outcome was satisfactory with Varistem® performing as expected.

# AGENDA

## 1. Trial Setup

- Indication of Split in the Block
- Information & Scaled Depth of Burial

## 2. Results

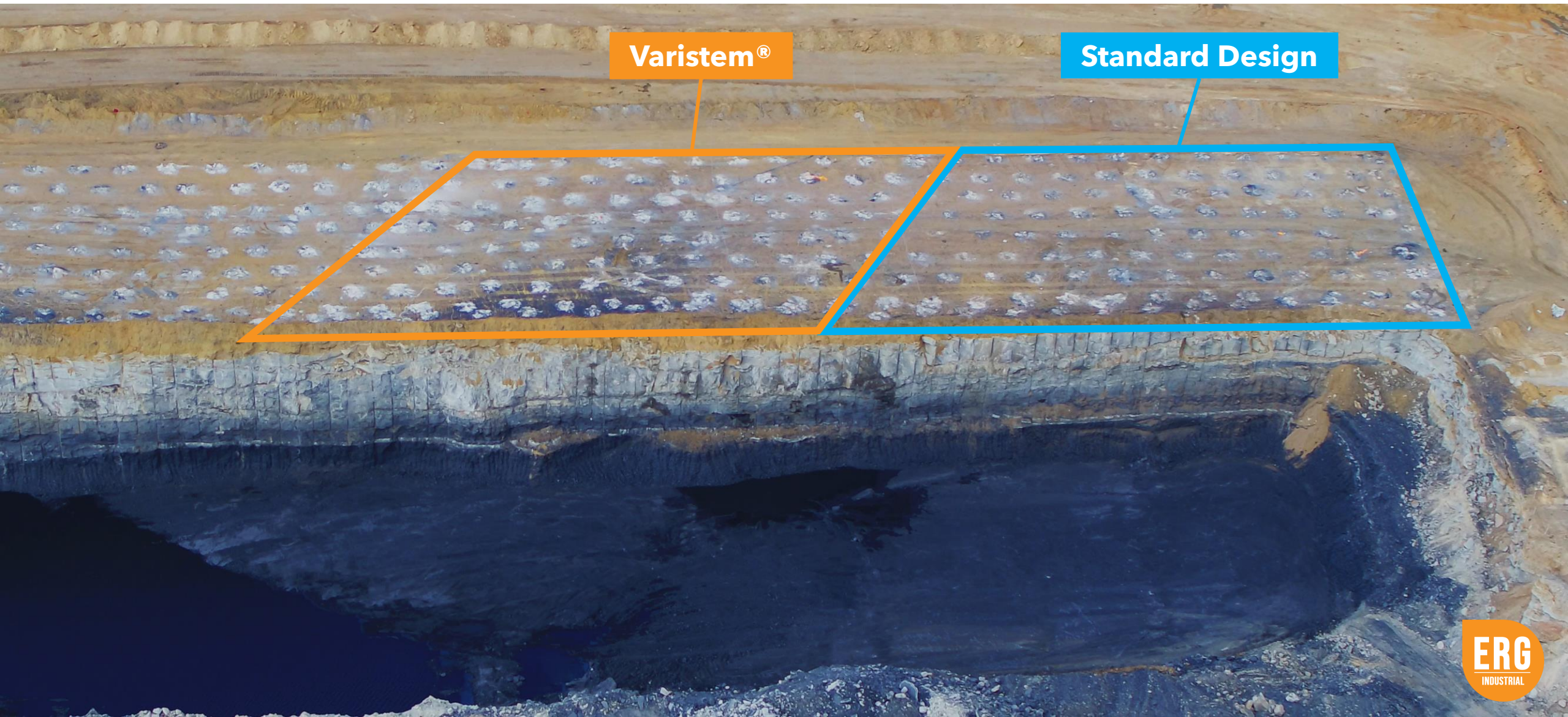
- Block Movement & Stemming Activity
- Pre-Blast to Post-Blast Transition
- Muckpile Comparison
- Cast Analysis
- Velocity of Detonation Comparison

## 3. Conclusions & Recommendations



# TRIAL SETUP

# TRIAL SETUP | INDICATION OF SPLIT IN THE BLOCK



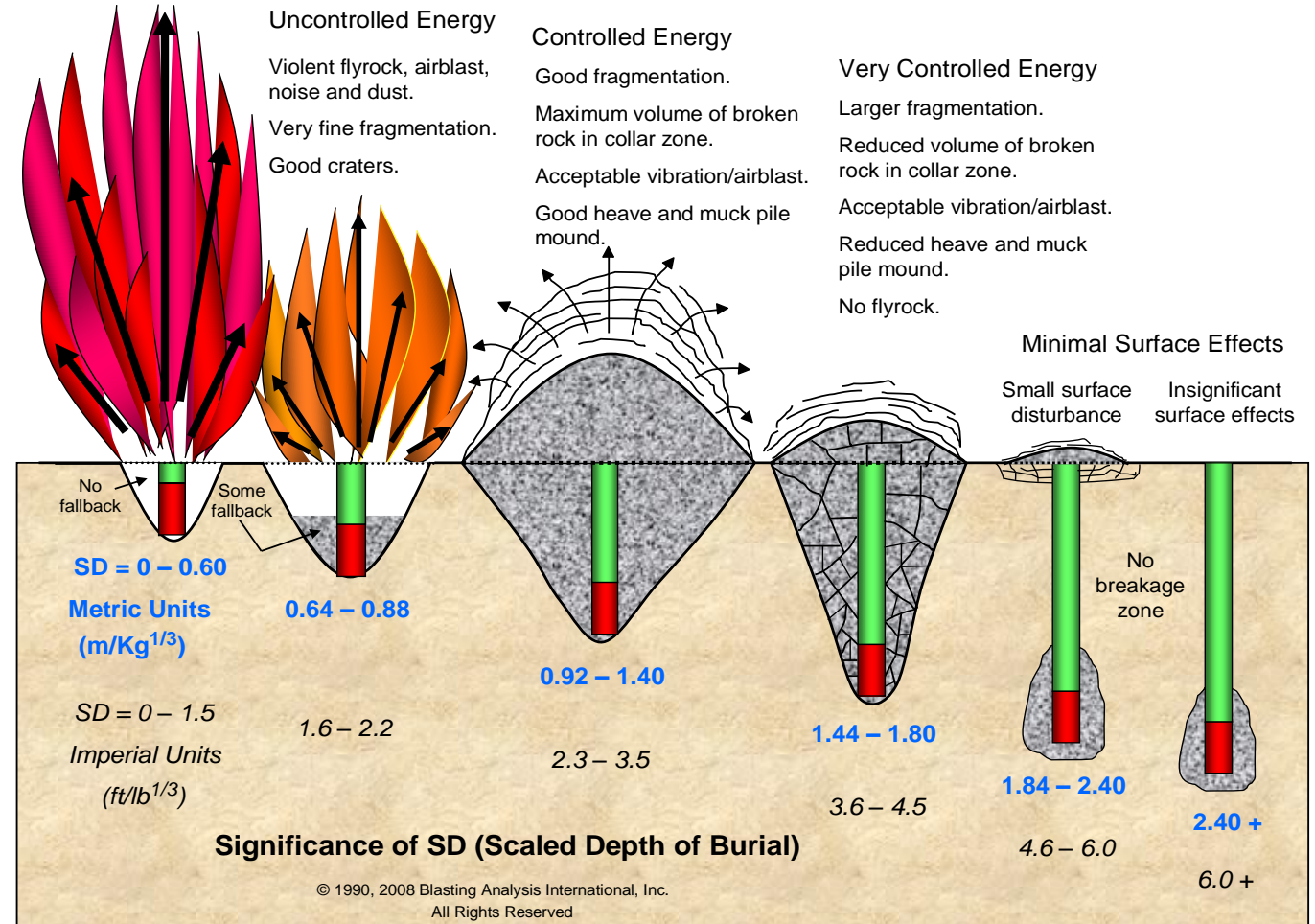
Varistem®

Standard Design

# TRIAL SETUP | INFORMATION & SCALED DEPTH OF BURIAL

Number of holes: 218  
 Average drill depth: 12.38m  
 Burden: 5.2m  
 Spacing: 6.1m  
 Geology: Sandstone  
 Average stemming height: 2.5m  
 Hole Diameter: 171mm  
 Average scaled depth of burial: **0.9** (as calculated by ENAEX)

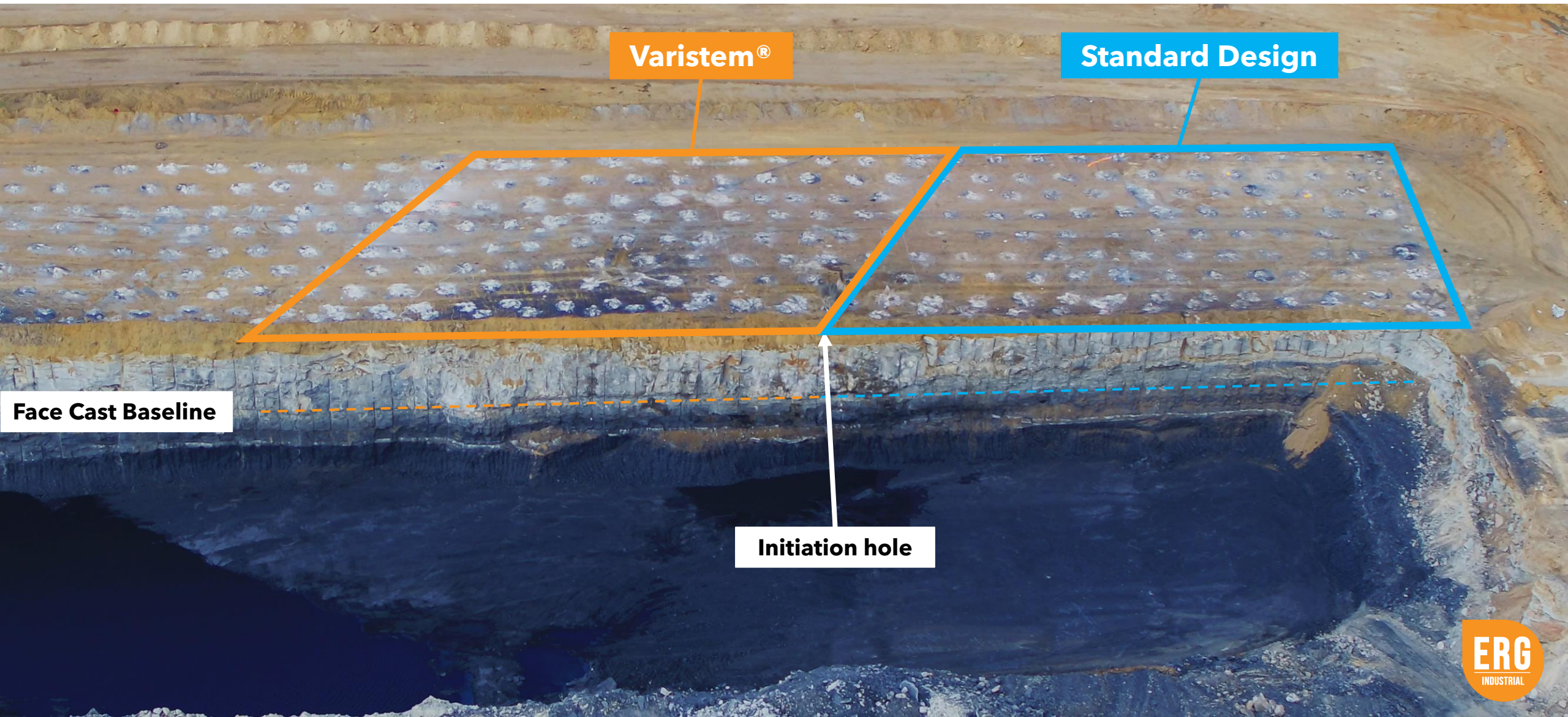
Based on the scaled depth of burial value, the expectation would be that the blast would be "semi-controlled, semi-uncontrolled" from a stemming movement perspective (refer to the figure on the right), as it falls right between the uncontrolled and controlled categories depicted.



