



ITH vs. Top Hammer Drills

In The Hole (ITH) vs. Top Hammer Drilling in Underground Applications

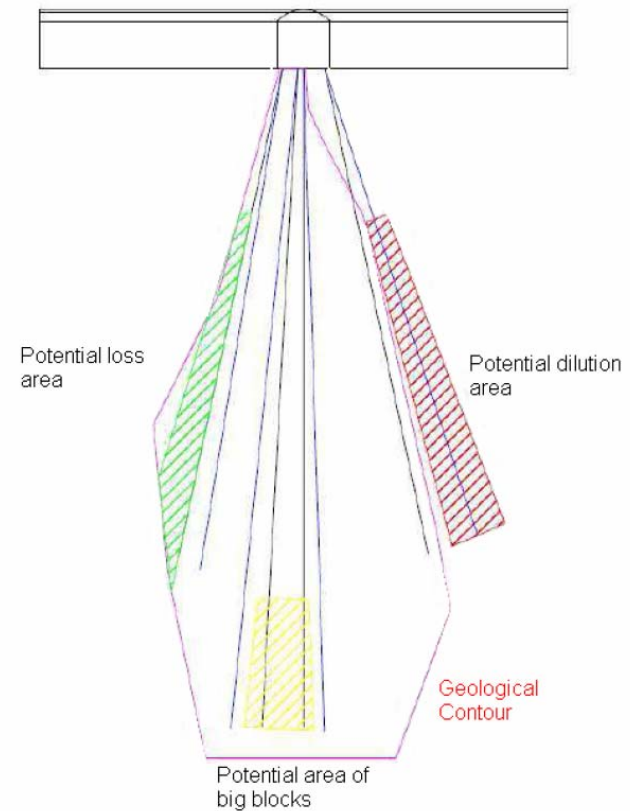
Presented by Peter Corcoran, Director of Sales and Marketing for Cubex Ltd



ITH vs. Top Hammer Drills

Overview

1. Drill and Blast Design Review
2. Drilling Accuracy, and its importance
3. Top Hammer Application
4. In The Hole (ITH) Hammer Application
5. Top Hammer advantages / disadvantages
6. ITH drilling advantages / disadvantages
7. Canadian Case Study – ITH vs Top Hammer
8. Summary





ITH vs. Top Hammer Drills

Production Drilling – ITH or Top Hammer?

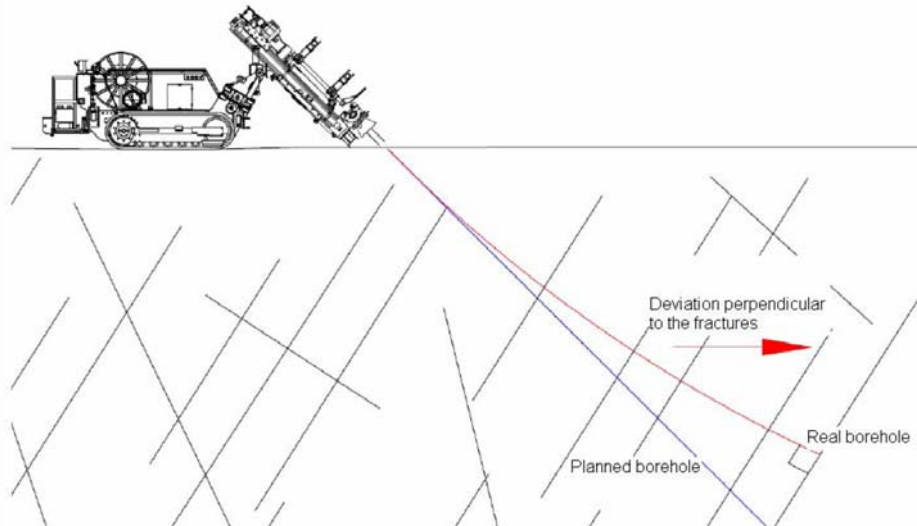
Key factors for review during drill and blast design:

- Mining Method
- Blast hole depth
- Diameter of hole
- Geology (drill-ability / rock hardness)
- Orientation of drill holes
- Equipment size

Note: Since drilling and blasting are the first steps in the processing operation, the accuracy obtained significantly impacts down stream costs (i.e. secondary drilling cost, mucking cost, ground control cost, hoisting requirements, milling costs, development requirements, and manning requirements).



