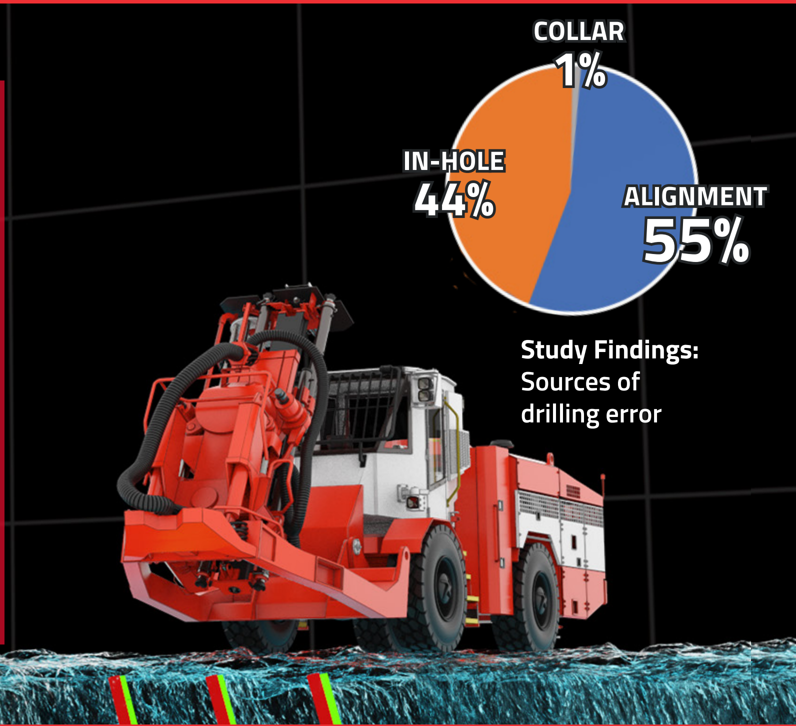
minnovare | DRILLING DOWN CASE STUDY

> Average deviation at the toe across the four sites using the 'Horse-Shoe' type drill was **5.4% (1.8m over a 33.2m hole)** - well outside 'best practice'.
>
> **55%** of the error at the toe was due to **alignment error** - indicating current drill setup processes are not only inaccurate, they are also highly inconsistent (2.2% Standard Dev.)
>
> There exists a significant opportunity for a step-change improvement in drilling accuracy and stope performance - **by reducing alignment error.**
>
> **Ryan Stimpson,**
> **Minnovare, Head of Engineering**



AUSTRALIAN SURVEY STUDY: HORSE-SHOE

Down-hole surveys were conducted across **17 Australian underground hard rock operations.** The results have been analysed to better understand typical drilling accuracy and the factors that result in blast-hole deviation. The data was further broken down by rig type (Boom and Horse-Shoe). **In this case study we'll be focusing on the results of the Horse-Shoe rig.**

LOCATION:	Australia
YEAR:	2019 - 2020
INDUSTRY:	Underground Mining, Long-Hole Stoping
CLIENT:	Multiple
FOCUS:	Production Drilling
DRILL TYPE:	Horse-Shoe
SOLUTION:	Production Optimiser

THE STUDY:

Survey data was captured from a total of 17 underground mine sites in Australia throughout 2019 and 2020.

Across the 17 sites, four commodities are mined – gold (16), zinc (1), copper (2) and nickel (1). Three of the operations are mining more than one commodity on site - resulting in the discrepancy in total sites.

All but one of the mines have narrow-vein ore bodies with the primary mining method being long-hole stoping (13), followed by open stoping (3), and the remaining mine conducting sub-level stoping.

Across the 17 sites, a total of 2,408 holes were drilled using the 'existing process' and then later surveyed. The average surveyed length of all holes was 24m. The average number of holes drilled and surveyed at each site, was 142. **4 sites were using the Horse-Shoe, with a total of 1,341 holes.**

EXISTING PROCESS:

The existing process is dependent on numerous variables which can influence set up accuracy.

