Drilling Applications

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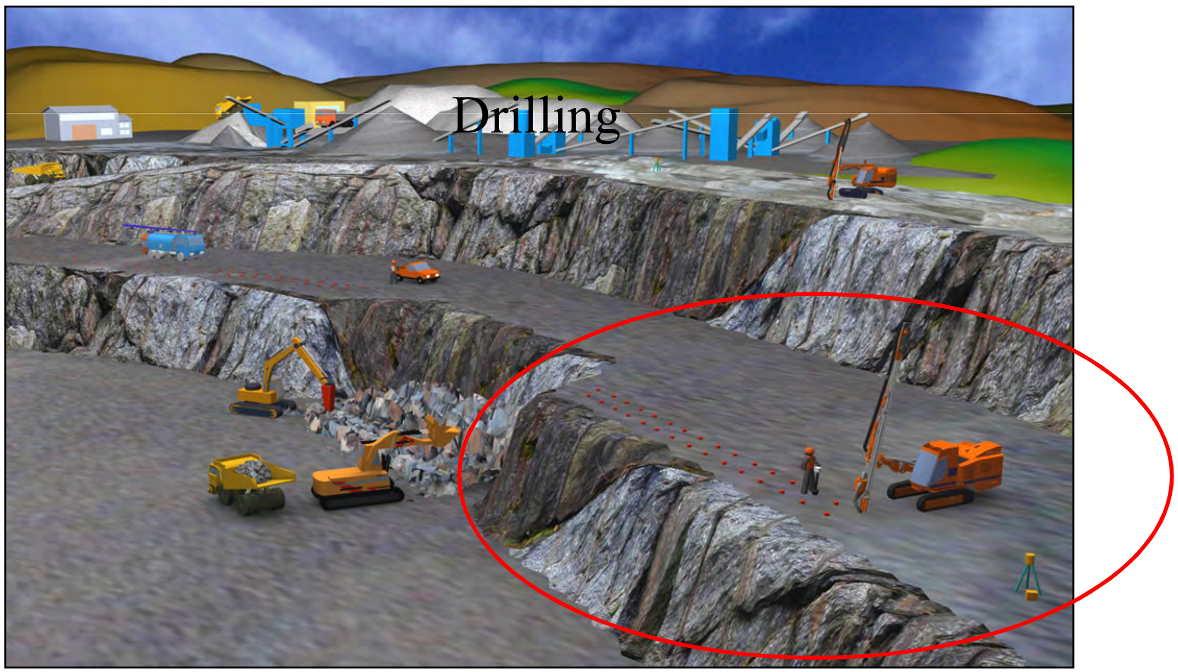
QUARRY ACADEMY

Improving Processes. Instilling Expertise.

Drilling Management

Agenda for presentation

- ***well planned operations and correctly selected rigs yields low cost drilling***
- ***technically good drilling and correctly selected drill steel yields low cost drilling operations***
- ***straight hole drilling yields safe and low cost D&B operations***



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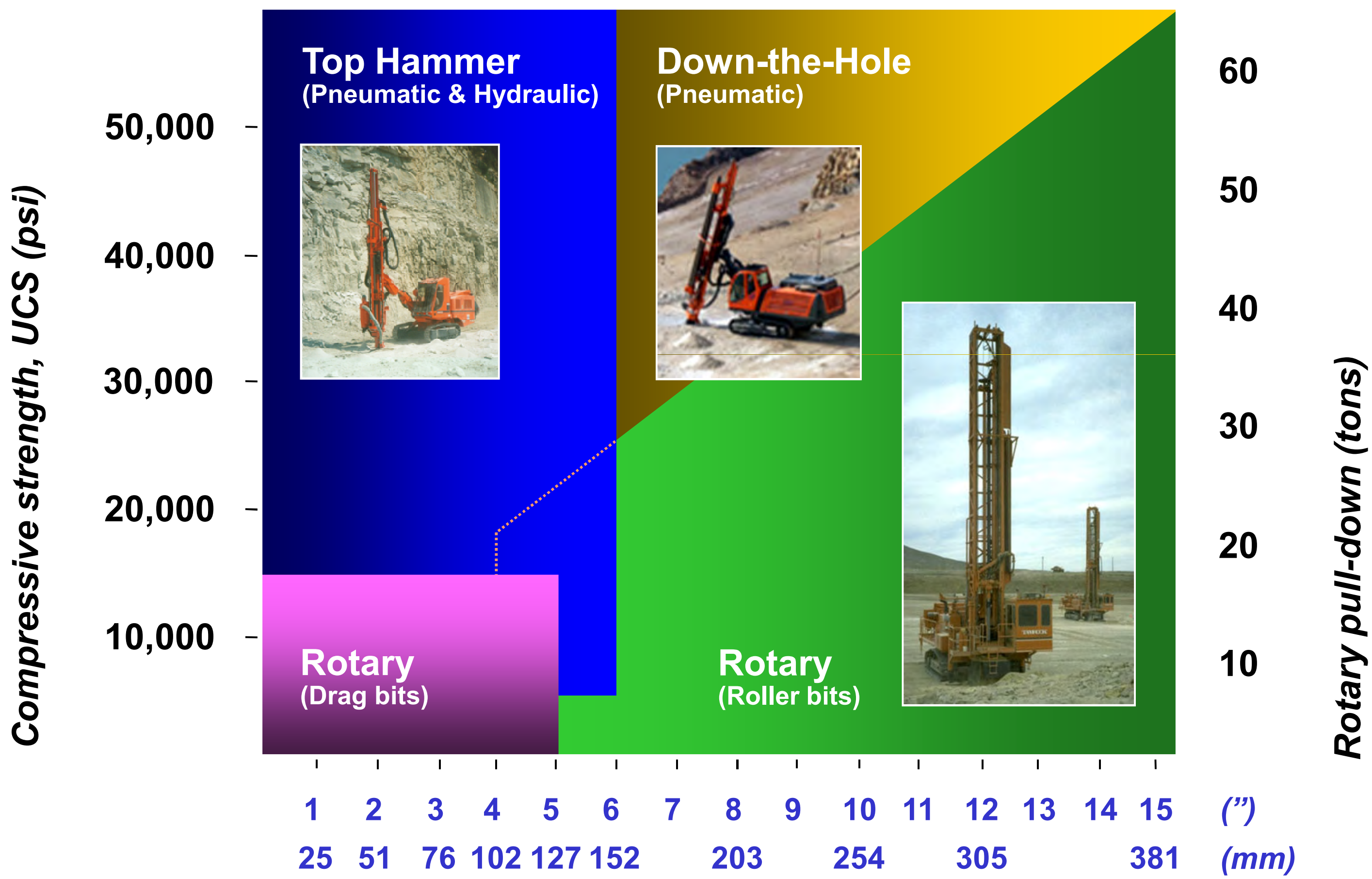
The most common drilling methods in use