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Agnico-Eagle Deviation of Longhole Drilling David Gallant

Dilution is Primarily Caused by Deviation

60% of deviation is caused by machine misalignment

40% of deviation is caused by in hole deviation

Accurate placement of explosives energy will protect weak ground conditions

The ultimate reason for efficient, accurate drilling is mine profitability. Hole deviation adversely effects profitability in the form of poor fragmentation, low ore recovery and ore dilution.



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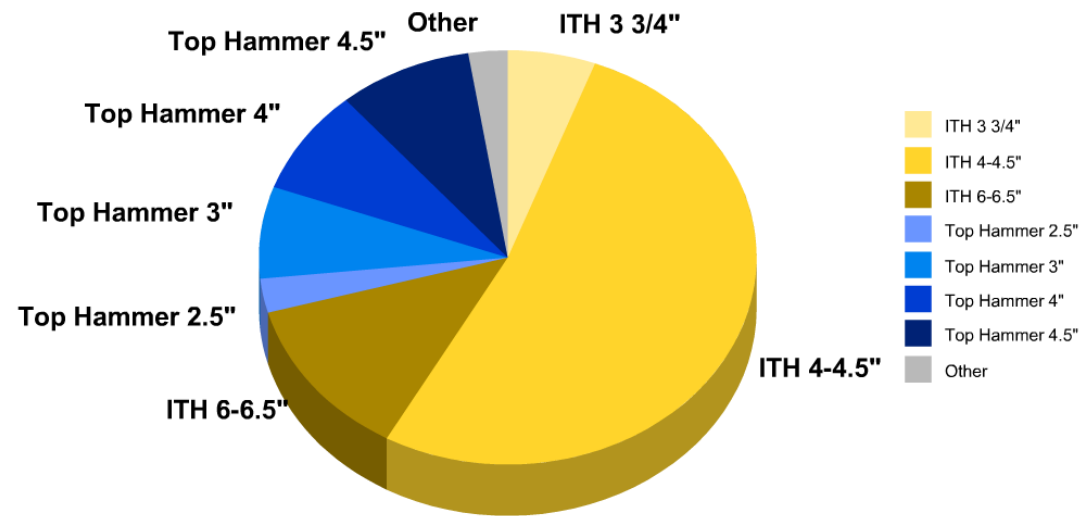
Percentages of ITH vs Top hammer

ITH: 71% of CDN and US underground drilling applications

Top Hammer: 27% of CDN and US underground drilling applications

Other (ranges not included in the study): 2%

Canadian and US Underground Drilling Applications



ITH vs. Top Hammer Drills

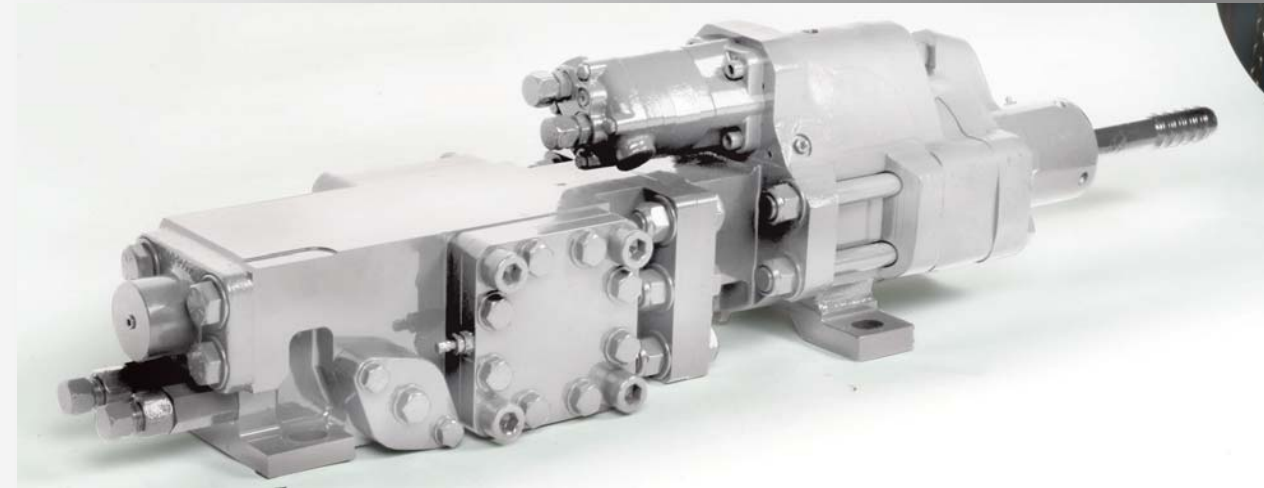


Top Hammer Application

- Designed to drill 2 - 4.5 inches (51 mm-113 mm) in diameter holes in soft, medium and hard rock formations
- Top Hammers are mounted on the mast of the drill, applying percussive force on the drill rods/tubes which is transmitted to the drill bit
- Powered by hydraulics