This includes the marking of laser lines, rig alignment to those lines, ensuring the rig is leveled and operator skill/judgment during drilling.

Across the 17 sites, there were two 'types' of long-hole production drill used – Boom and Horse-Shoe.

> **The existing process relies on multiple variables which create drilling errors - regardless of whether you're drilling with a Boom or Horse-Shoe rig.**

BLAST-HOLE DEVIATION EXPLAINED:

Blast-hole deviation is measured as the extent to which the toe-point of a blast-hole deviates from the plan. Blast-hole accuracy is widely understood to be key to optimal blasts, defined as **minimised dilution**, **maximised recovery** and **optimised fragmentation** size.

Most underground drill and blast operations have targets in place regarding acceptable levels of deviation, commonly referred to as 'tolerance'.

Holes drilled are classified as either 'within' or 'outside' tolerance, with holes sufficiently outside tolerance potentially requiring re-drilling – a further cost of production.

There are three factors that contribute to blast-hole deviation; **collar** error (due to collar location error), **in-hole** deviation (due to ground conditions and operator skill/judgment during drilling) and **alignment** error.

Consistently inaccurate drilling causes sub-optimal blasts and as a result, poor stope performance.

This includes reduced ore recovery, over/under-break, dilution and lost drilling productivity as a result of re-drills - increasing stope cycle time.

METHOD:

All holes were set up using the existing process. All holes were surveyed using non-magnetic survey instruments.

The alignment error was calculated by measuring the hole trajectory at the first 6ft (1.8m) of the survey.

The actual collar position was measured by the mine surveyor and compared to the plan.

The error at the toe and in-hole deviation was measured by comparing the surveyed hole trajectory and hole position to the plan.

FINDINGS ACROSS SITES:

Inaccurate Drilling: Across the four sites, average toe deviation was **5.4%.** Over the average hole length (33.2m), this equates to an error of **1.8m.** Average toe deviation is therefore well outside industry 'best practice'.

Sources of Error: The majority of toe deviation **(55%)** was due to alignment error - indicating flaws in the existing process for setting up the drill were primarily to blame for overall inaccuracy.

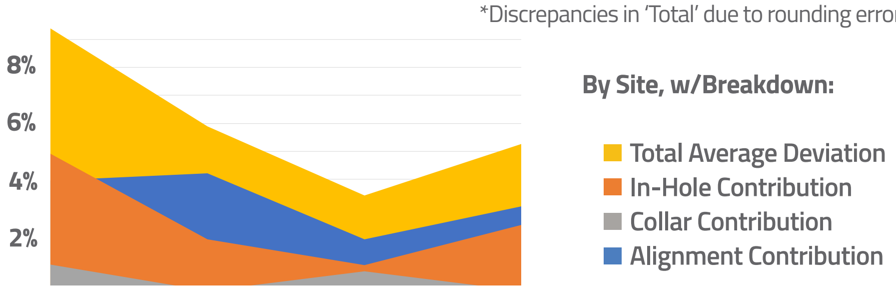
Around 1% of the error at the toe was due to collaring error and 44% due to in-hole deviation.