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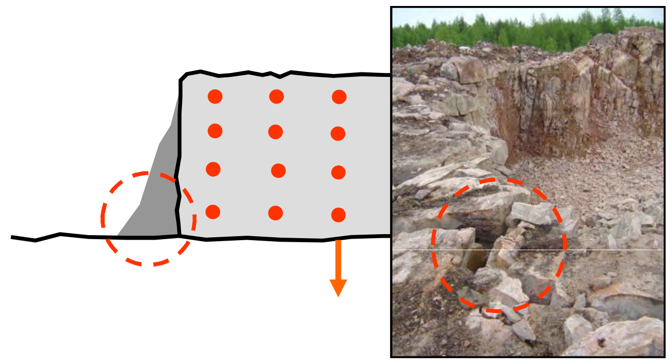
Difficult drilling conditions

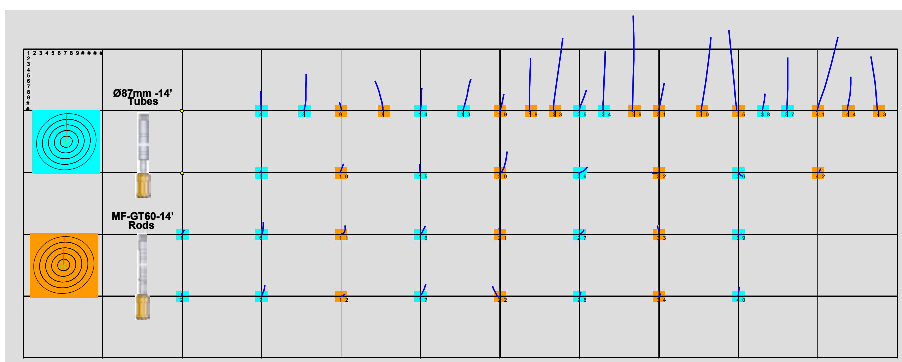
- where hole quality, drilling tools and drilling capacities are lost

Collaring

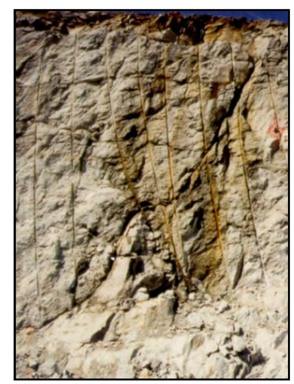
Open corner damage



1st row drilling



Drilling in open joints



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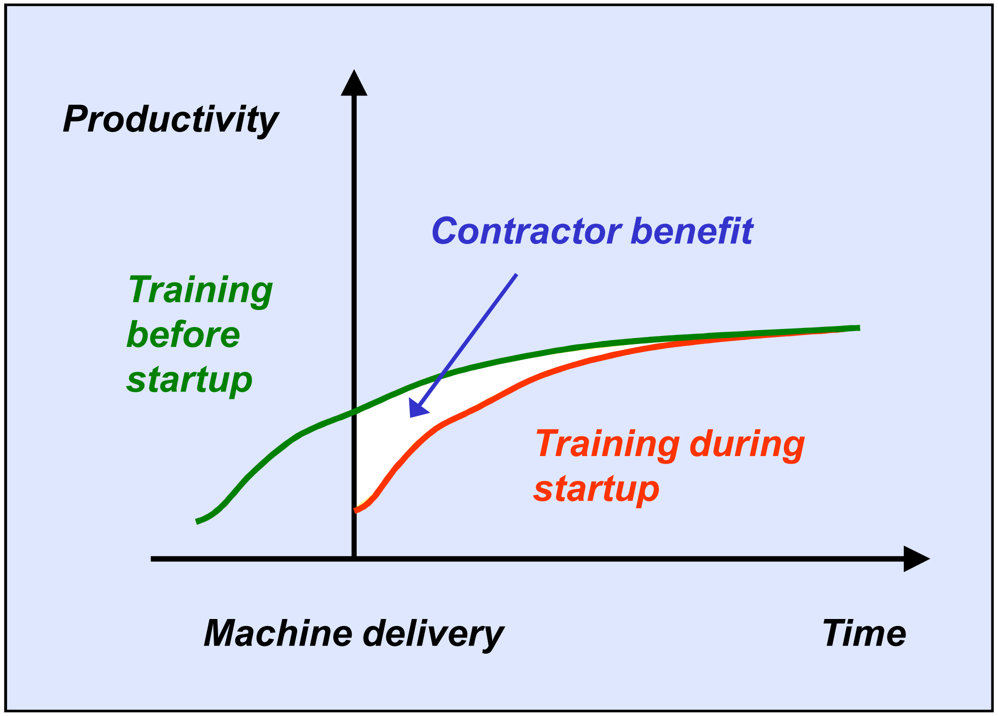
Simulation tools – Operator training for DPi



Drilling Management

Drilling consists of a working system of:

- *bit*
- *drill string*
- *boom or mast mounted feed*
- *TH or DTH - hammer*
  Rotary - thrust
- *drill string rotation and stabilising systems*
- *drilling control system(s)*
- *powerpack*
- *automation and data acquisition packages*
- *collaring position and feed alignment systems*
- *flushing (air, water or foam)*
- *dust suppression equipment*
- *sampling device(s)*

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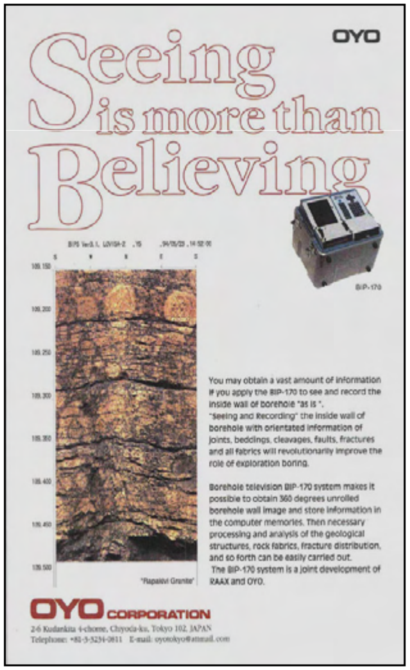
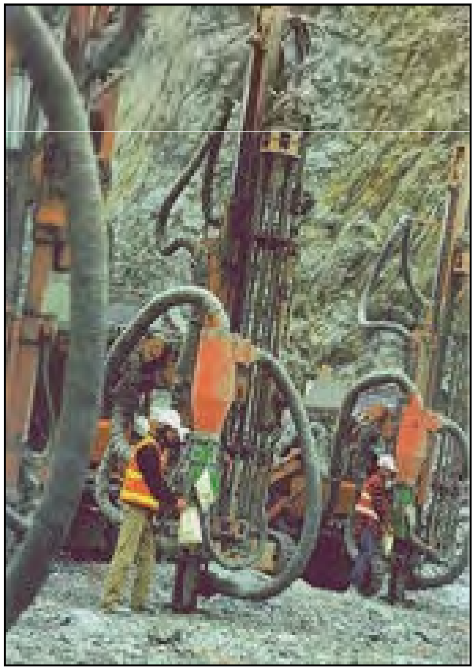
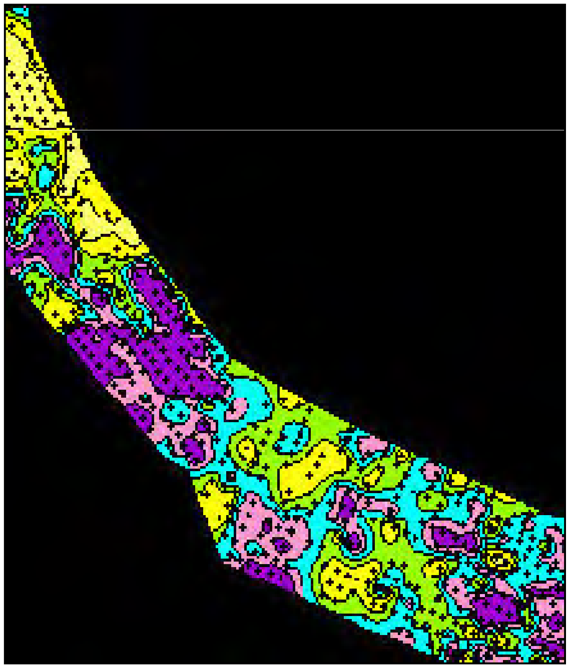
Drilling Management