# RESULTS



# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY



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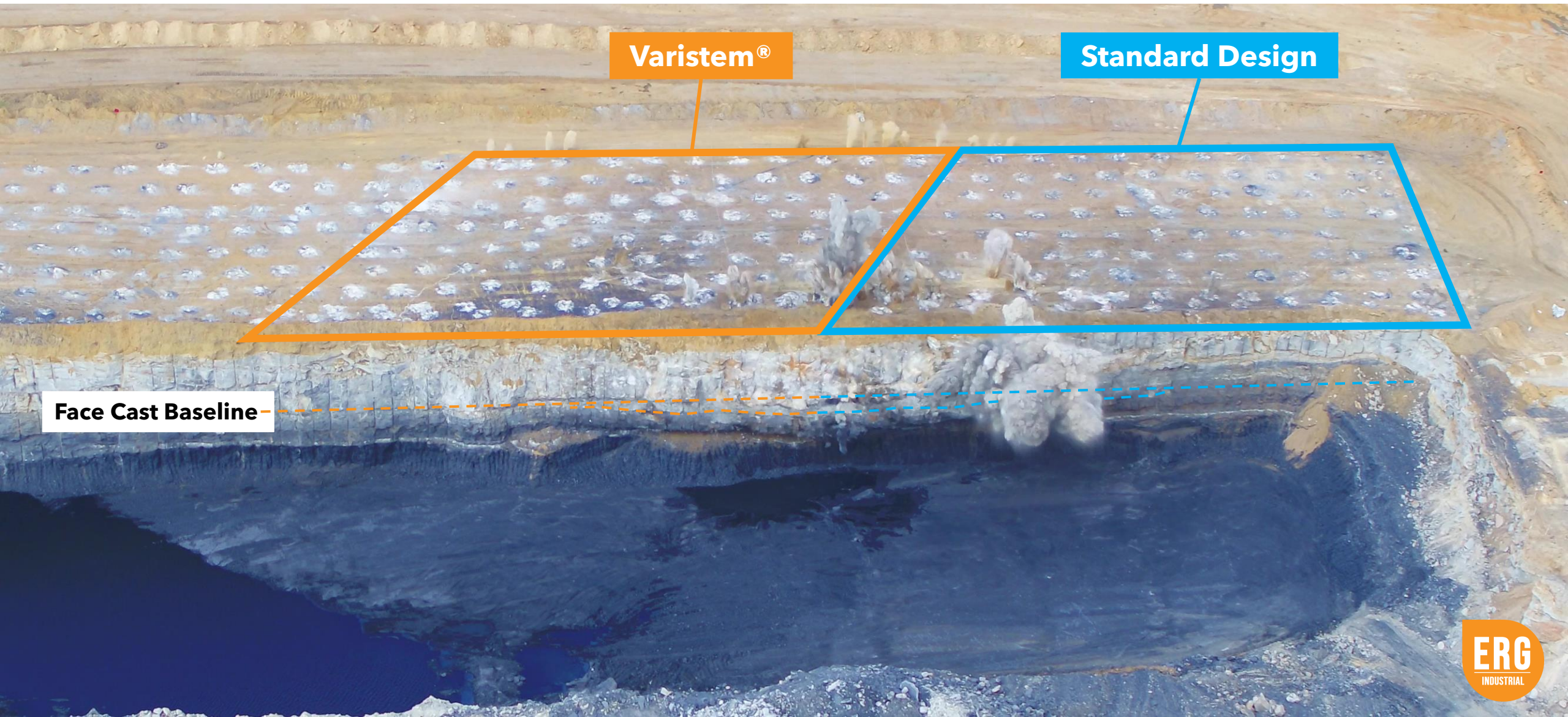
Standard Design

Face Cast Baseline

Initiation hole



# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY



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Face Cast Baseline

# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY

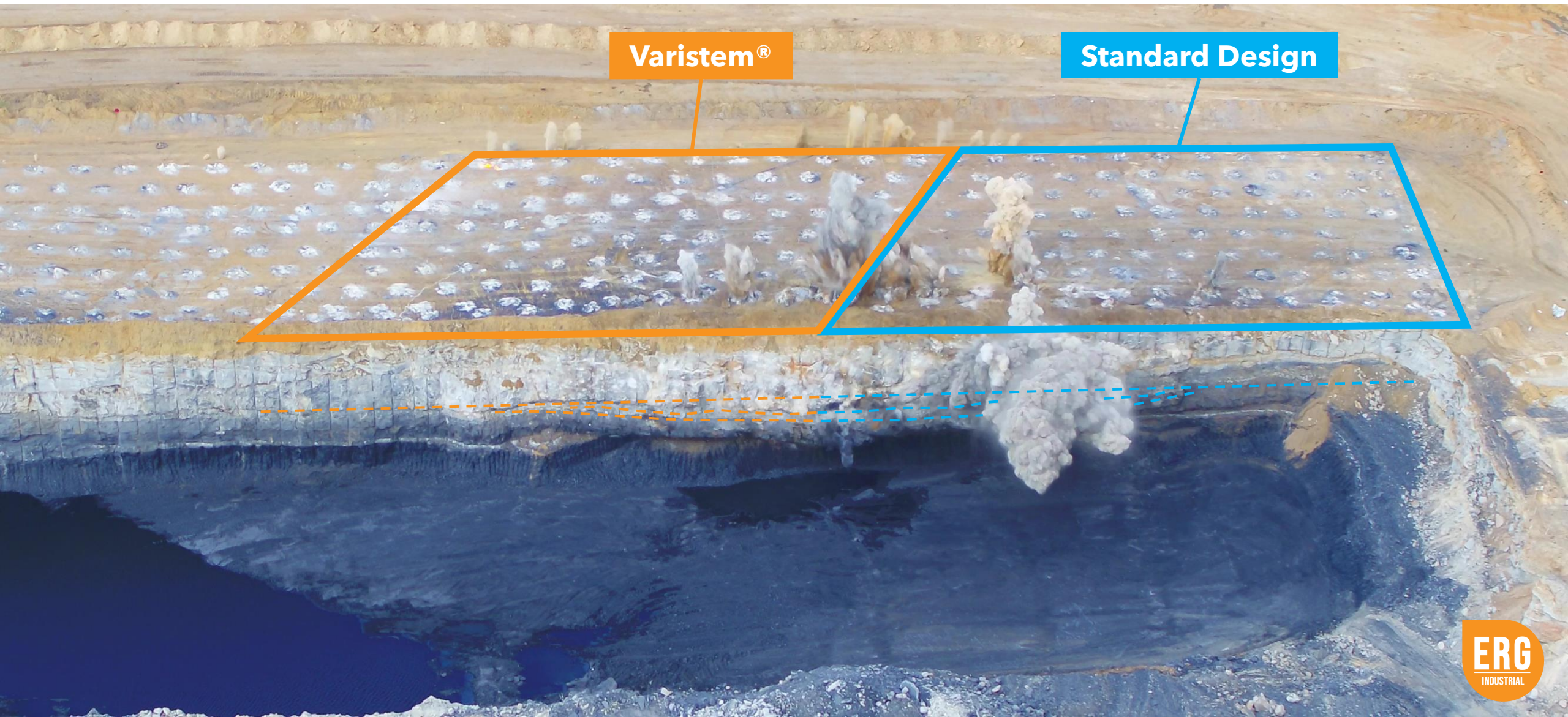
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The faceburst was likely due to pre-existing fracturing in the highwall, as shown in the photo.

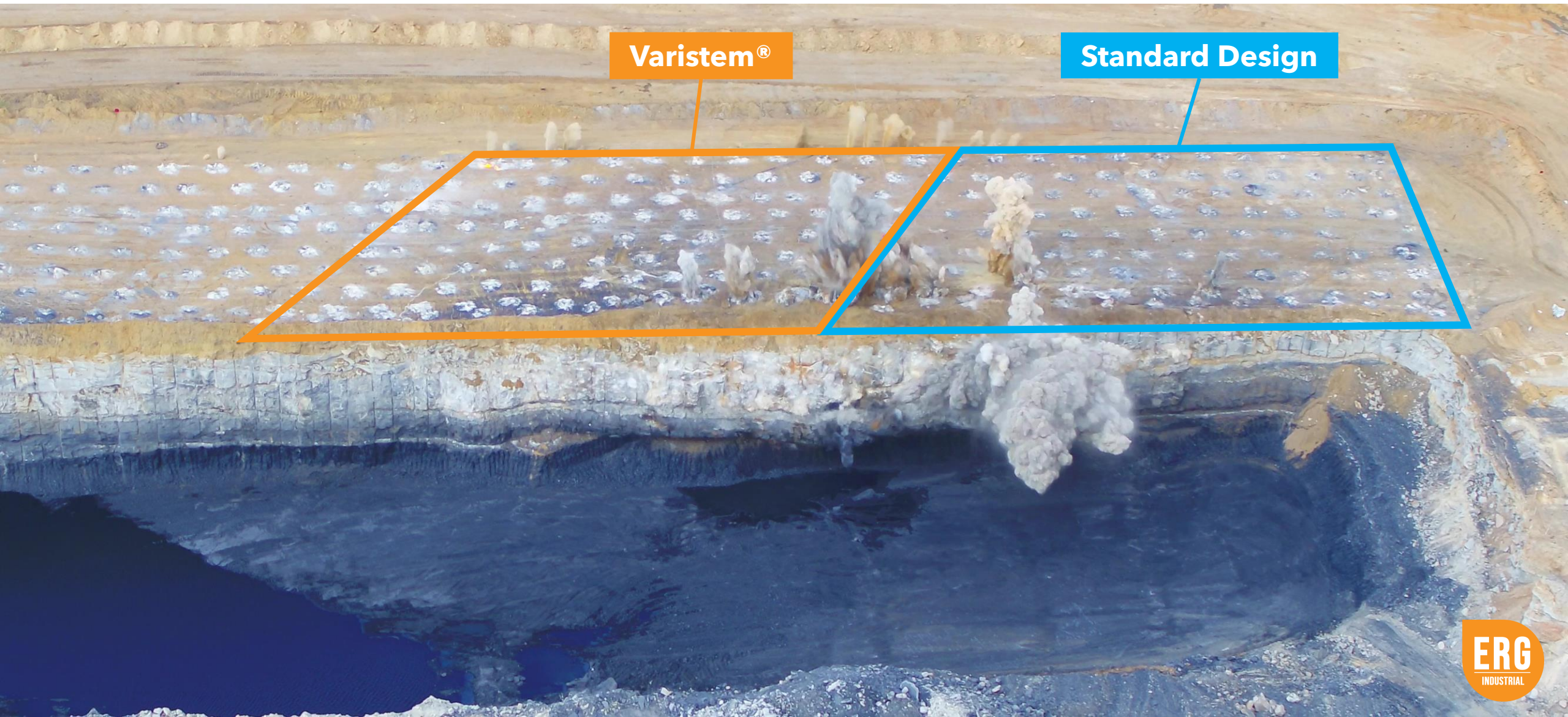
# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY