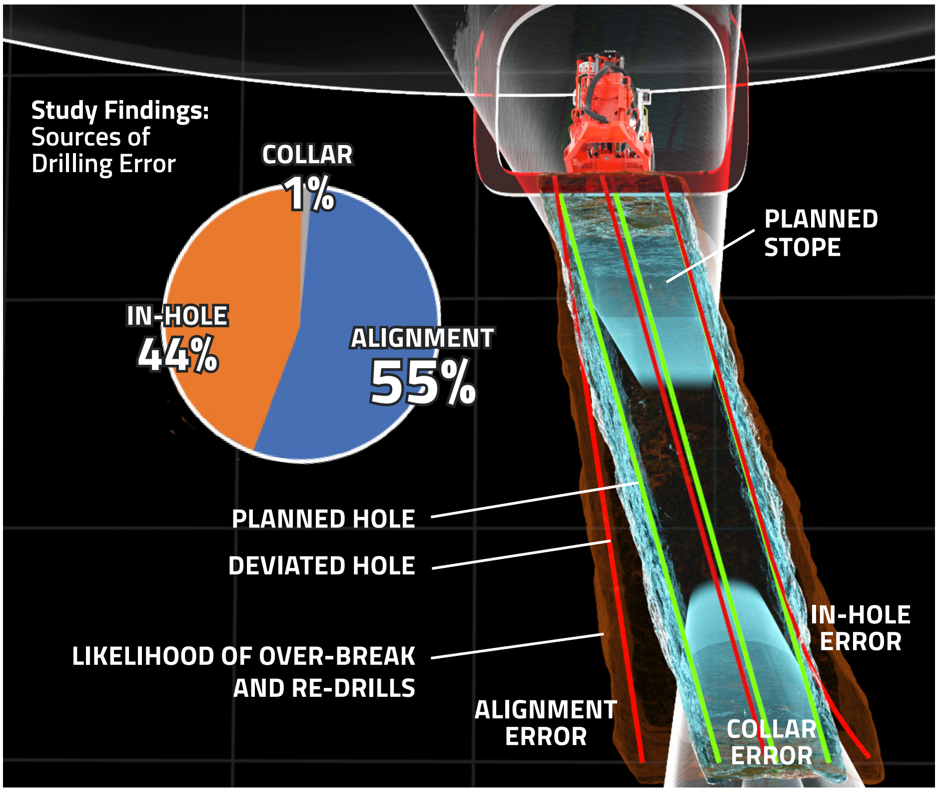
Inconsistent Drilling: The stand dev. in alignment error was 2.2% with the Horse-Shoe, indicating highly variable set up accuracy.

The Result: Inaccurate and inconsistent drilling can result in poor stope performance. (re-drills, over/under-break, reduced recovery).

	All Holes	Collar Error Avg	Alignment Error Avg	In-Hole Error Avg	Total (Toe) Deviation Avg*
Four Sites	1,341	0.05%	3.0%	2.4%	5.4%

*Discrepancies in 'Total' due to rounding errors





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THE SOLUTION:

Minnovare's **Production Optimiser** is an advanced hardware / software system that is applicable to all production drill makes and models.

The system **eliminates up to 70% of error at the toe** by removing multiple variables from the existing setup process that result in inaccurate and inconsistent drilling, including;

Laser line mark-up, alignment to the laser lines, drill leveling, multiple inclinometer calibrations, wear and slack in the drill.

The Production Optimiser simplifies the setup process down to a single tolerance - between the drill rod and the collar.

Reducing these variables results in highly accurate, consistent drilling, which in turn delivers;

Less re-work, **reduced ore-loss** (under-break) due to inaccurate drilling and **reduced costs** associated with re-access and dilution/waste. The simplified process also leads to an **increase in stope turnover**, with more time spent drilling.

The technology enables mines to 'do more with the same' - increasing productivity, without adding additional drills. Finally, the system uses digital drill plans and plods to deliver real-time accuracy and accountability for both engineers and drillers.