In situ testing of rock mass properties

- ***inhole video surveys of shotholes***
- ***sampling of cuttings for chemical analysis***
- ***measurement-while-drilling or MWD based digital pit mapping***







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Drilling Management

Occupational health and safety

- ***work related accidents for:***
  - ✓ ***mobile equipment***
  - ✓ ***hazardeous work areas***
- ***emissions control***
- ***noise control***
- ***dust control***
- ***fly rock / charging / straight-hole drilling***
- ***falling rocks / wall control***

⇒ ***safety is linked as much to equipment as it is to attitudes***

⇒ ***health, safety and environmental issues are everyones' concern***

⇒ ***the ultimate safety target is zero harm – not just a mimimum occurrence of accidents***

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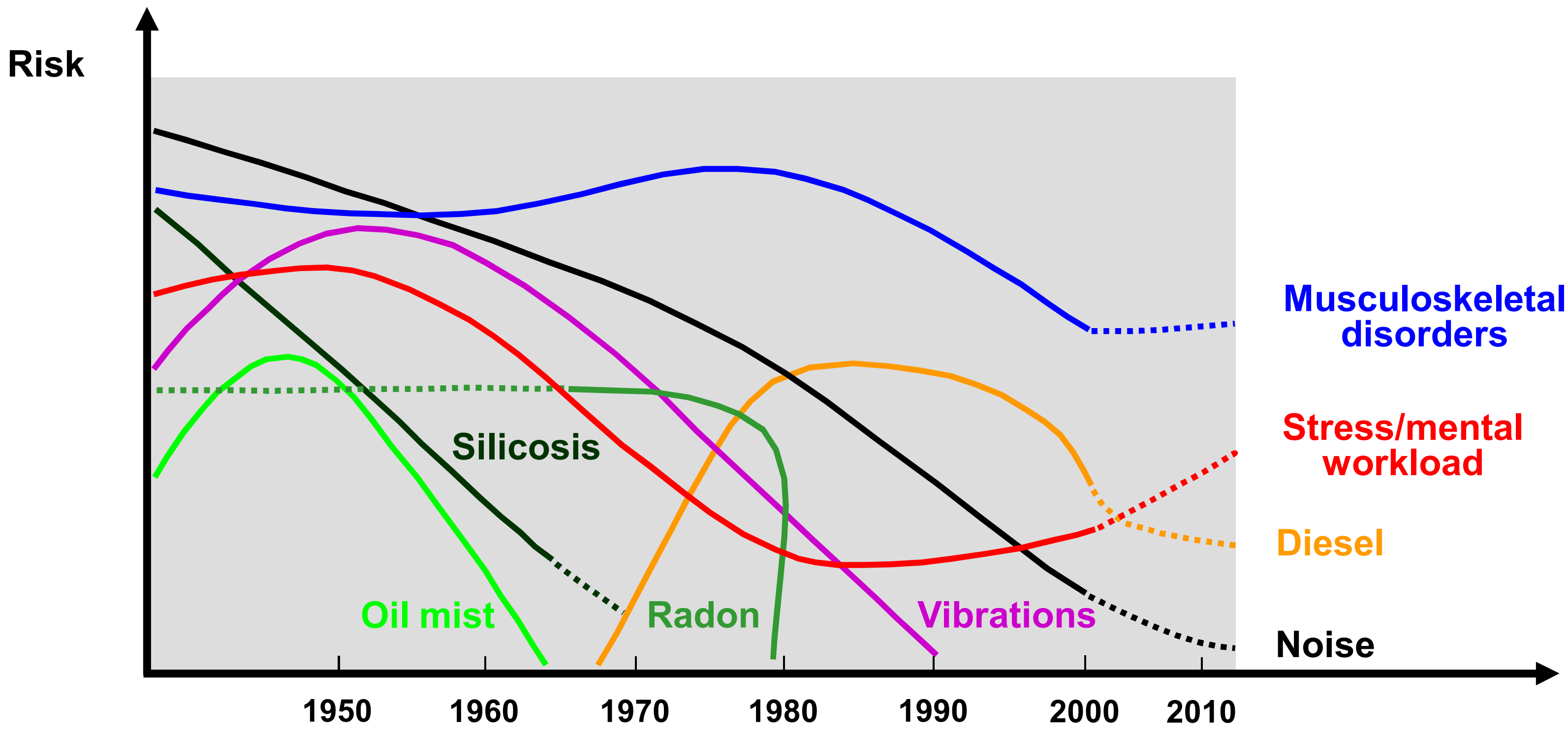
Drilling Management

General assessment of some health risks by Swedish authorities (UG + SF)