Main Applications:

- Development drilling
- Ground support drilling
- Production long hole drilling, mainly up hole



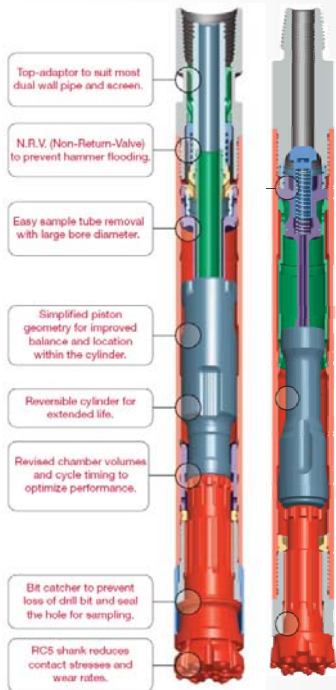
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ITH Hammer Application

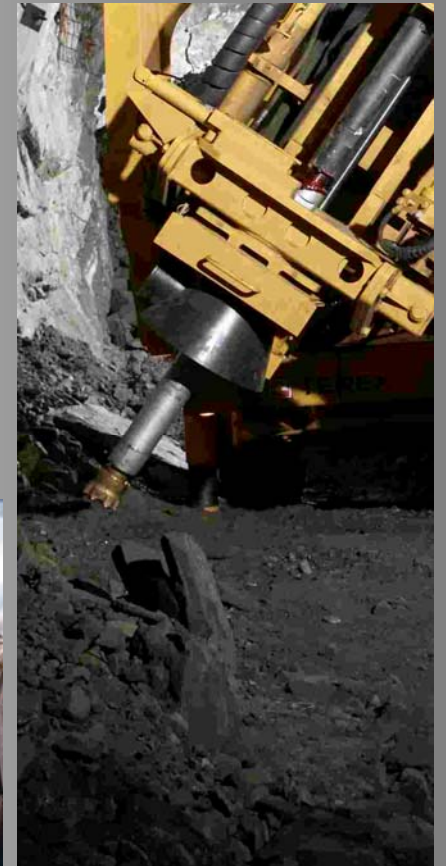
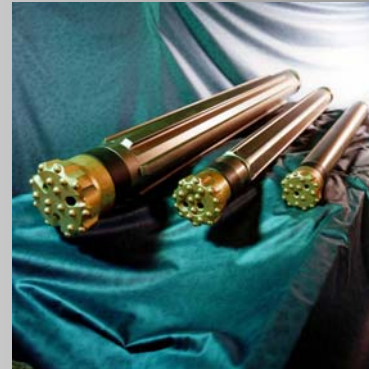
ITH Hammers: Range from 3" – 12" (76 mm-305 mm) diameter holes in soft, medium and hard rock formations

- Hammers are mounted in the hole, applying percussive force directly to the drill bit
- Powered by high pressure air: **400psi (34.5 bar)** or water (new technology)
- Cable bolt holes, blast holes, drop raises, utility and drain holes, reverse circulation sampling, dewatering wells, blind raises, slot raises, rapid raises



ITH Reverse Circulation Hammers: For effective and cost efficient sampling

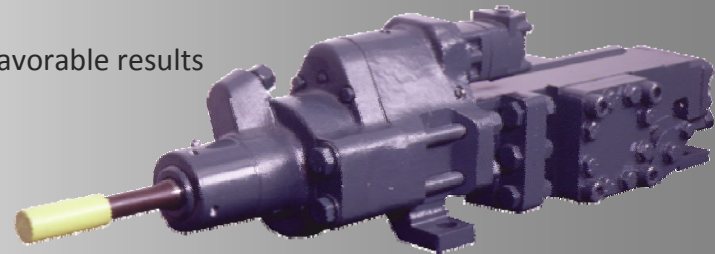
Wassara Water Hammer




ITH vs. Top Hammer Drills

Advantages of Top Hammer Drills

- Hole diameters of 1 5/8" – 4" (41mm-102mm)
- Where hole-lengths are between 20-25 meters- Top hammer drills have a faster initial penetration rate (up to ~20 meters / 66 ft)
- Where small up holes are required (with a small enough hole diameter to hold in overhead explosives)
- Is able to drill a smaller hole for less damage to the formation
- When the mine is utilizing top-hammers extensively for other tasks such development drilling with face drilling rigs, and cable-bolting. Using a top-hammer for production drilling could result in lower initial capital cost
- With the installation of drill tubes into the drilling system, more favorable results are experienced with hole accuracy





