

# **Drilling Applications**

**Arne Lislrud – Bill Hissem**



**Improving Processes. Instilling Expertise.**

# Drilling Management

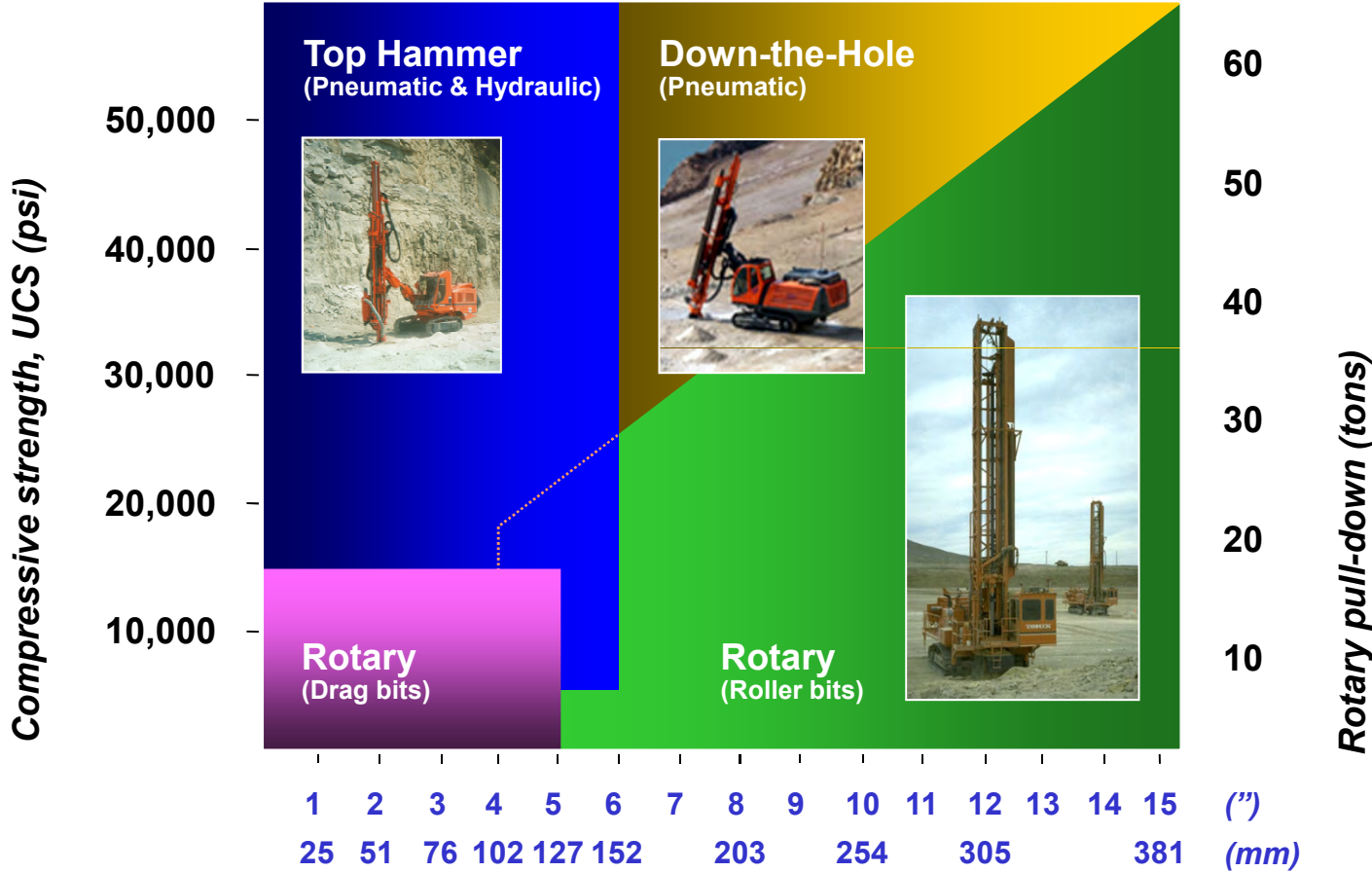
## *Agenda for presentation*

- *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*



# Drilling Management

*The most common drilling methods in use*