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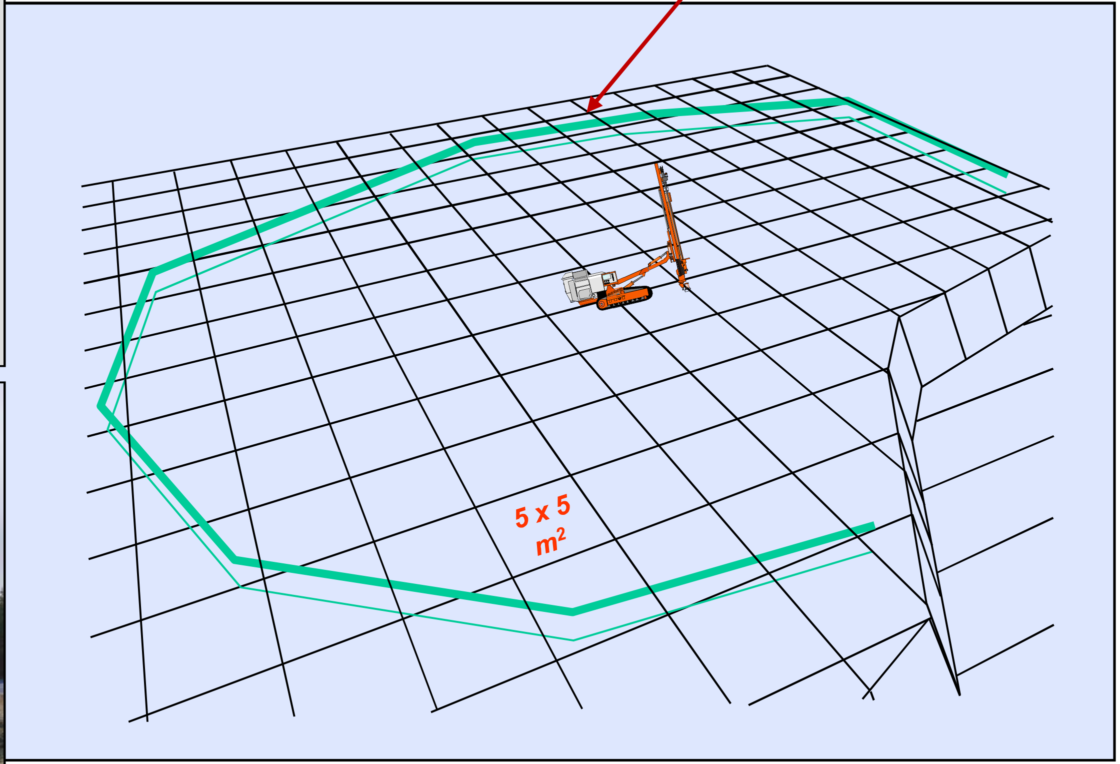
Drilling Management

Drilling noise levels - TH

Standard	***ISO 4872***
Pressure	***L_{WA} dB(A)***
Commando DC100	***125.7***
Commando DC300	***123.8***
CHA 660	***124.2***
Ranger DX700	***126***
Pantera DP1500	***127***

85 dB(A) boundary for CHA 660



Feed casing reduces noise levels by approx. 10 dB(A)

Drilling Management

Safety of in-pit operations

- ***unwanted incidences do not just happen – they have root causes***
- ***actions can be taken so as to reduce frequency and consequences of unwanted occurrences***
- ***the relationship between complexity and knowledge in the workforce is often unbalanced - e.g. operator hazard training is a must!***

Rollover from terrain bench - 35m drop

Premature ignition of electric detonators and blast due to lightning

Pit wall failure burying 3 drill rigs in rubble

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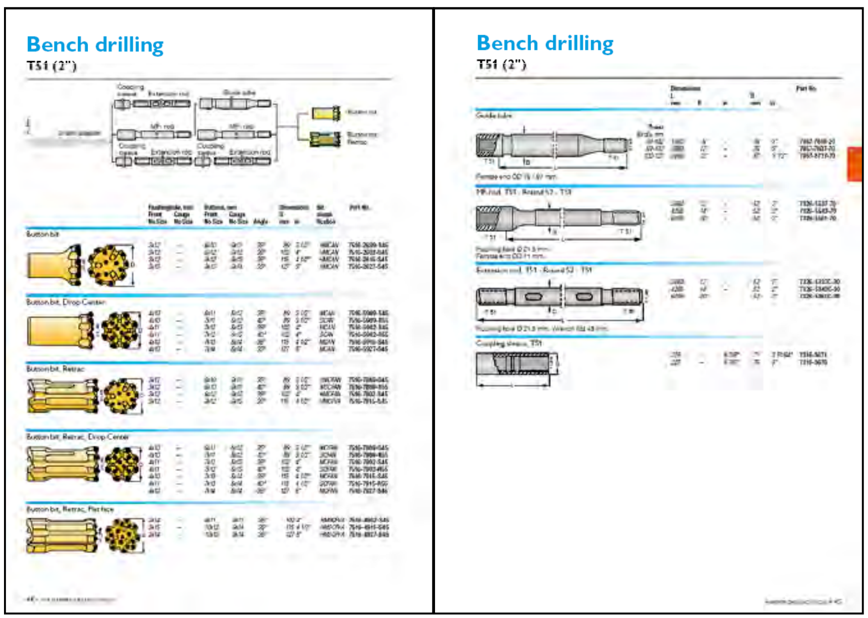
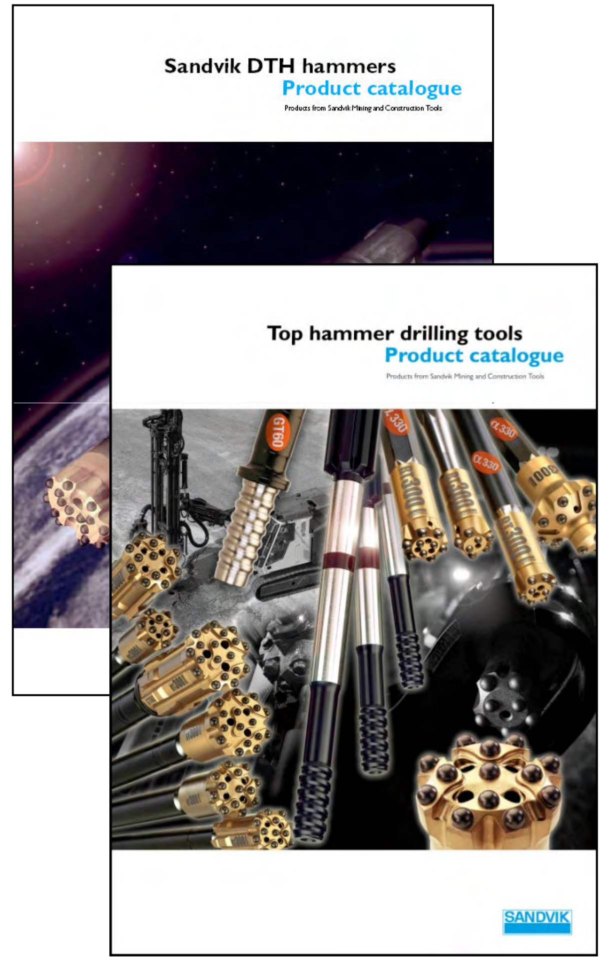
Selecting drilling tools - TH

- *bit face and skirt design*
- *button shape, size and cemented carbide grade*
- *drill string components*
- *grinding equipment and its location at jobsite*