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# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY



Varistem®

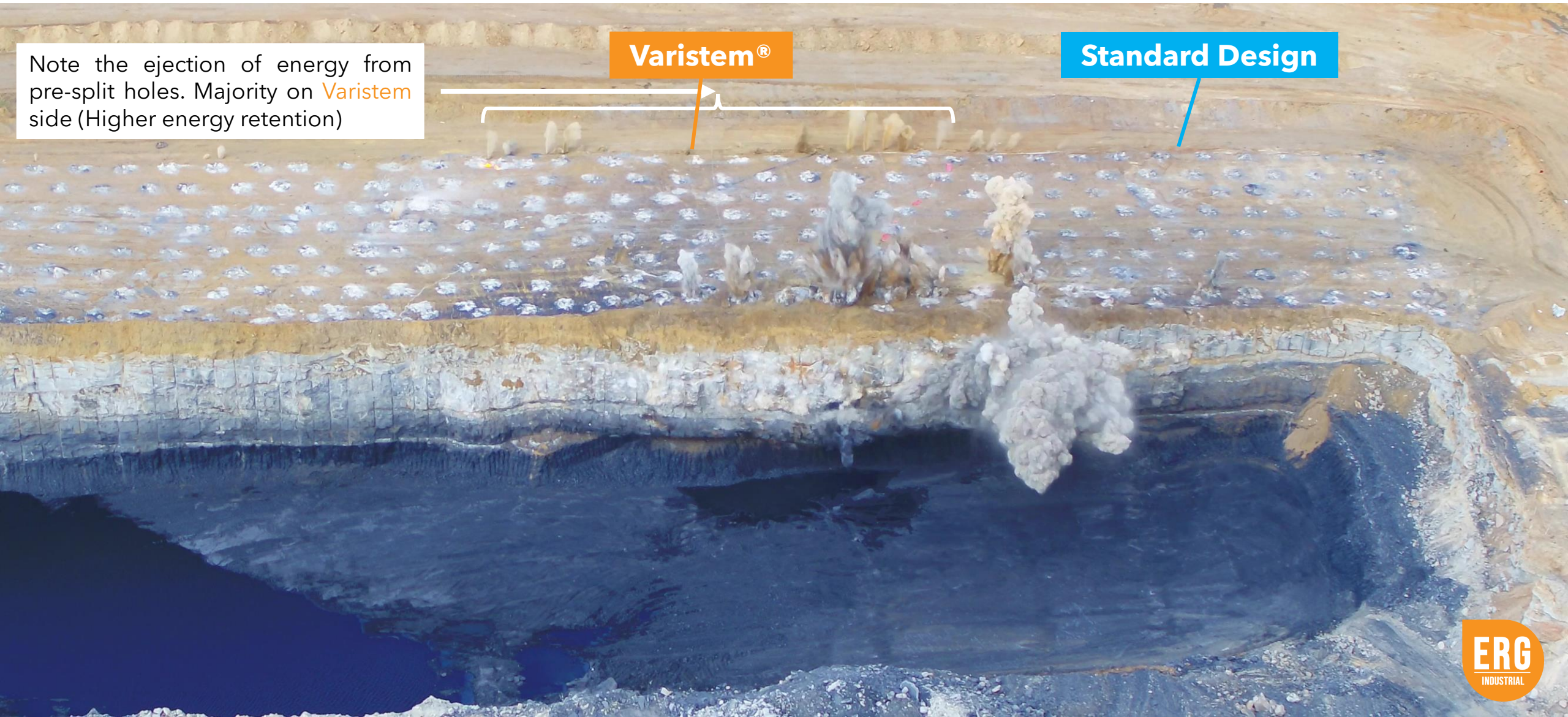
Standard Design

# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY

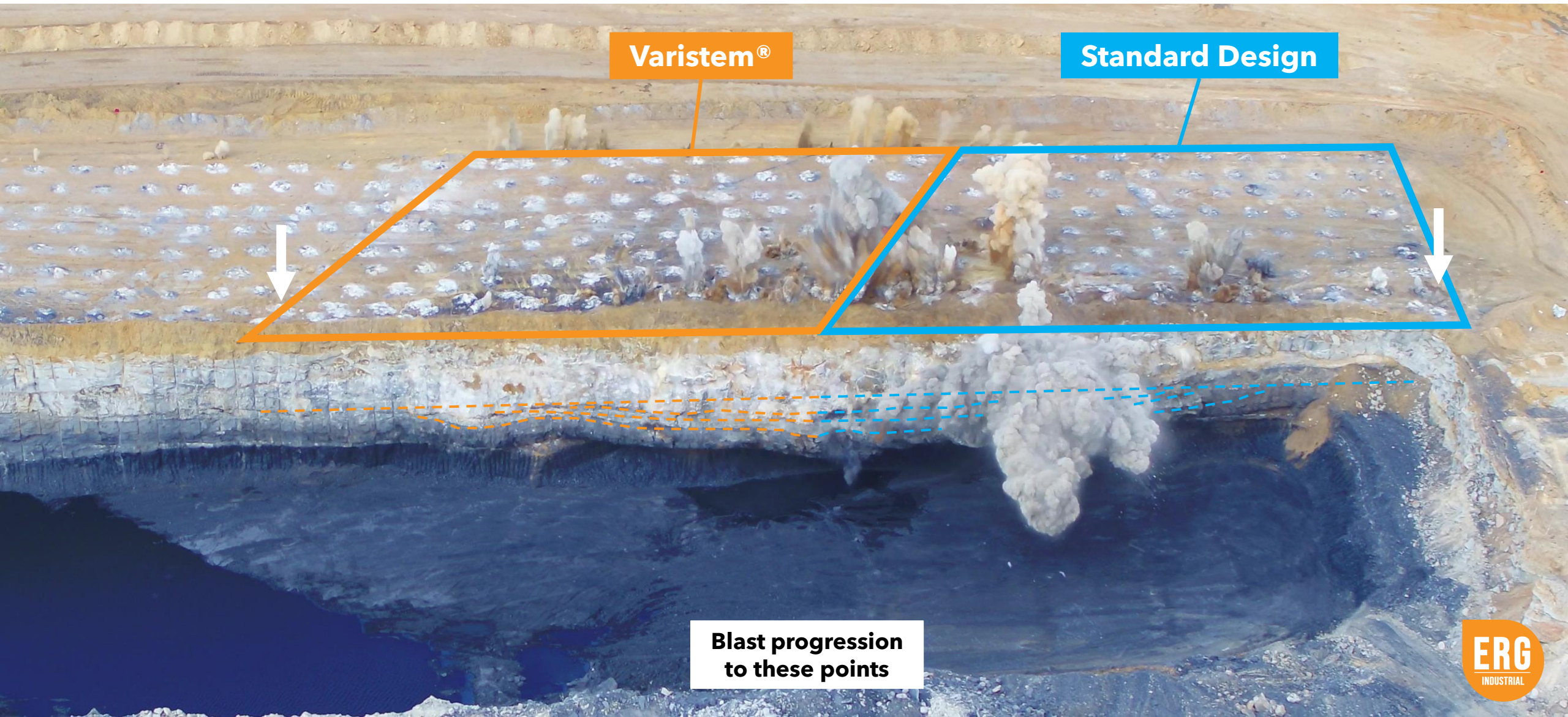
Note the ejection of energy from pre-split holes. Majority on **Varistem** side (Higher energy retention)