# Drilling Management

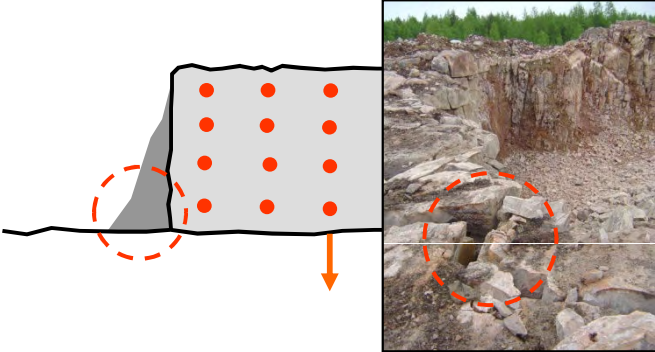
## Difficult drilling conditions

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

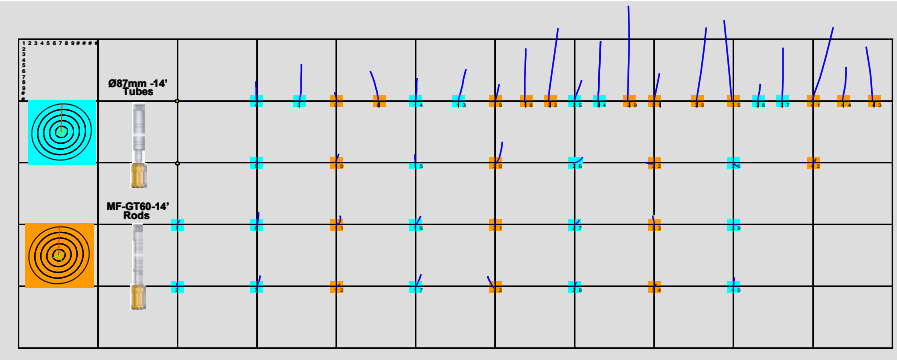
### Collaring



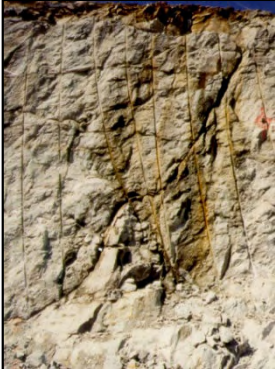
### Open corner damage



### 1st row drilling

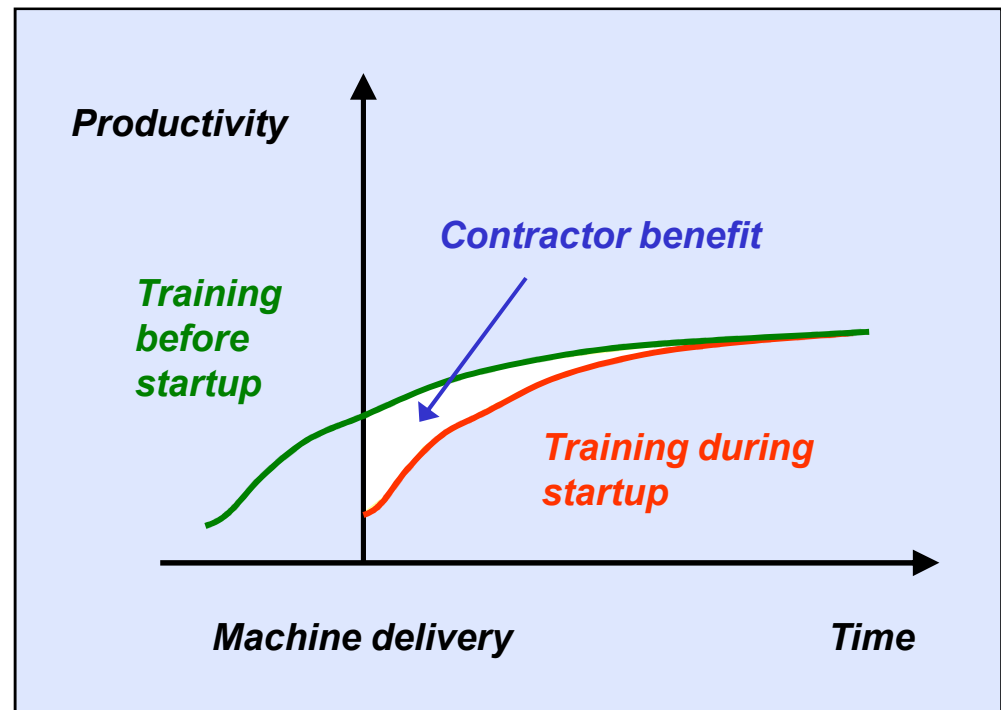
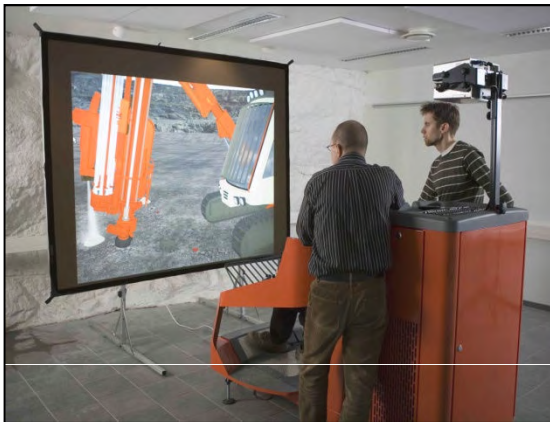