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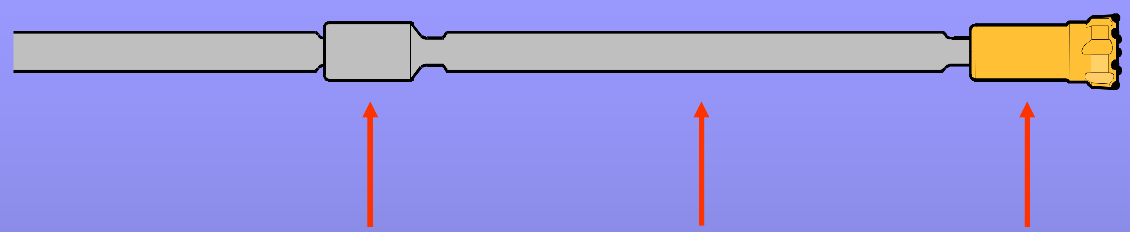
Drilling Management

Optimum bit / rod diameter relationship - TH



Thread	Cross section coupling	Cross section	Optimum bit size
R32	∅44	∅32	∅51
T35	∅48	∅39	∅57
T38	∅55	∅39	∅64
T45	∅63	∅46	∅76
T51	∅71	∅52	∅89
GT60	∅82	∅60	∅92
GT60	∅85	∅60/64	∅102

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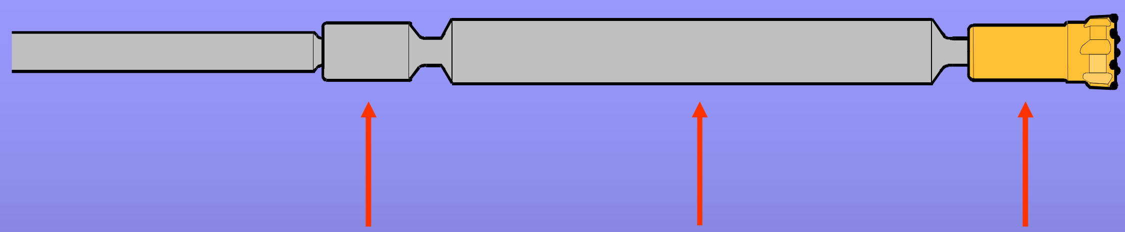
Optimum bit / guide or pilot (lead) tube relationship - TH



Thread	Cross section coupling	Cross section	Optimum bit size
T38	∅55	∅56	∅64
T45	∅63	∅65	∅76
T51	∅71	∅76	∅89
GT60	∅85	∅87	∅102
GT60	∅85	∅102	∅115

Drilling Management

KPI's for drill steel follow-up work

- ***drilling capacity dr-ft/eh***
- ***drill-hole straightness***
- ***avg. percussion pressure***
- ***geological conditions***

- ***drill steel component life***
- ***bit regrind intervals***
- ***component discard analysis***
- ***cost USD per dr-ft or yd^3***

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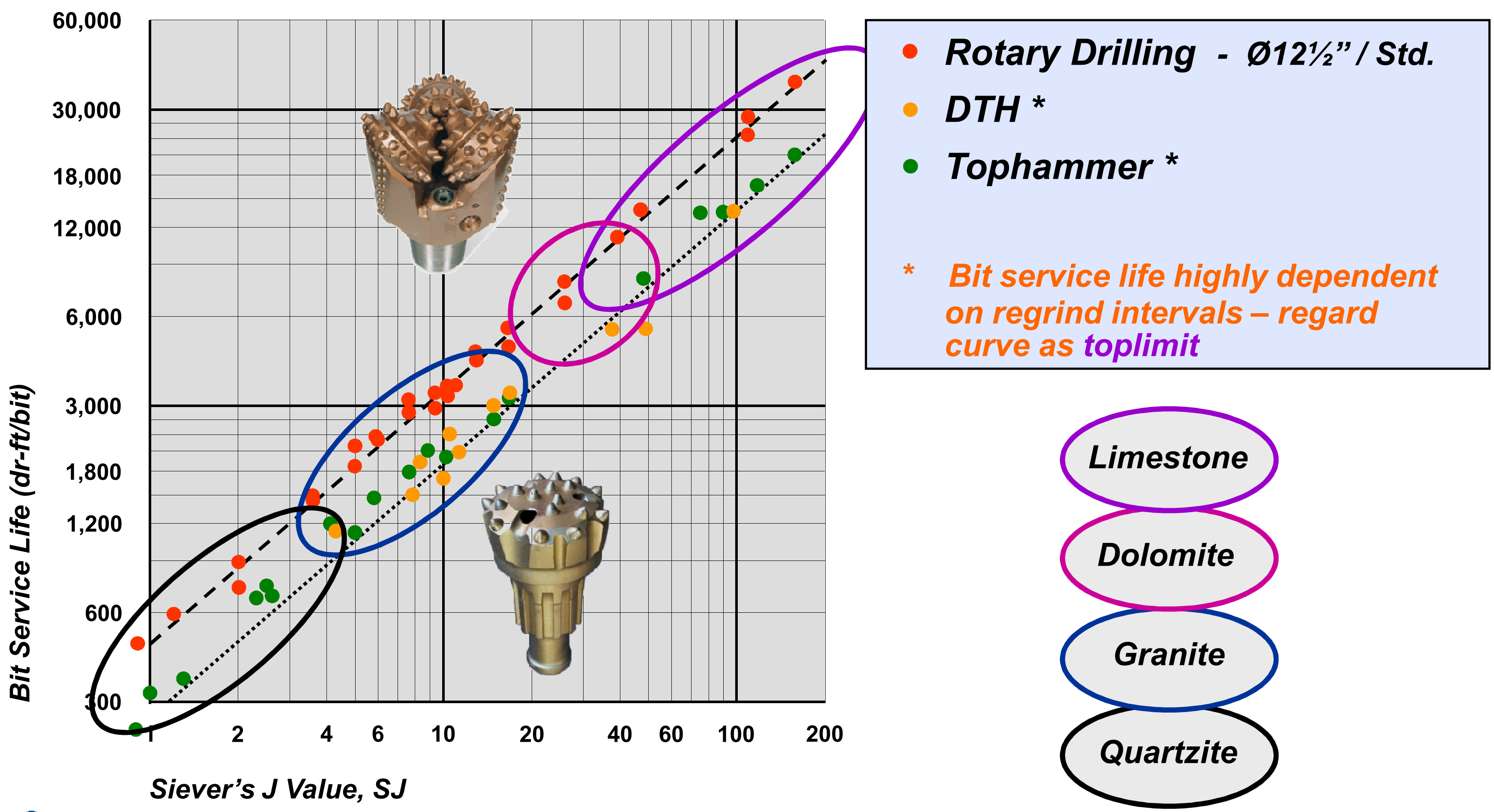
Drilling Management