ITH vs. Top Hammer Drills

Disadvantages of Top Hammer Drilling

- Reduced penetration rate after ~20 meters
 - 4-6% of the impact energy is lost at each joint (exact figure depends on the design, mass, number and tightness of joints)
- Drilling in fractured rock with top-hammers is difficult since sticking of the drill string is common
- Top hammer drilling is prone to have deviation of 5%-10% of the length of the hole.
- Excessive deviation after ~20m
- Top hammer drills are unable to efficiently clear cuttings at depth – often requiring the drill to complete a certain amount of non-productive drilling per hole to ensure achieving the full required depth
- Rods and couplings are often considered as major consumable items, due to percussive energy exerted on the rods and couplings with each hole drilled
- Drill mast is subject to heavy vibration, due to the hammer mounted on the mast
- Increased noise from top hammer reduces the operators ability to hear for drill rod binding or insert breakage
 - Noise can be reduced for operator by installing a cab, but this increases overall unit size



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Advantages of ITH Drilling

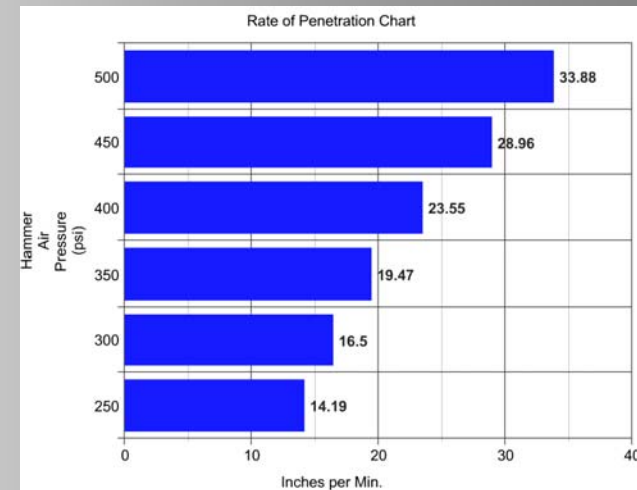
- Straighter, cleaner holes
- More accurate than top-hammer , due to the impact being in the hole (normally deviation maintained within +/- 1.0%)
 - Creates less draw-point hang-ups, less secondary breaking, fewer ore pass and chute hang-ups
 - No loss of energy through the drill string from start to finish of the hole, as with top hammer
 - Lower cost on drill rod consumables
- Larger hole diameter
 - Allows for larger drilling pattern which in turn reduces the powder factor (kg explosives / metric ton) creating time efficiencies and lowering mine explosives cost
- ITH is able to complete service hole drilling: Cable bolt holes, blast holes, drop raises, utility and drain holes, reverse circulation sampling, dewatering wells, blind raises, slot raises, rapid raises.
- With ITH Big-hole open stoping, vertical sublevels can be extended from 40 m with sublevel open stoping to 60 m (based on improved drill accuracy providing improved blasting)
- Reduced risk of getting stuck in fractured and faulted rock conditions



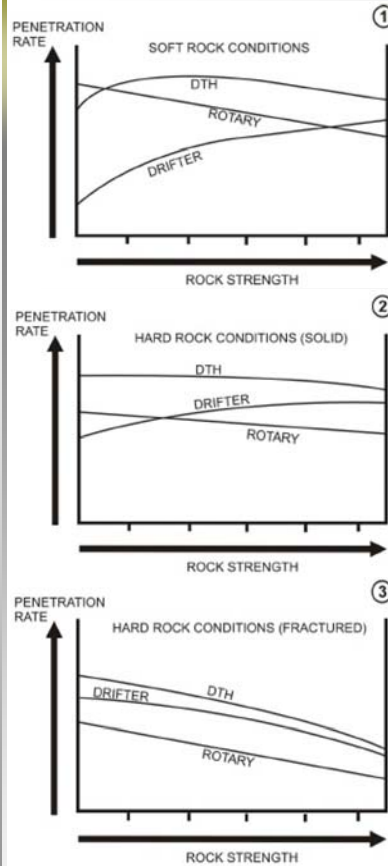
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Advantages of ITH Drilling – Continued