**Varistem®**

**Standard Design**



# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY

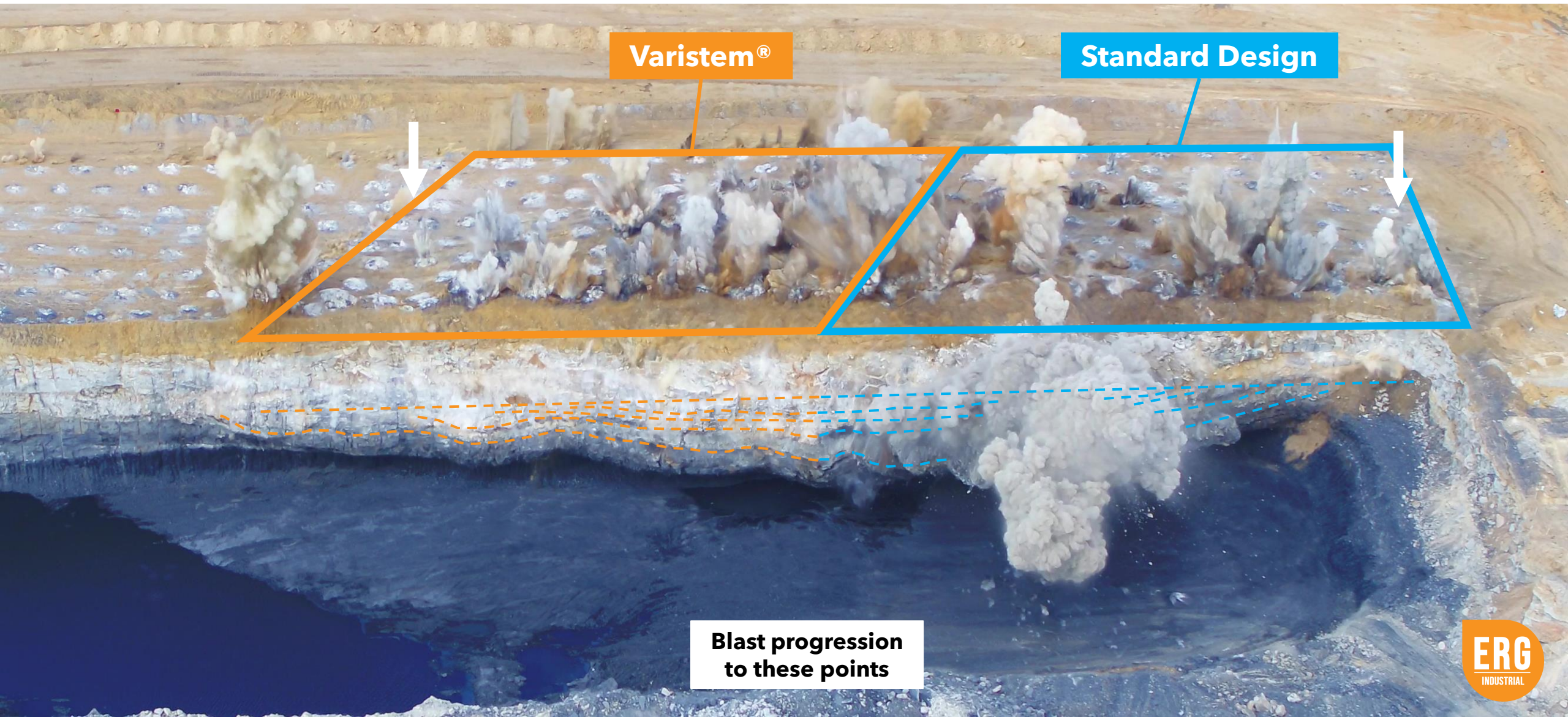


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Blast progression  
to these points

# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY

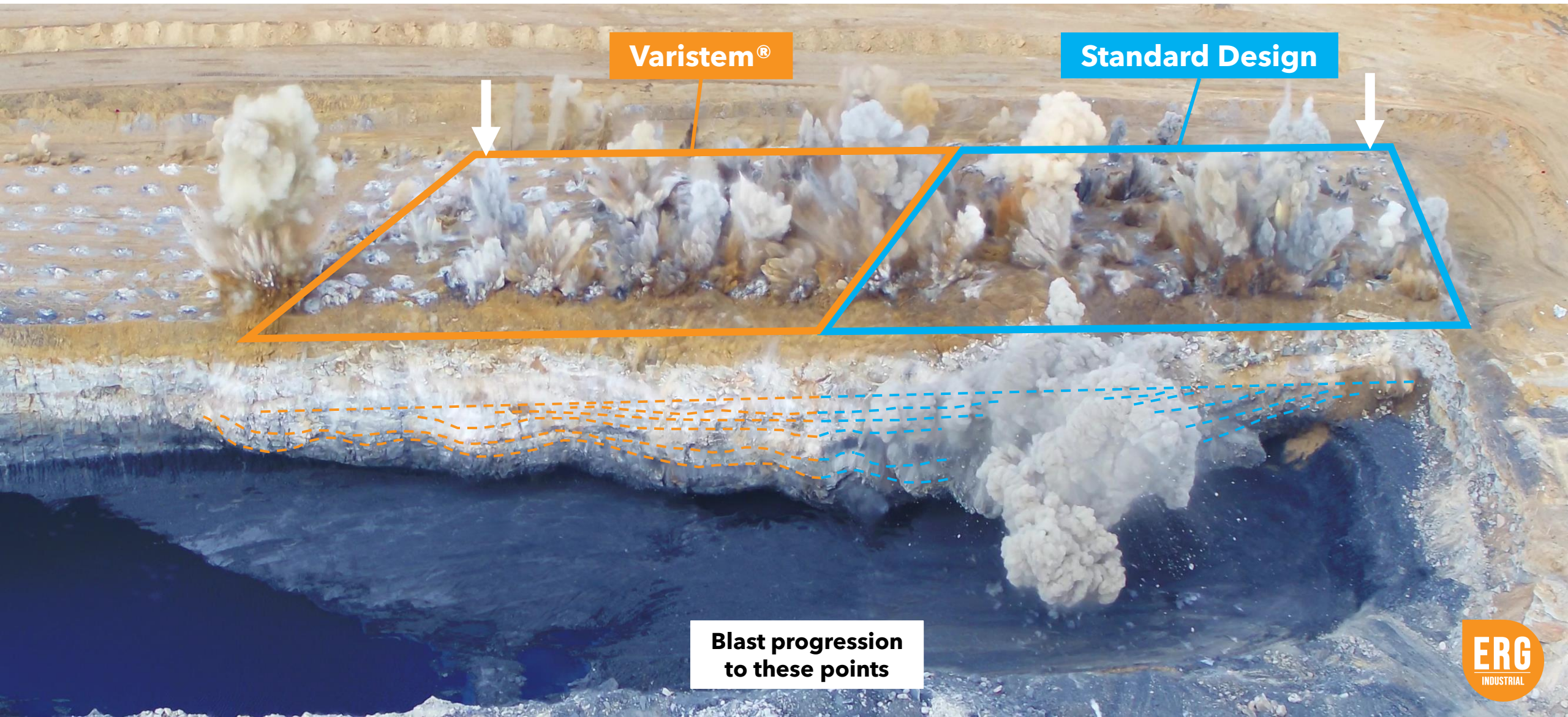


Varistem®

Standard Design

Blast progression  
to these points

# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY



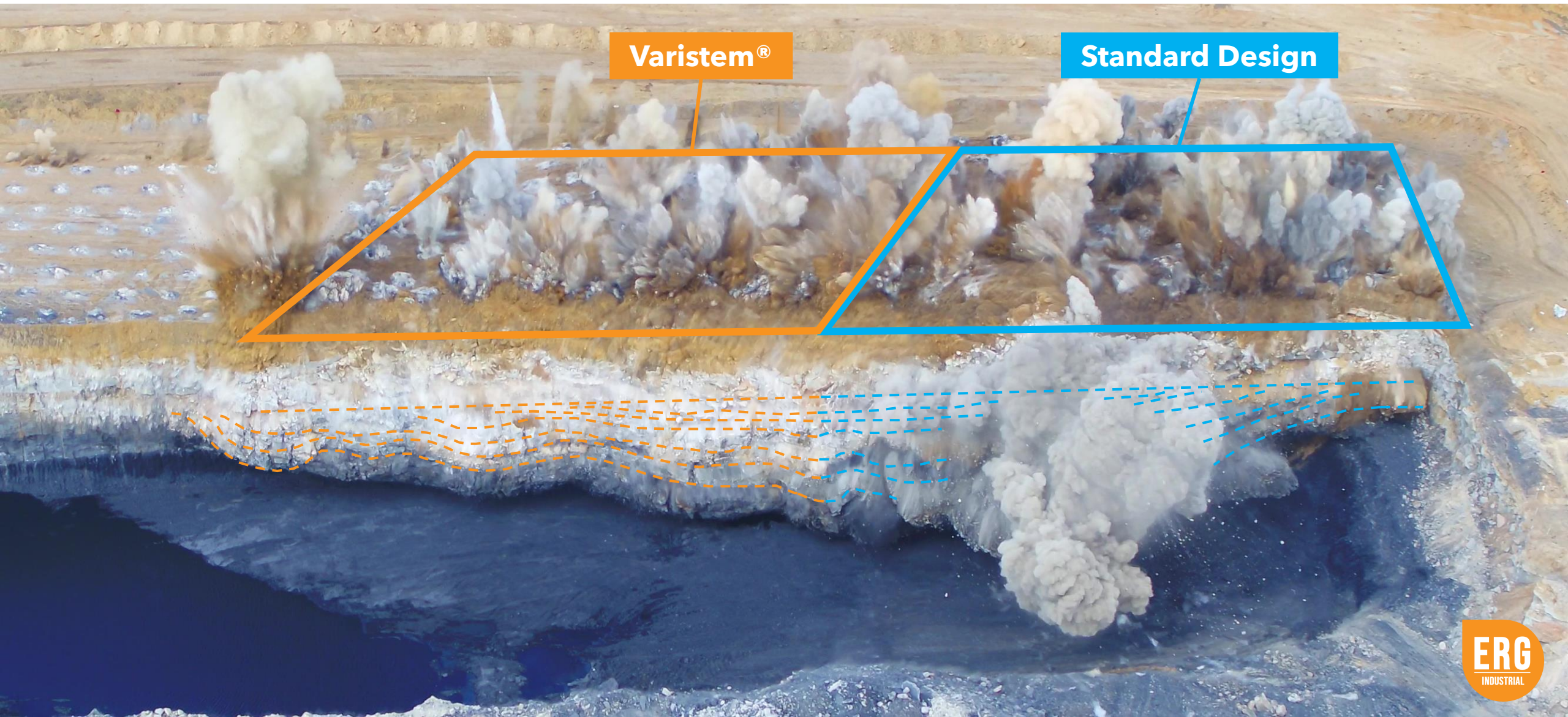
Varistem®

Standard Design

Blast progression  
to these points



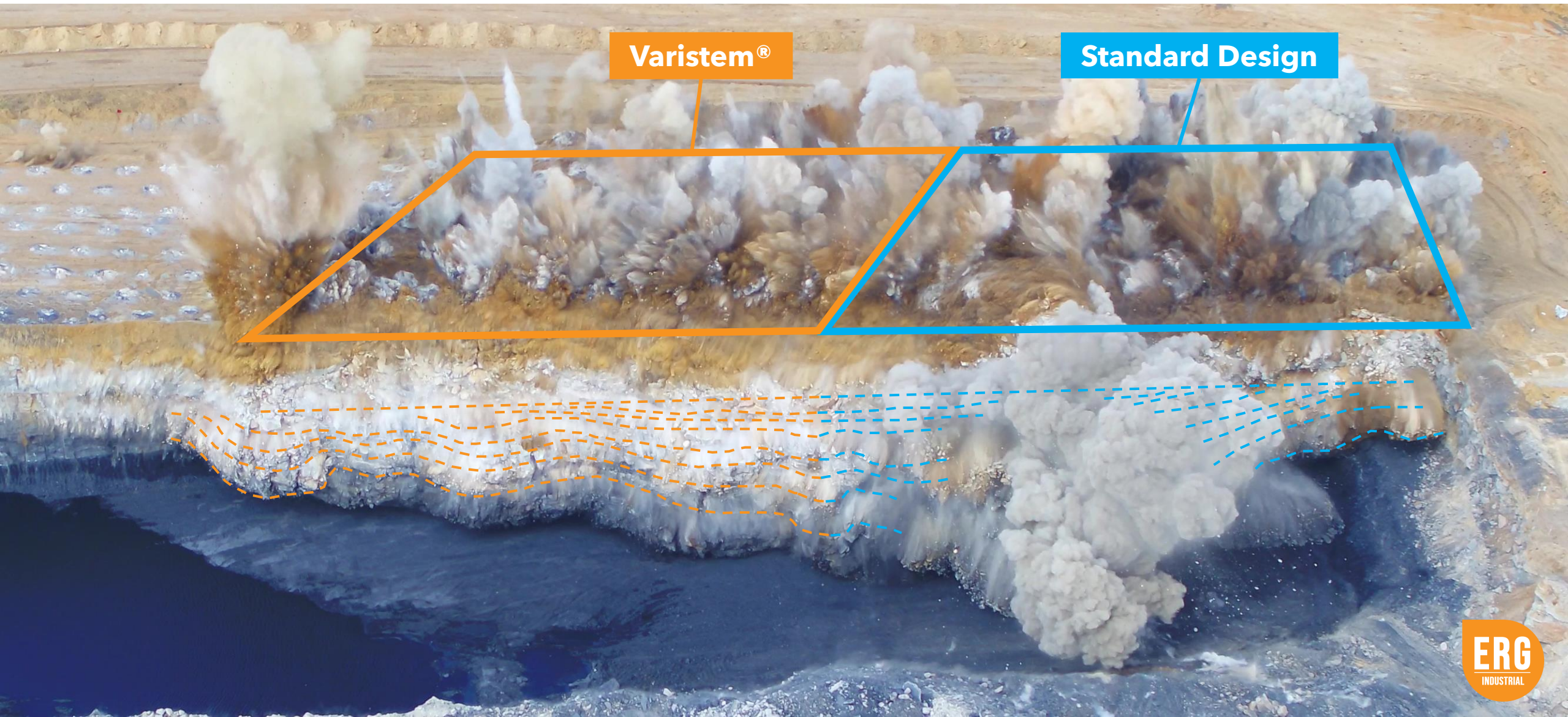
# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY



Varistem®

Standard Design

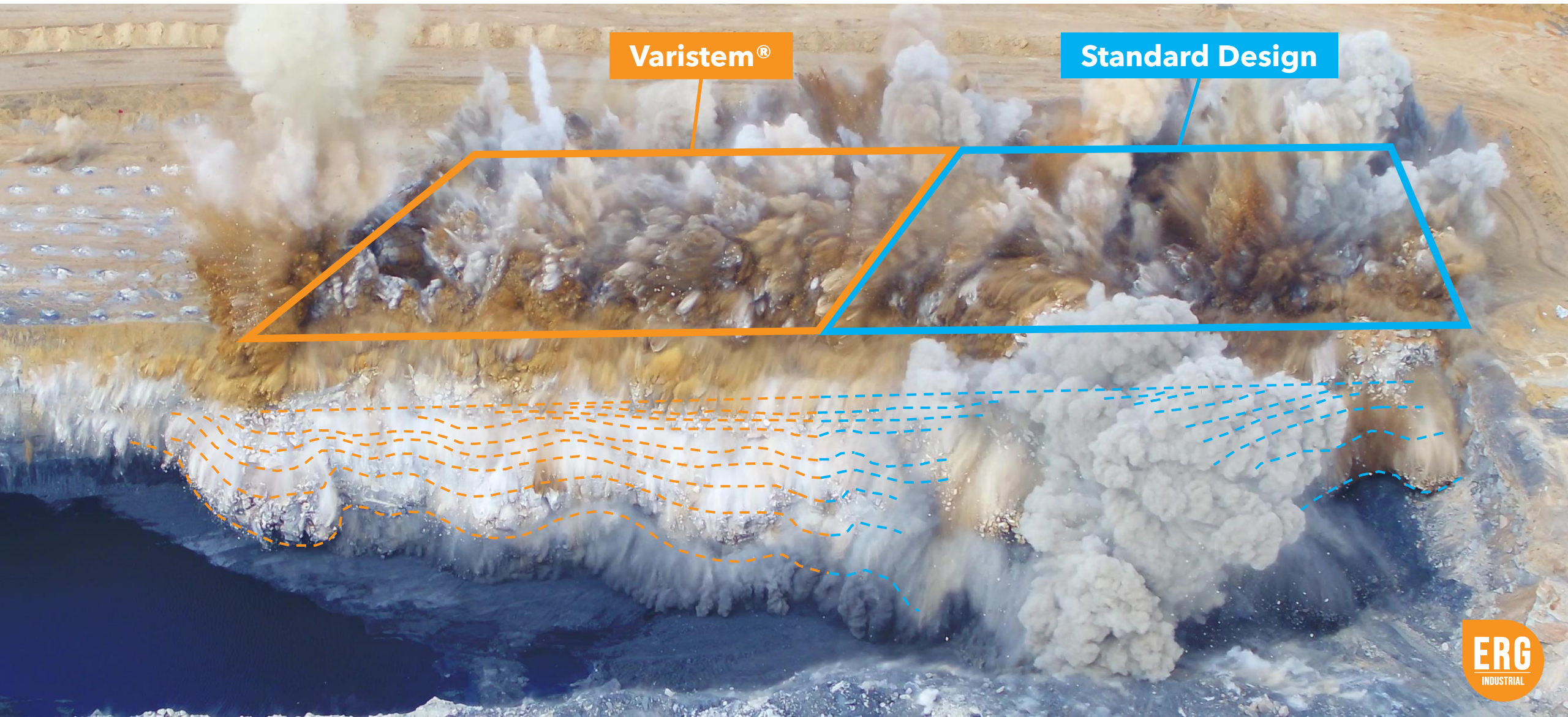
# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY



Varistem®

Standard Design

# RESULTS | BLOCK MOVEMENT & STEMMING ACTIVITY



# RESULTS | PRE-BLAST TO POST-BLAST TRANSITION

Varistem®

Standard Design



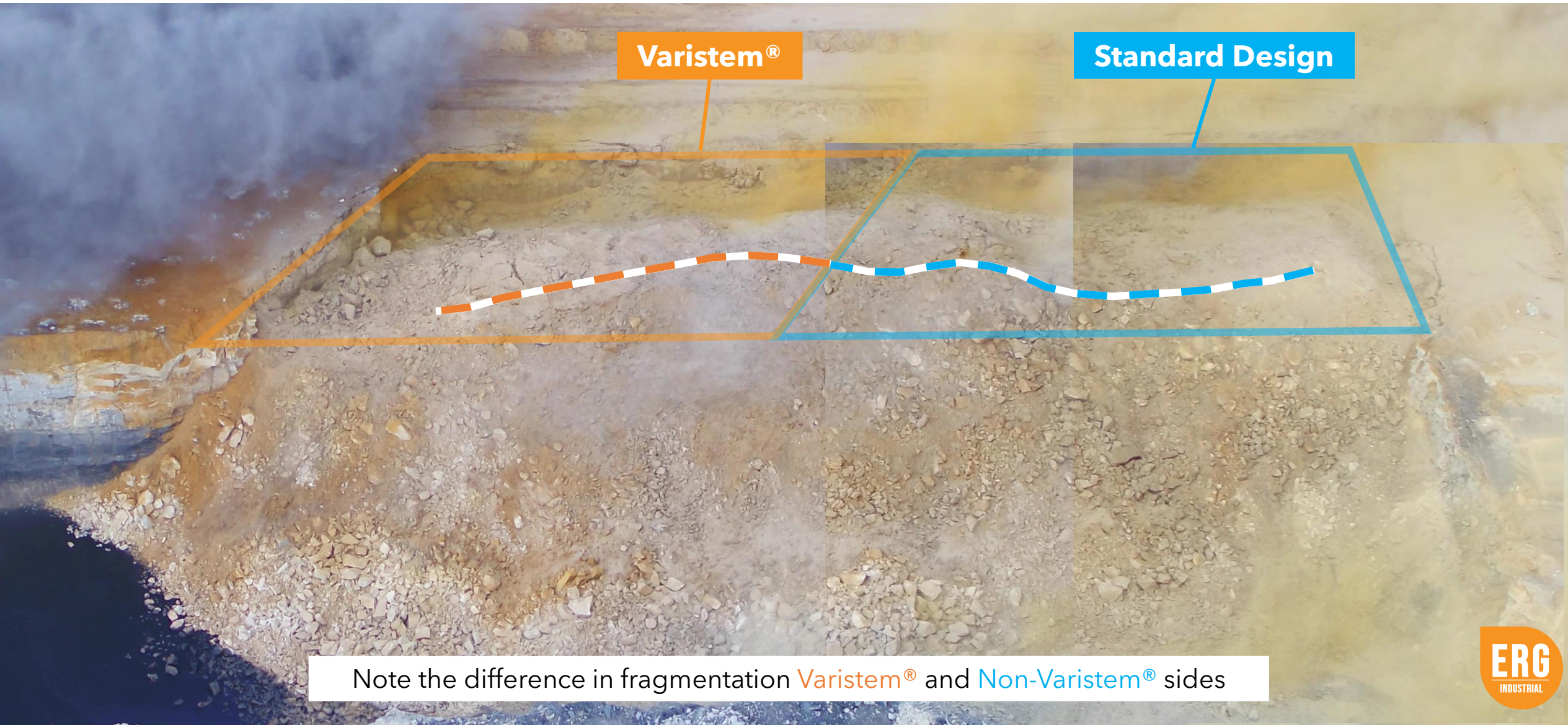
# RESULTS | PRE-BLAST TO POST-BLAST TRANSITION