Trendlines for bit service life



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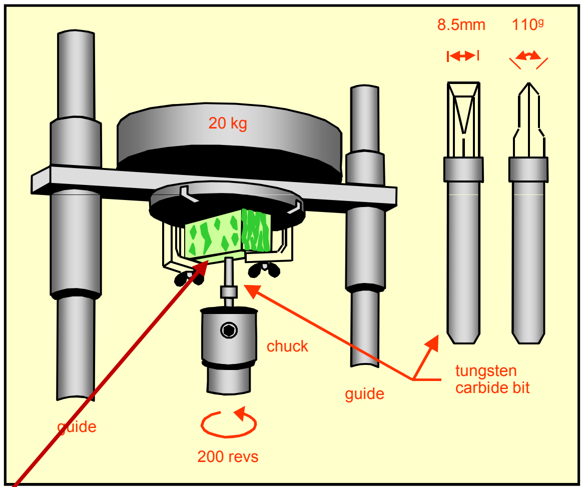
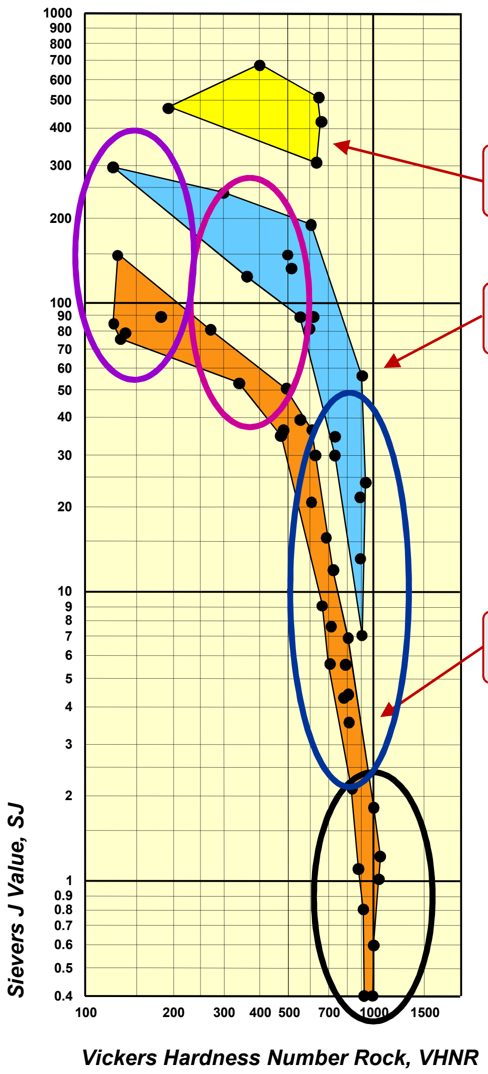
Relationship SJ and VHNR

- ***rock surface hardness, VHNR***
- ***rock surface hardness, SJ***





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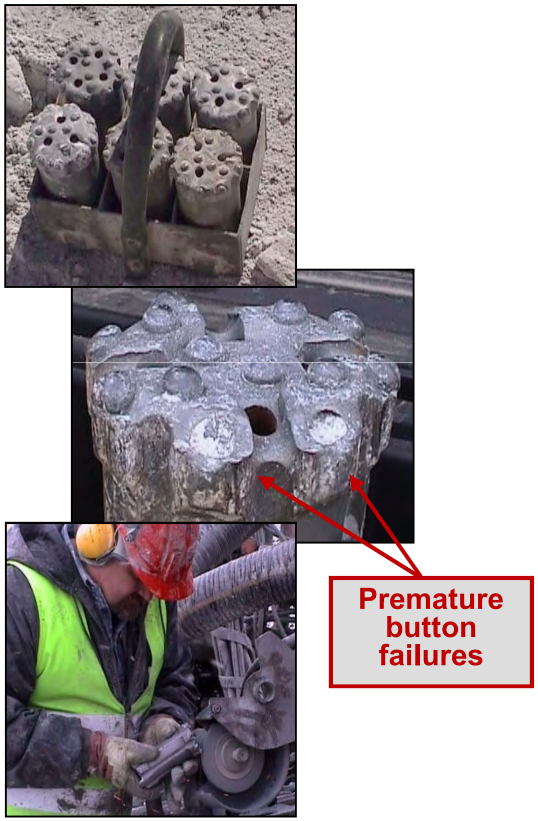
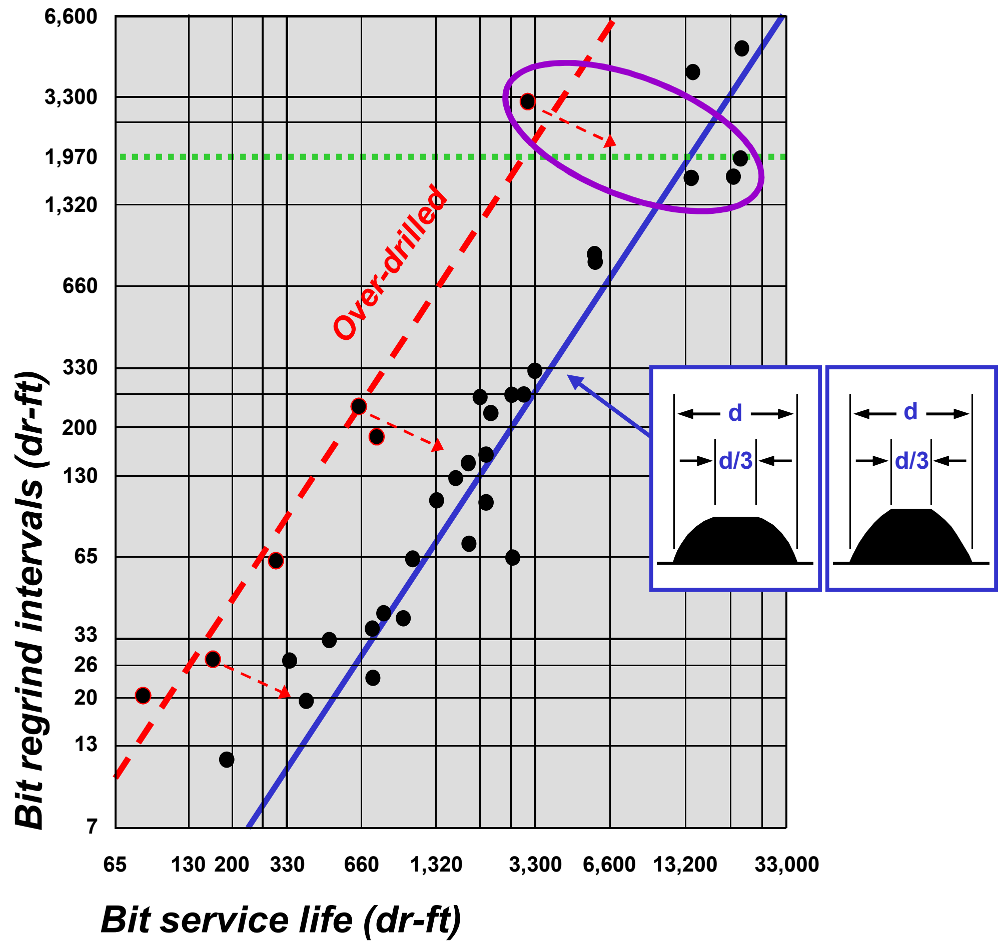
Bit regrind intervals, bit service life and over-drilling