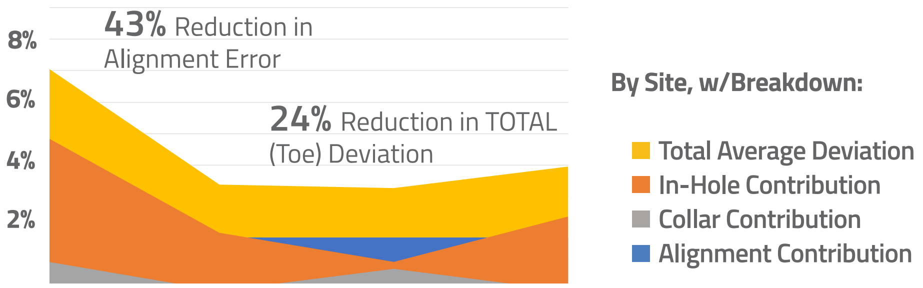
PRODUCTION™ OPTIMISER

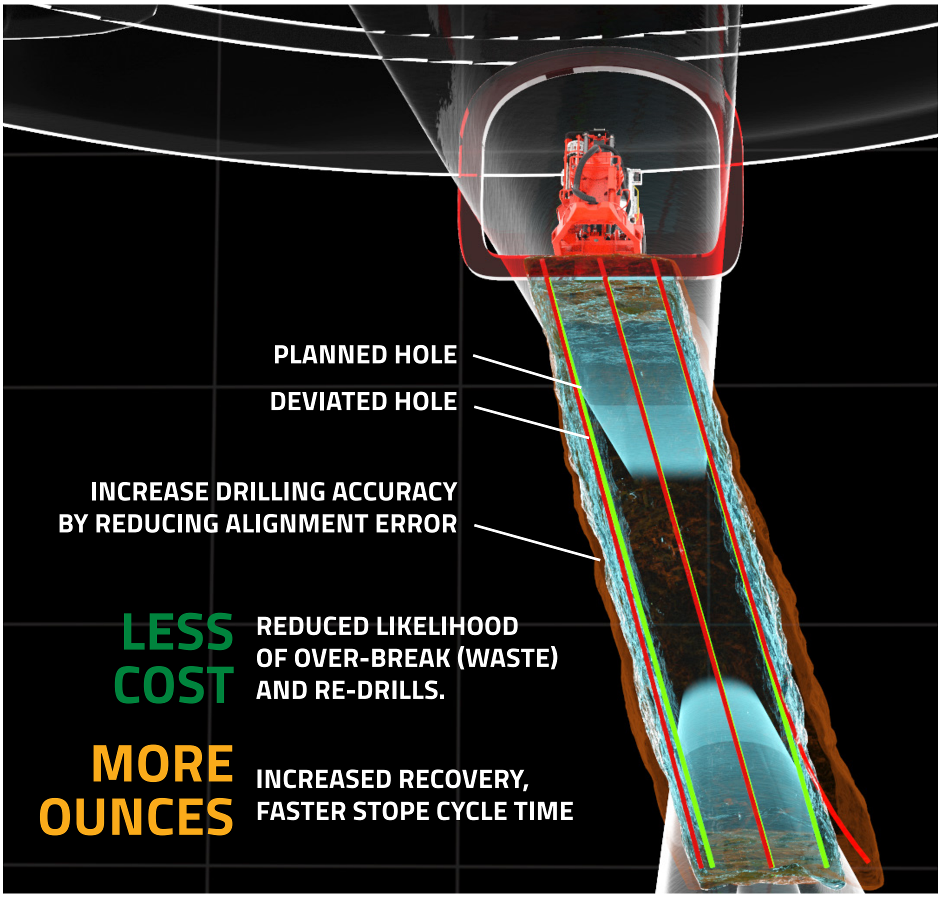
Reduce deviation.
Reduce dilution.
Increase recovery.

Applying average results achieved with existing Production Optimiser clients (currently over 30 underground mines), to the findings in this study, a 24% reduction in toe deviation could be achieved;

	All Holes	**Collar** Error Avg	**Alignment** Error Avg	**In-Hole** Error Avg	**Total** (Toe) Deviation Avg*
Four Sites	1,341	0.05%	1.7%	2.4%	**4.1%**

*Discrepancies in 'Total' due to rounding errors





More Information

For more information on this case study and/or Minnovare technology, send us an email at **info@minnovare.com**

CONTACT US:
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