Varistem®

Standard Design



# RESULTS | MUCKPILE COMPARISON

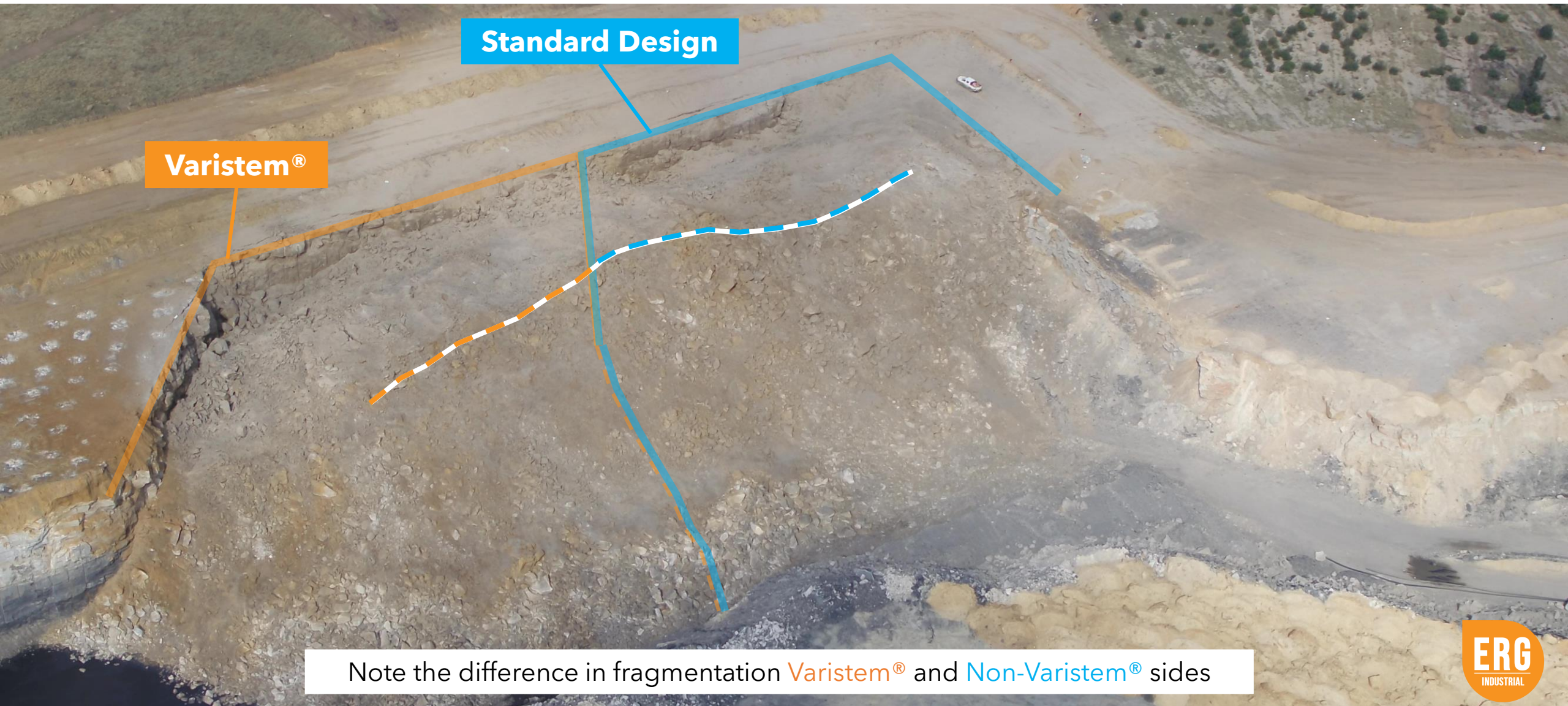


Varistem®

Standard Design

Note the difference in fragmentation **Varistem®** and **Non-Varistem®** sides

# RESULTS | MUCKPILE COMPARISON



Varistem®

Standard Design

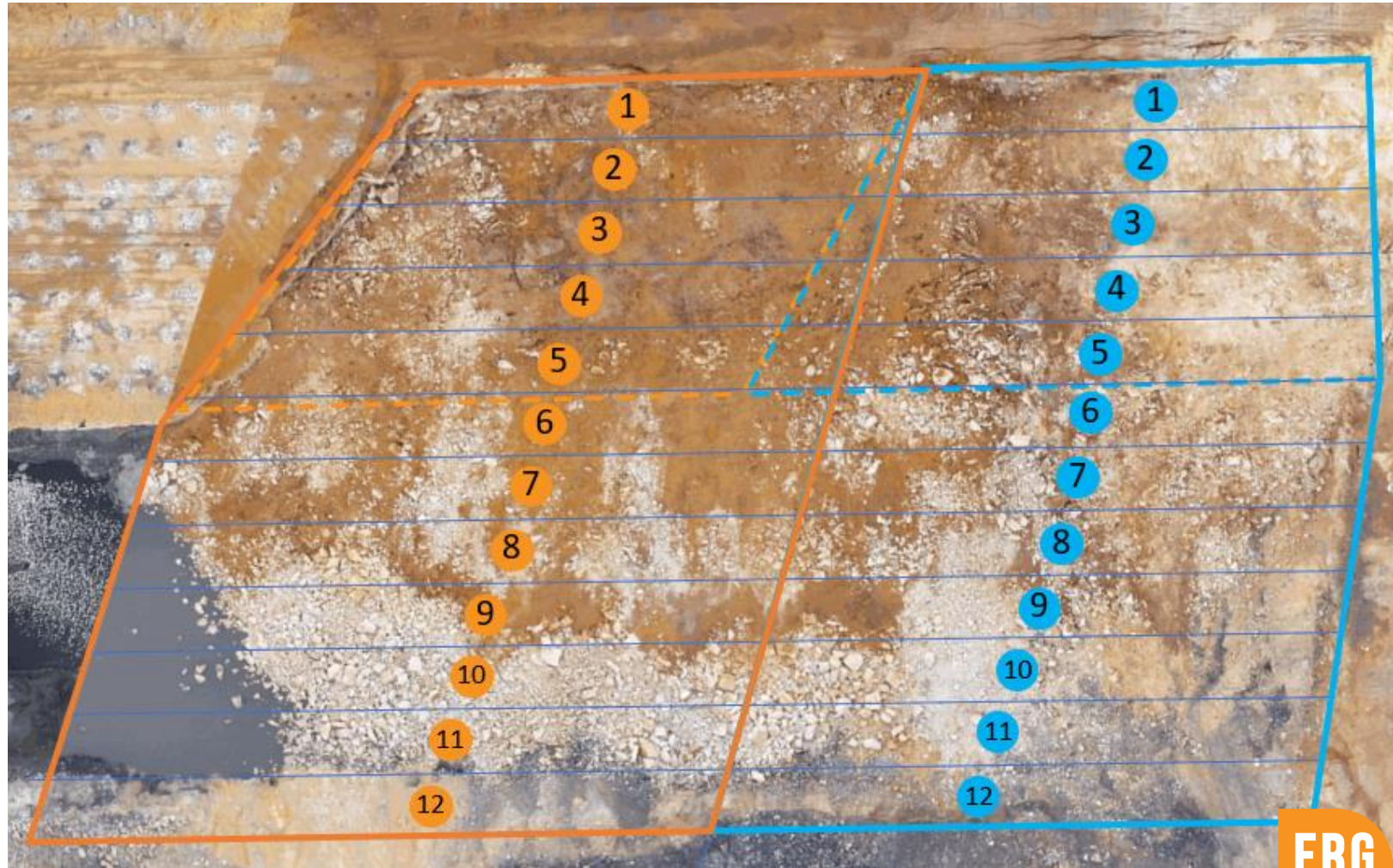
Note the difference in fragmentation Varistem® and Non-Varistem® sides

# RESULTS | CAST ANALYSIS

The main focus of the trial was to establish the improvement of the cast by utilizing Varistem® Plugs.

The analysis is achieved through the use of drones equipped with survey sensors:

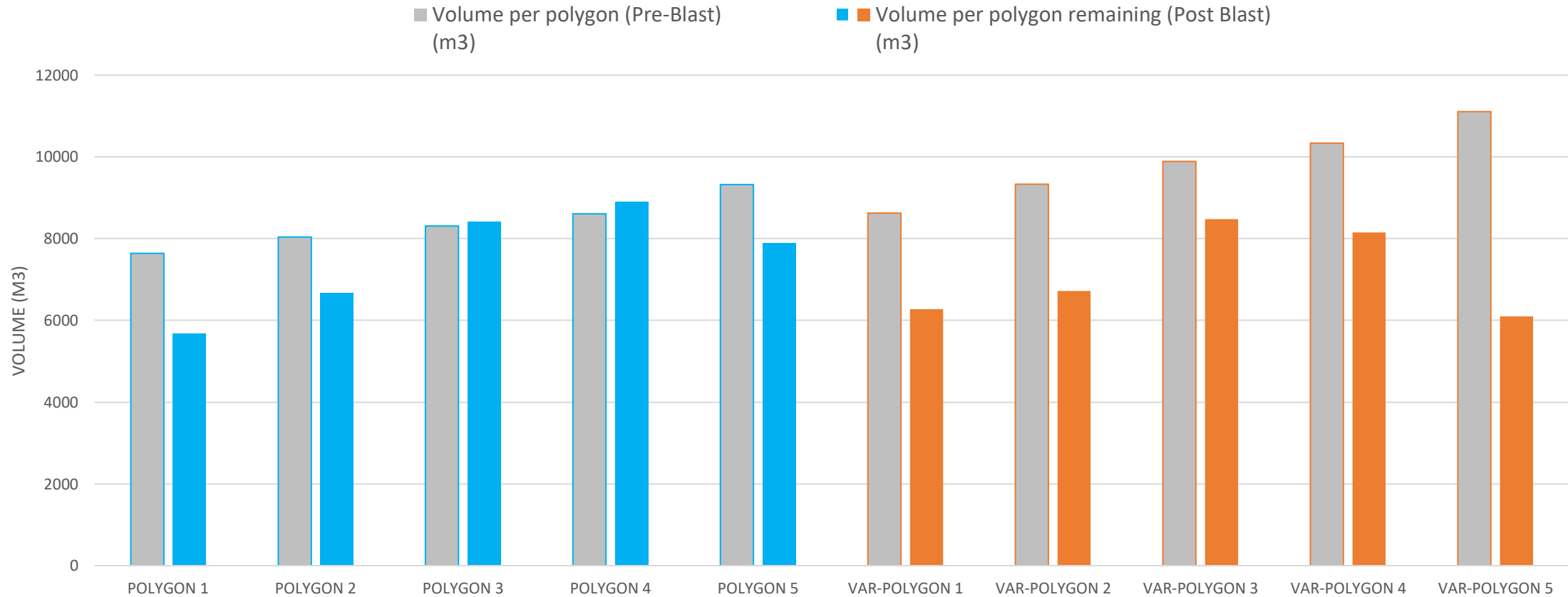
- A surface, with geological and spatial data, is obtained of the block prior to the blast.
- A surface of the muckpile is obtained post blast
- The block is divided into area sections (polygons) as indicated (to the right)
- The two surfaces (pre and post blast) are then superimposed to calculate volume differences for a specific area/polygon.