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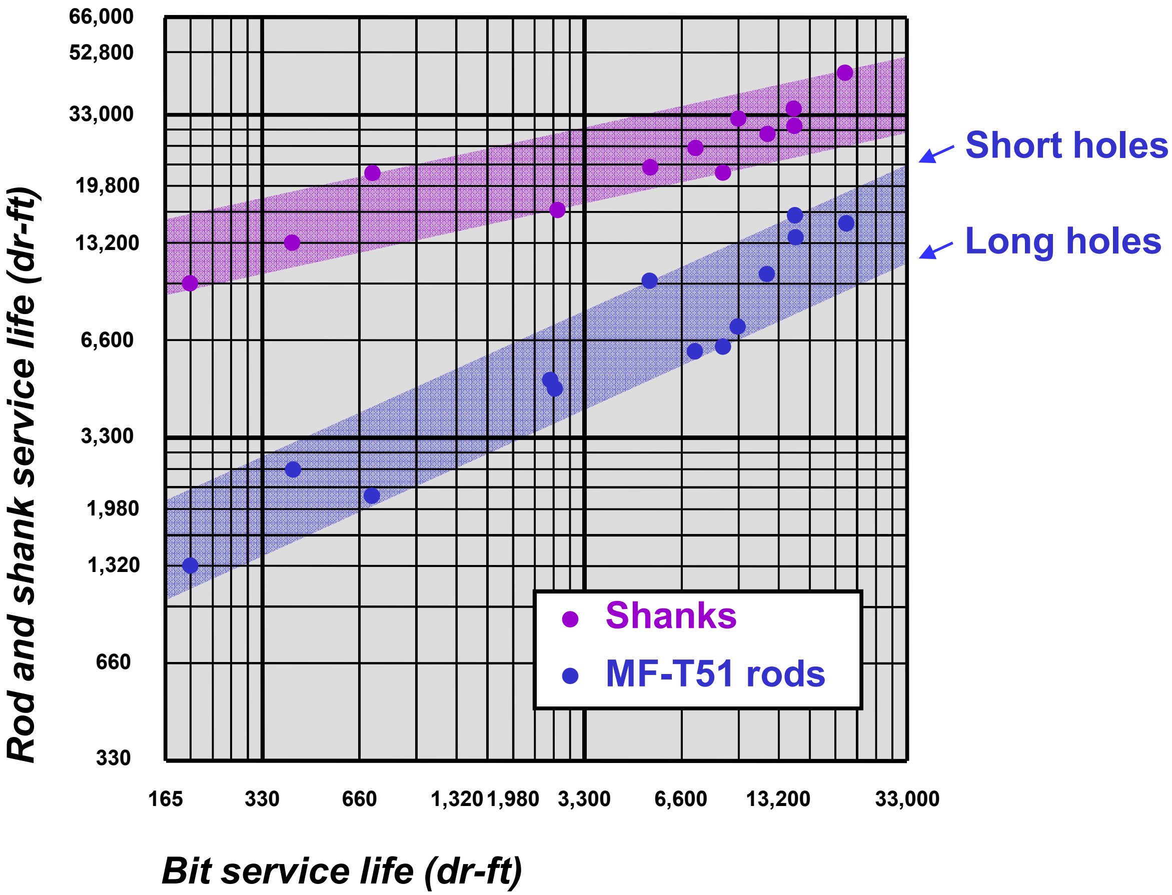
Example of drill steel followup for MF-T51

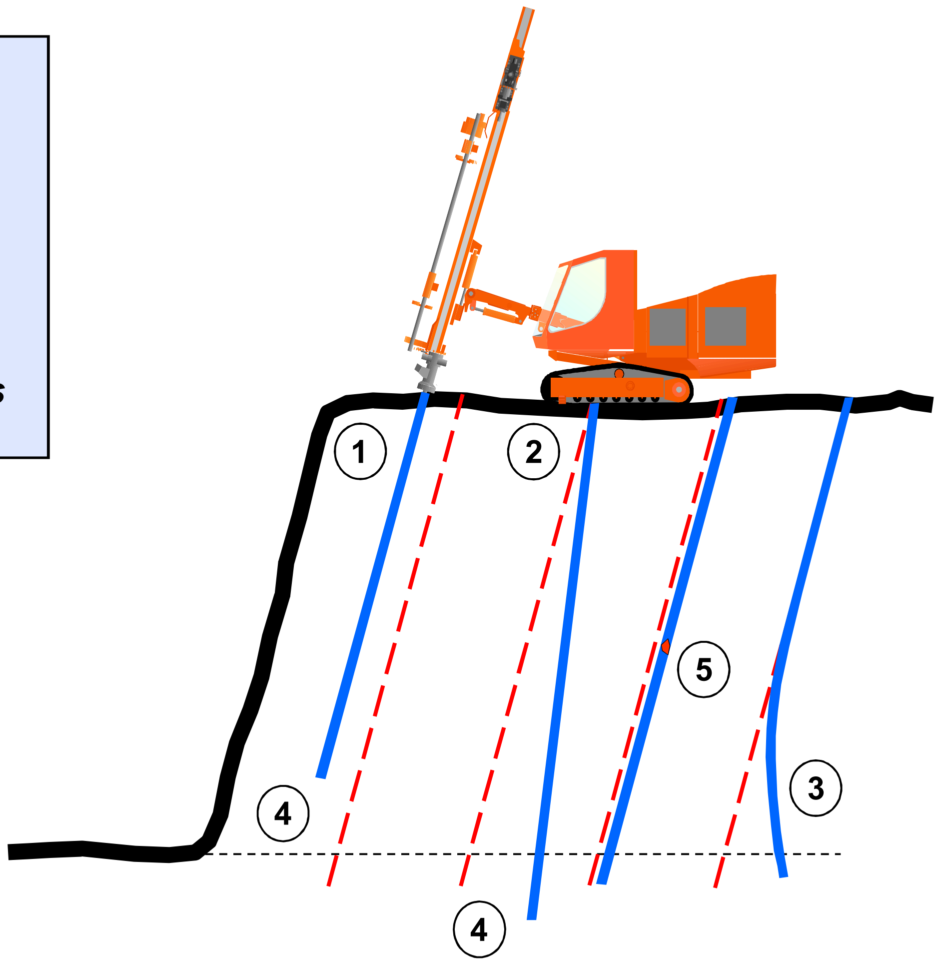


Drilling Management

Accurate drilling gives effective blasting

Sources of drilling error

1. *Marking and collaring errors*
2. *Inclination and directional errors*
3. *Deflection errors*
4. *Hole depth errors*
5. *Undergauge, omitted or lost holes*