- Lower noise level at the worksite – due to the hammer working in the hole
- Simplicity of operation/service and maintenance – which typically translates to high machine availability
- Tons per meter drilled is higher for ITH drills vs Top Hammer drills
- Wide range of holes sizes available
- Drill string is not subjected to heavy percussive force as with top hammer drilling, and drill string life is therefore greatly lengthened
- Penetration rates with ITH hammers are almost directly proportional to air pressure. Therefore doubling the air pressure will result in approximately double the penetration



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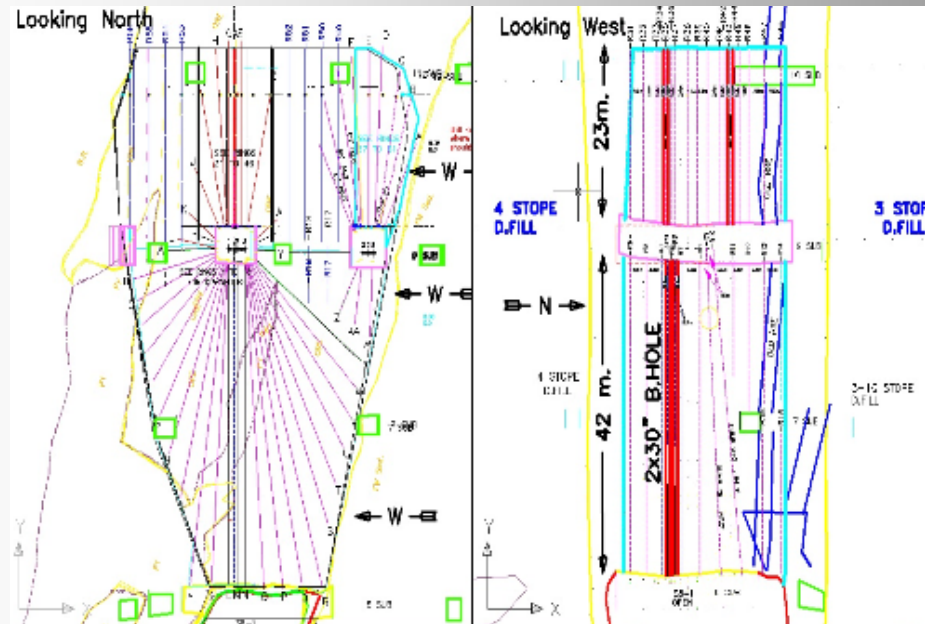
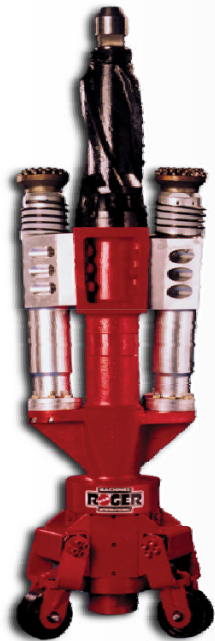
- Top hammer /drifter systems do not drill well in soft conditions, but drill better as the rock hardness increases and becomes more competent
 - ITH systems are less efficient at the lower end of the scale, but work extremely well at a consistent level in all other conditions
- Top hammer / drifter systems work well in solid conditions with high drilling rates on shallow holes
 - ITH systems are at the peak of efficiency in hard rock, being less affected than other systems in these conditions
- Top hammer / drifter systems tend to deviate and jam in fractured conditions
 - ITH systems consistently produce good results and are less affected even at depth



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Advantages of ITH Drilling – Large Diameter Reaming

- ITH drilling is able to ream holes up to 30"
- An initial pilot hole is drilled, and then reamed out to the desired diameter