# CAST BLAST ANALYSIS – VOLUME MOVED PER POLYGON

## VOLUME PER POLYGON SECTION (BLOCK FOOTPRINT)

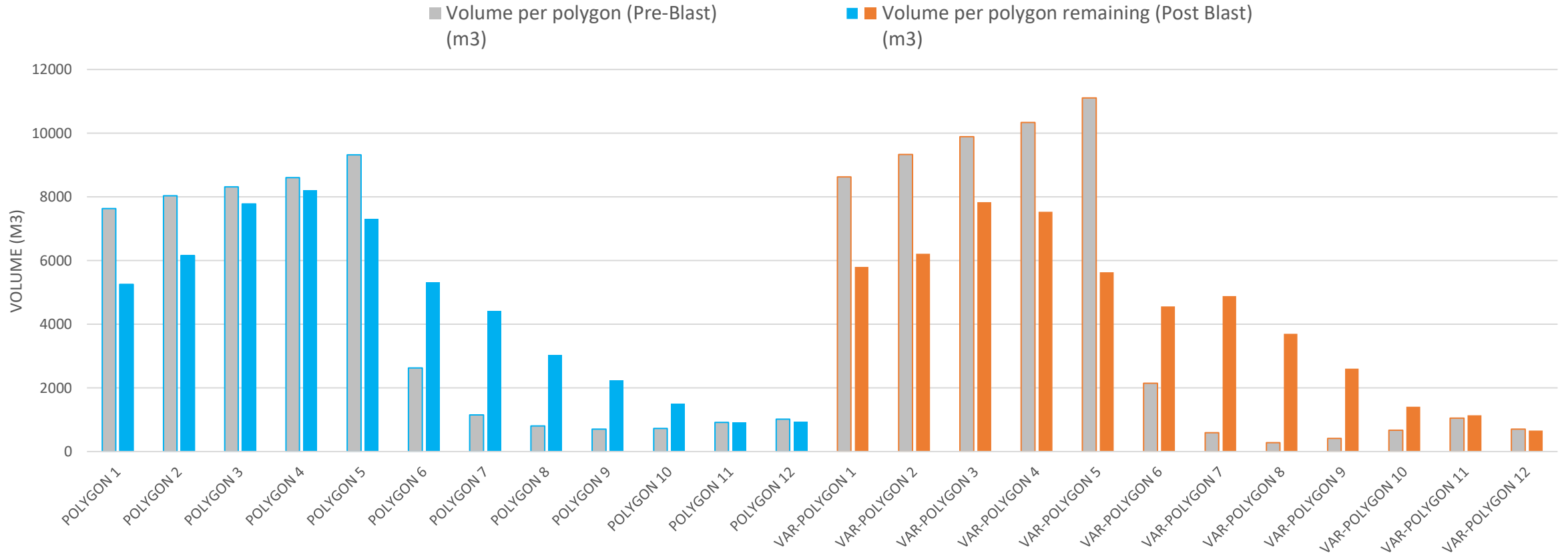


**Standard design**

**Varistem® design**

# CAST BLAST ANALYSIS – VOLUME MOVED PER POLYGON

## VOLUME PER POLYGON SECTION (BLOCK AND MUCKPILE)

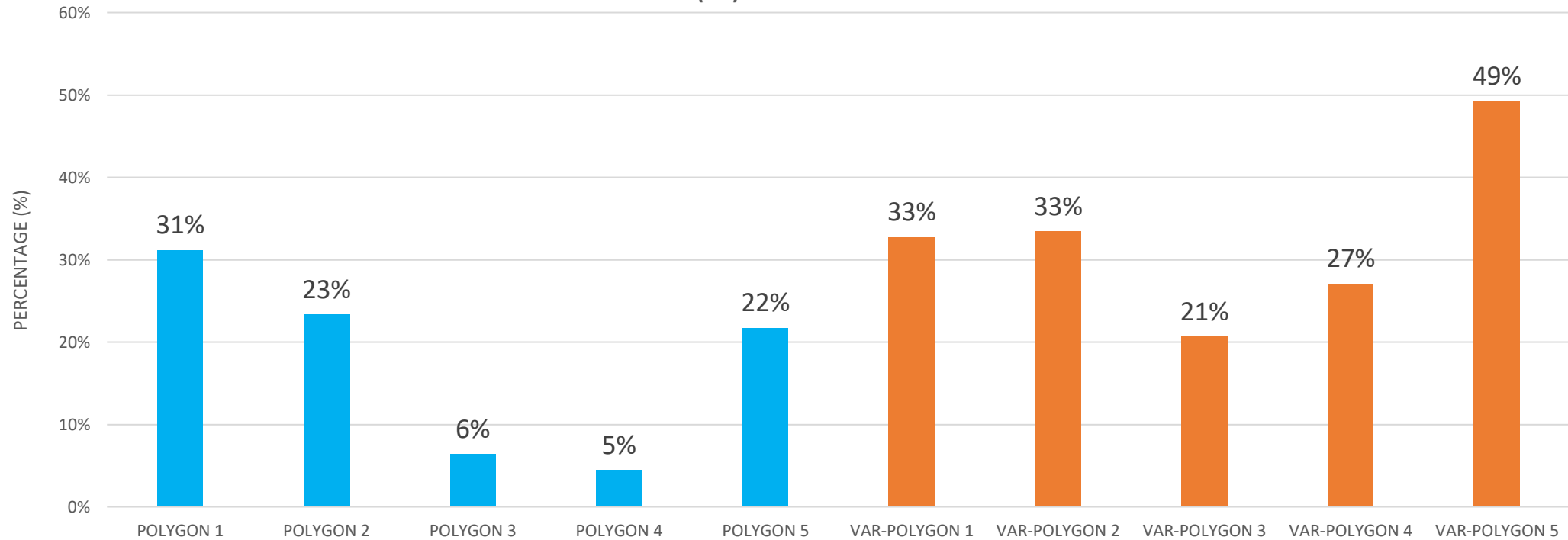


**Standard design**

**Varistem® design**

# CAST BLAST ANALYSIS – PERCENTAGE CAST [%]

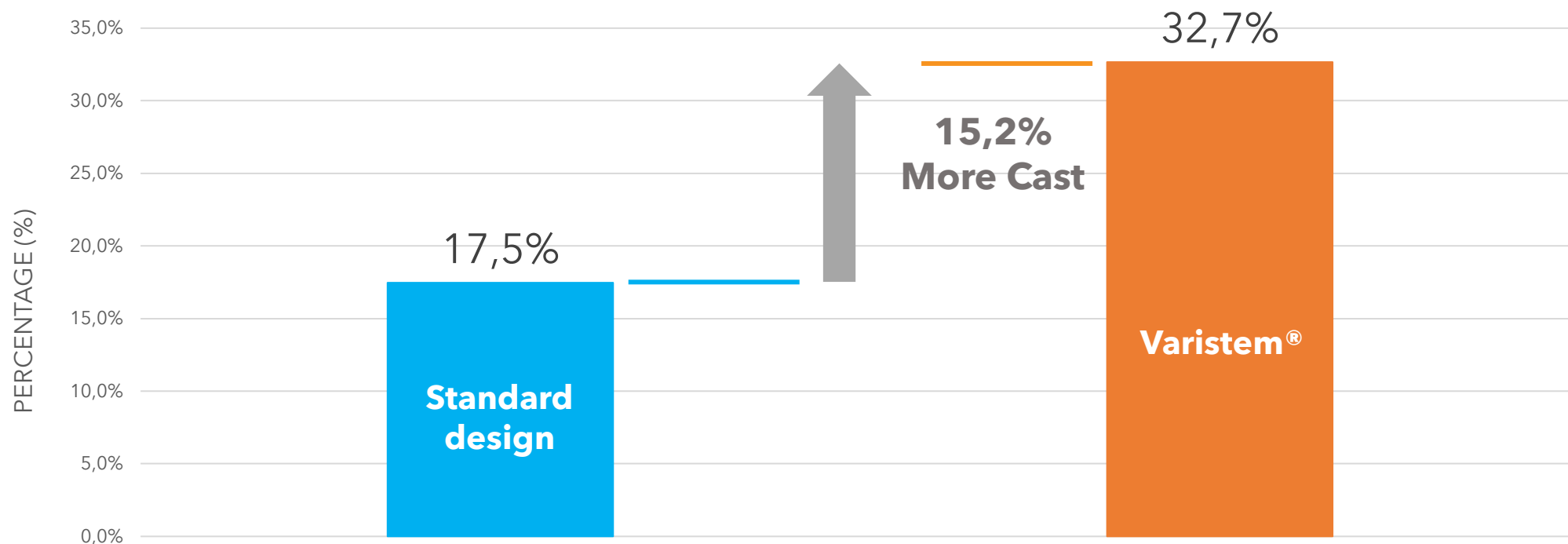
Percentage Cast per Polygon  
(%)