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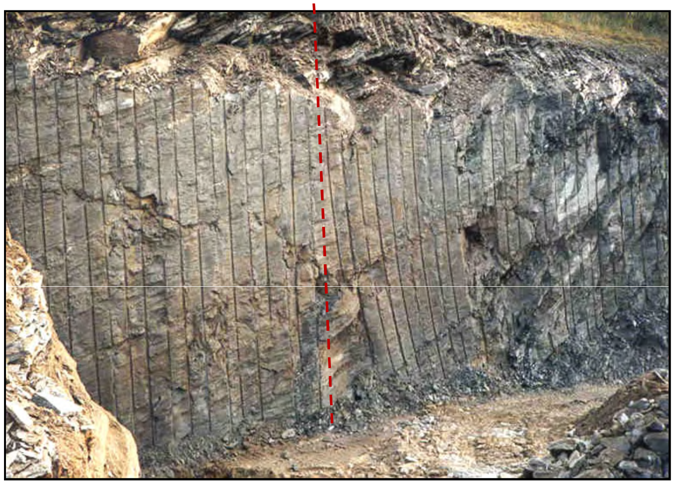
Examples of drill-hole deviation

Deflection with and without pilot tube for Ø3½" DC retrac bit / T51 in micaschist



Directional error Ø3½" retrac bit / T45 in granite

Deflection caused by gravitational sagging of drill steel in inclined holes in syenite

Drilling Management

Lafarge Bath Operations, Ontario

Annual production	*1.6 mill. tonnes*
Rock type	*limestone*

Current program - Pantera DP1500

Bench height	*32 m*
Bit	*Ø115 mm guide XDC*
Drill steel	*Sandvik 60 + pilot tube*
Hole-bottom deflection	*< 1.5 %*
Gross drilling capacity	*67 drm/h*
Drill pattern	*4.5 x 4.8 m^2 (staggered)*
Sub-drill	*0 m (blast to fault line)*
Stemming	*2.8 m*
No. of decks	*3*
Stem between decks	*1.8 m*
Deck delays	*25 milliseconds*
Charge per shothole	*236 kg*
Explosives	*ANFO (0.95 & 0.85 g/cm^3)*
Powder factor	*0.34 kg/bm^3*

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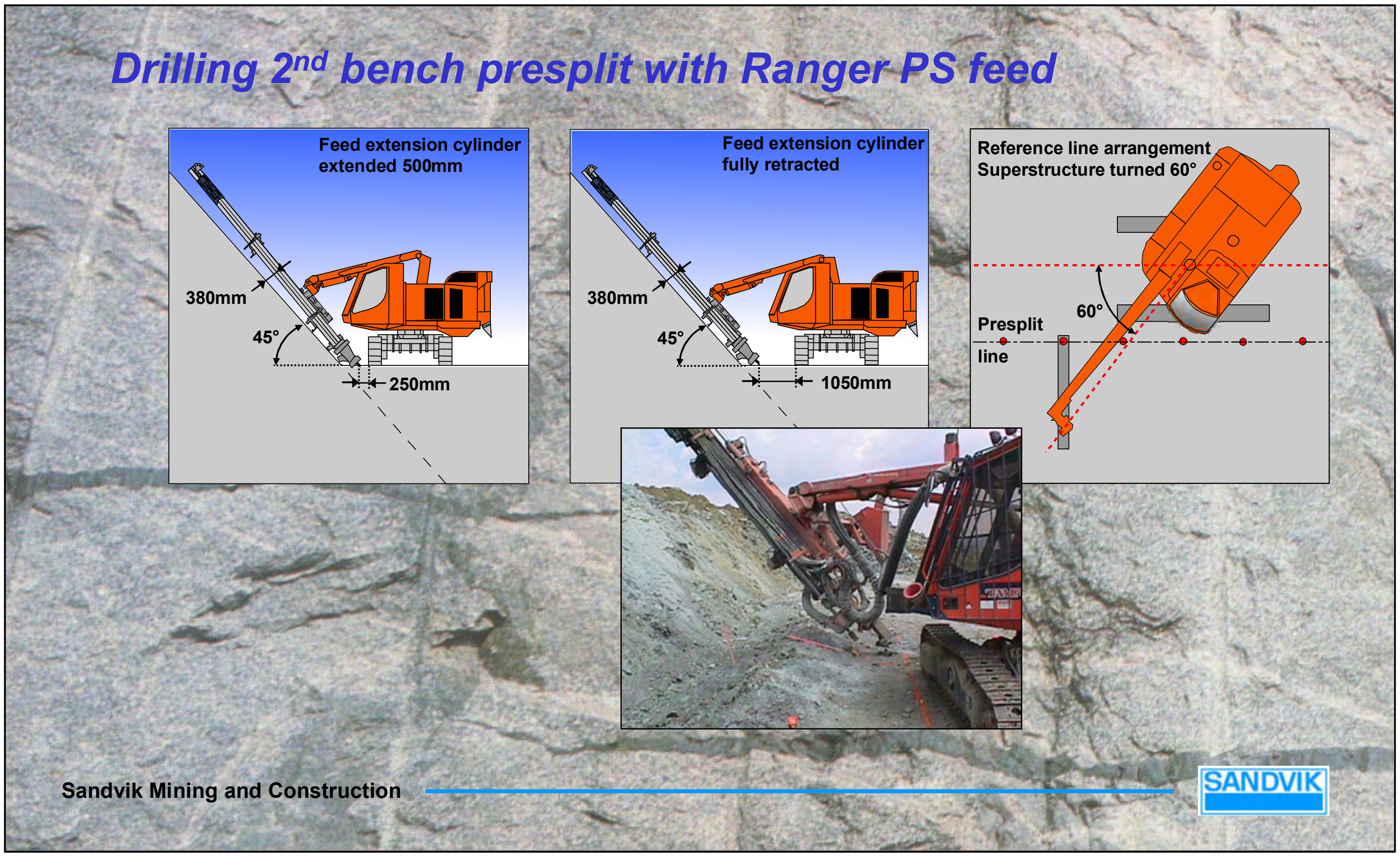
Drilling Management

I-26 Mars Hill Highway Project, North Carolina

D & B excavation volume	*13.7 mill. m^3*
Contractor for presplitting	*Gilbert Southern Corp.*
Equipment for presplitting	*3 x Ranger DX700 with PS feeds*
Bench height	*7.6 m with 40° inclined walls*
Drill steel	*Ø3" retrac / T45*
Target accuracy at hole bottom	*152 mm at 10.0 m or 15.2 mm/m*
Rock type	*biotite-granite gneiss*

Drilling Management

I-26 Mars Hill Highway Project, North Carolina



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