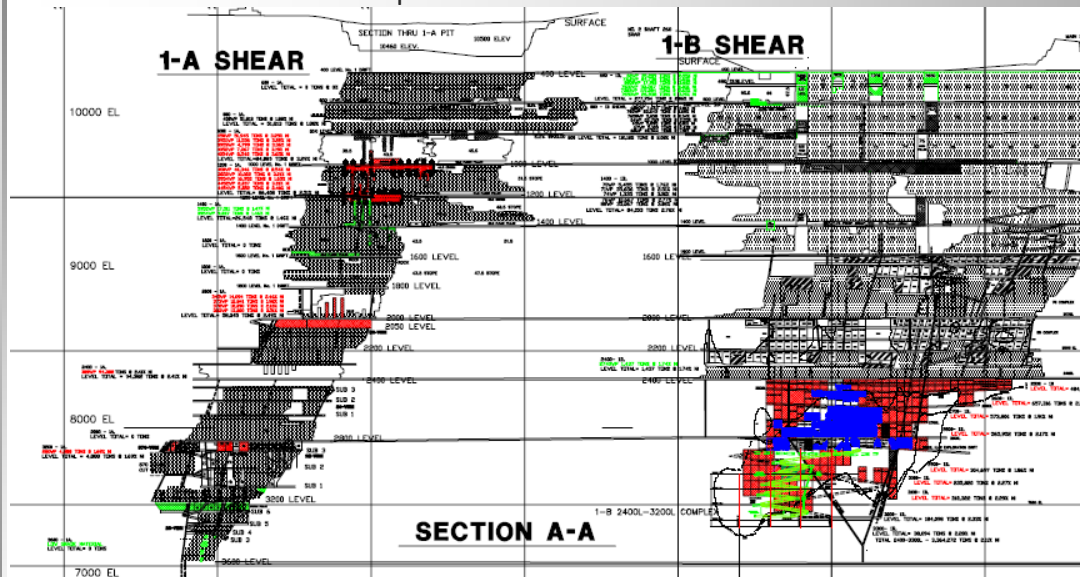
Xstrata Zinc Brunswick Mine



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Advantages of ITH Drilling – Cost Savings

- Due to increased accuracy of underground ITH drilling, the average distance between sublevels can be increased
- With the average cost of lateral development at ~ **\$4000 CDN/meter**, the cost savings obtained by increasing the distance between sublevels is significant
- Typically with ITH drilling, mines are able to increase their sublevels from 20m to 40m, which will supply a significant reduction in sublevel development costs



“When a mine is able to double the intervals, they’re close to half of the development cost”
Ted Smethurst, Canadian Representative for Cubex

Longitudinal view of T1 Thompson Mine

LEGEND

- WORKPLACES IN 5 YEAR PLAN
- WORKPLACES IN 20 YEAR PLAN
- WORKPLACES NOT SCHEDULED



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Disadvantages of ITH equipment

- Minimum hole size is 3 5/8"
- Mine needs compressed air
- Reticulation to carry air to production headings



Underground Booster



ITH Drill with Onboard Booster



ITH vs. Top Hammer Drills



Case Study: Canadian Underground Operation

Review of Top Hammer / ITH Drilling process for best production results

<u>Top Hammer</u>	<u>ITH</u>
Excessive deviation after drilling 20 m gave poor results, when drilling 33m stope intervals.	Due to ITH hammer, and larger diameter drill string, hole deviation is minimal at 35 m range (maximum deviation at 35 meters was recorded at 0.57 m)
Close spacing of boreholes (2.5 m with 89 mm boreholes) – Causing confusion for blasters due to many double dipped holes	Wide spacing of boreholes (3.5 m spacing for 115 mm boreholes) – less confusion for blasters, and cost savings due to reduced number of holes, and greatly reduced amount of explosives
Tons per drilled foot were low	Tons per drilled meter increased by 1.5 times over 89 mm top hammer drilling
Machine limited to ‘vertical only’ slot raises (to limit deviation)– this limited the location of the raise, since it needed to break through to the lower level.	Able to drill down the dip of the ore body , maximizing drilling efficiency and ore recovery.

Results: ITH drilling allowed for larger bore hole diameters with expanded patterns (115 mm holes spaced at 3.5 m). There is also, improved hole accuracy, and no loss in penetration with the larger ITH bits. Additionally, the tons per drilled meter increased by 1.5 times with ITH drilling over top hammer drilling.



ITH vs. Top Hammer Drills

Summary – Equipment selection for proper application

Drilling system and process needs to be reviewed to ensure optimum drill and blast pattern is maintained

Top Hammer



- Is able to drill a smaller hole for less damage to the formation
- Faster initial penetration rate (up to ~20 meters / 66 ft)
- Lower capital cost
- Hole diameters of 1 5/8" – 4" (41mm-102mm)

ITH



- Accurately drilled holes
- Wide range of holes sizes available (flexibility)
- Service hole drilling capabilities
- Allows for larger drilling pattern
- Low cost on drilling consumables

There are pros and cons depending on the drilling application and there is also substantial development taking place related to Top Hammer and ITH drilling technologies.

This is where the O.E.M and the mine operator need to come together to discuss the most productive and profitable solution for the particular application.



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Thank - You