**Standard design**

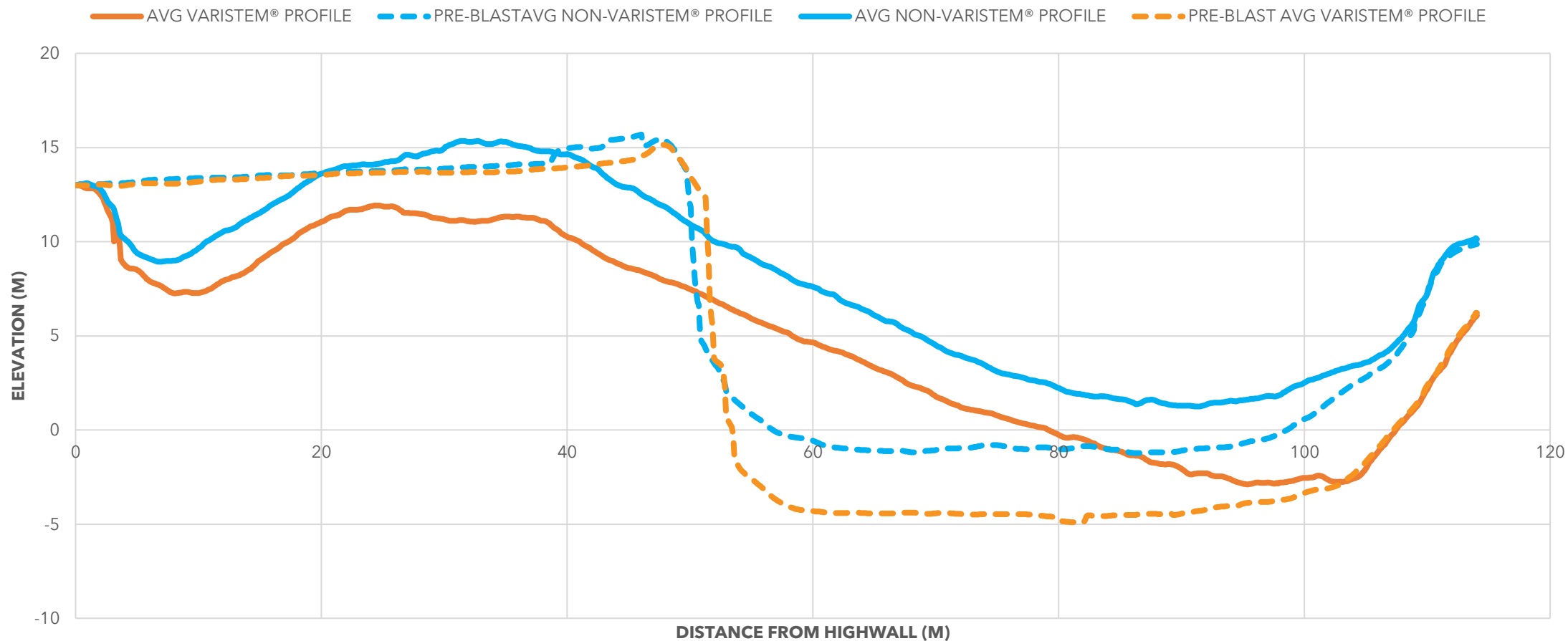
**Varistem® design**

## RESULTS | CAST ANALYSIS - % CAST



**87%** Improvement in muckpile volume cast between **Non-Varistem®** and **Varistem®**

# RESULTS | CAST ANALYSIS – AVERAGE MUCKPILE PROFILE



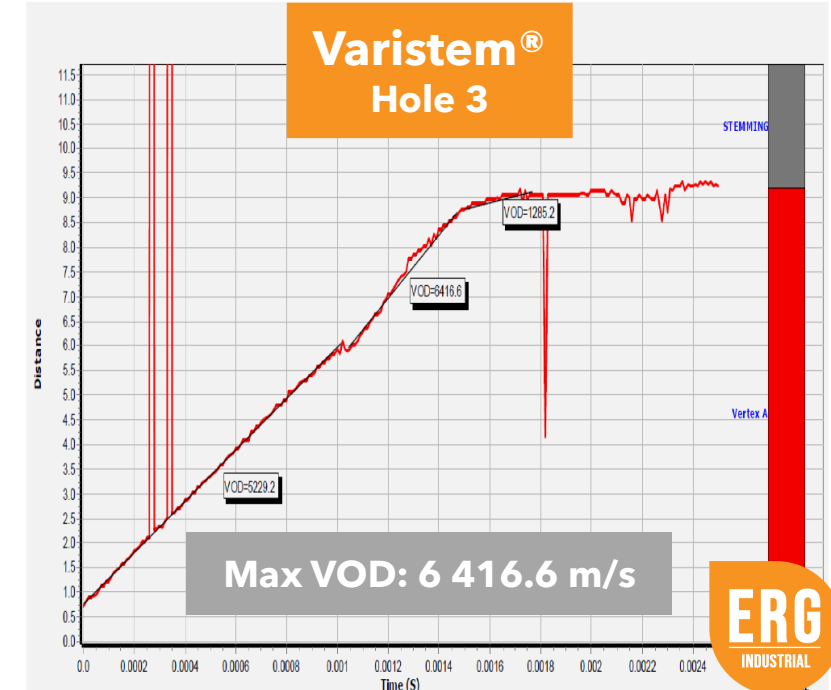
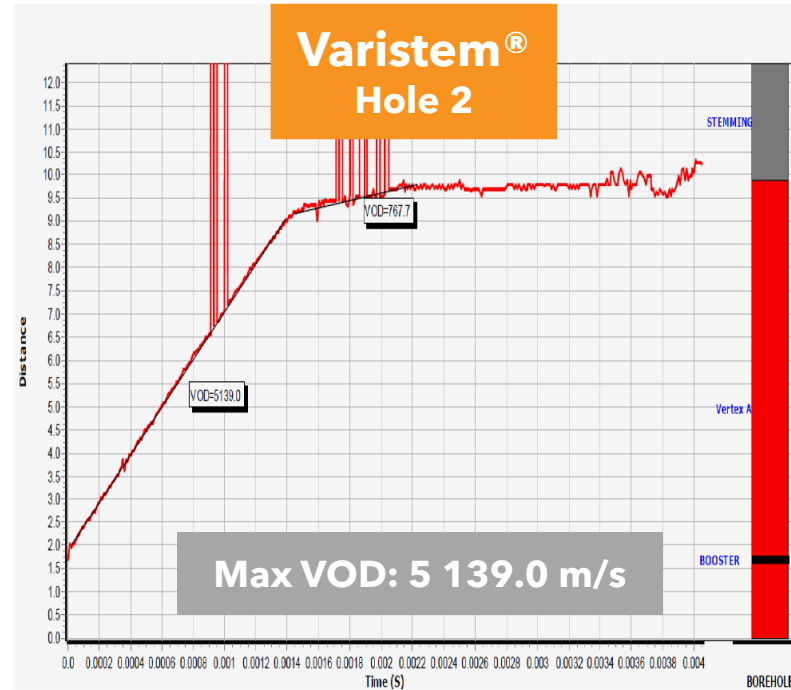
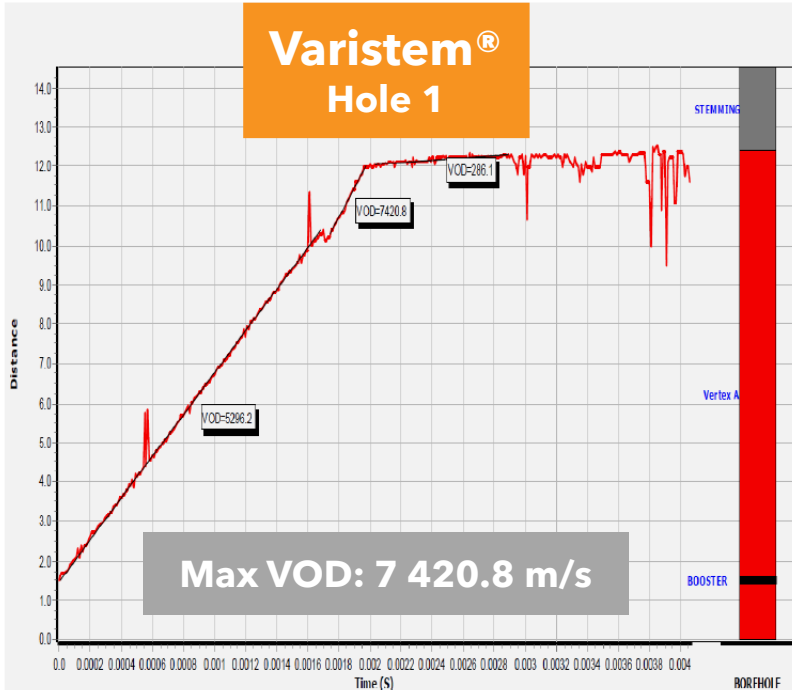
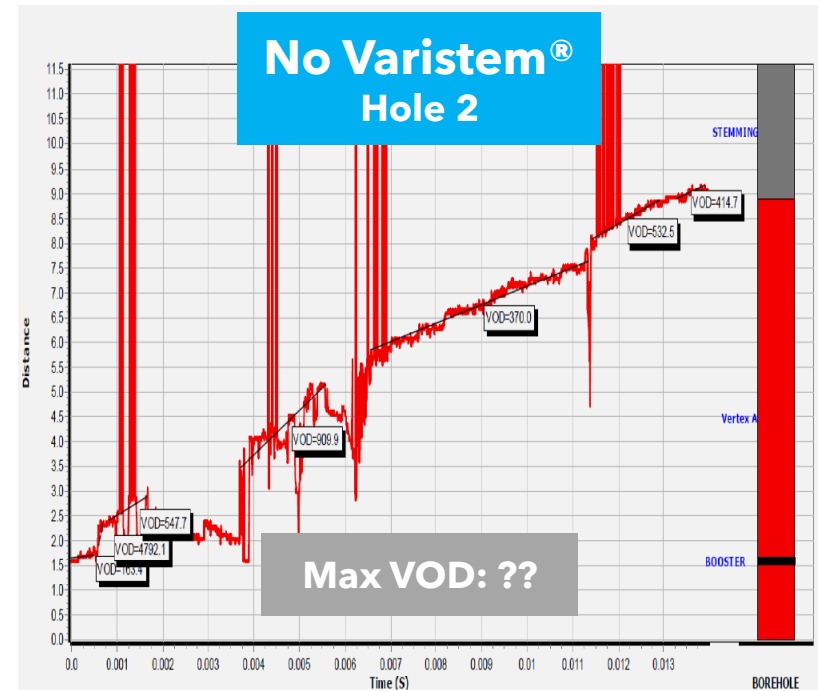
Standard design

Varistem®



# RESULTS | VELOCITY OF DETONATION COMPARISON

**ENAEX Summary:** Five drilled blast holes on the crest, initiated directly after one another from the initiation point, were identified and instrumented to measure the velocity of detonation of the Vertex A explosives type. In three of these holes stemming plugs were inserted and an average VOD of 5 774.00m/s was measured. The remaining two holes were stemmed with drill chips as usual. The VOD trace in the unplugged hole indicated deflagration which possibly could have been a result of column shift (as witnessed in borehole tracking results of hole #5). The geology around the instrumented hole was cracked and in-situ material badly damaged as a result of back break from the previous blast. The VOD results captured in this hole is not a good representative result for the given explosives type and geology.



# CONCLUSIONS



# CONCLUSIONS

- **Block Movement & Stemming Activity**

From the visual analysis conducted, it appears that the holes on the Varistem® side of the block had a longer time-to-stemming-movement as compared to the non-Varistem® side of the block. This can be seen by comparing the visuals of the surface of the block at different points in time. Although the block still showed a number of ejections, no significant flyrock was present. The type and number of ejections was expected, based on the scaled depth of burial values.

- **Pre-Blast to Post-Blast Transition & Muckpile Comparison**

When looking at the shape and peak of the muckpile following the blast, it is evident that the Varistem® side of the block had a deeper and wider power trough, and a muckpile peak that was further away from the highwall. In terms of fragmentation, visual observations reveal that the fragmentation was finer on the Varistem® side of the block.

- **Cast Analysis**

The cast analysis showed that the portion of the block that used Varistem® cast the material, on average, **87% further** than the portion that did not use Varistem®. Although this is a significant increase, it must be noted that there were some differences in timing (due to the sensitive nature of the blast) that may have had an impact in the percentage of material cast by the non-Varistem® side. However, it is unlikely that this difference was wholly responsible for the entire difference of 87%, and it is likely that there would still have been a significant difference with a “normal” timing pattern.

- **Velocity of Detonation Comparison**

A total of 5 holes were used for VOD measurements (3 x holes with Varistem®, 2 x holes without Varistem®). On average, the Varistem® holes had a VOD of 5 774.00 m/s, with a maximum VOD of 7 420.8 m/s. Of the 2 x non-Varistem® holes, only one registered during the blast, and this hole was deemed to be not representative due to a likely column shift. The 5 x holes selected for the VOD analysis were subject to adverse geology, and thus the conclusion was reached that the VOD results could not be deemed as representative.





# THANK YOU

**Contact Us**

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