### Drilling in open joints



# Drilling Management

## 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)***



# 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*

**OYO**

# Seeing is more than Believing

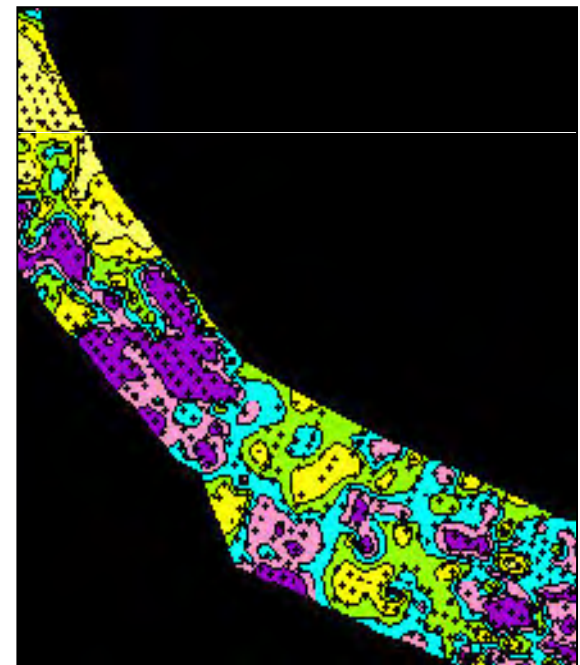
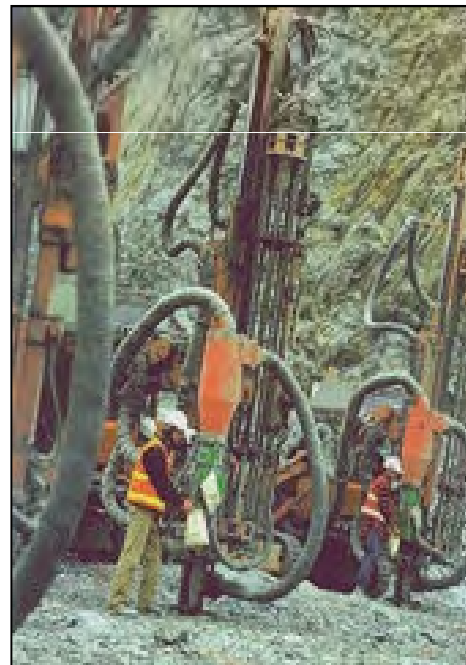
BP-170 is a L-shaped, 10" diameter, 14' long system.

BP-170

You may obtain a vast amount of information if you apply the BP-170 to see and record the inside wall of borehole "as is". "seeing and recording" the inside wall of borehole with orientated information of joints, beddings, cleavages, faults, fractures and all features will revolutionarily improve the role of exploration boring.

Borehole television BP-170 system makes it possible to obtain 360 degree unrolled borehole wall image and store information in the computer memories. Then necessary processing and analysis of the geological structures, rock fabrics, fracture distribution, and so forth can be easily carried out. The BP-170 system is a joint development of KAXX and OYO.

**OYO CORPORATION**  
24 Kusanaka 4-chome, Choshi-ku, Tokyo 102 JAPAN  
Telephone: +81-3-5211-0811 E-mail: oyokyo@nmail.com



# Drilling Management

## *Occupational health and safety*

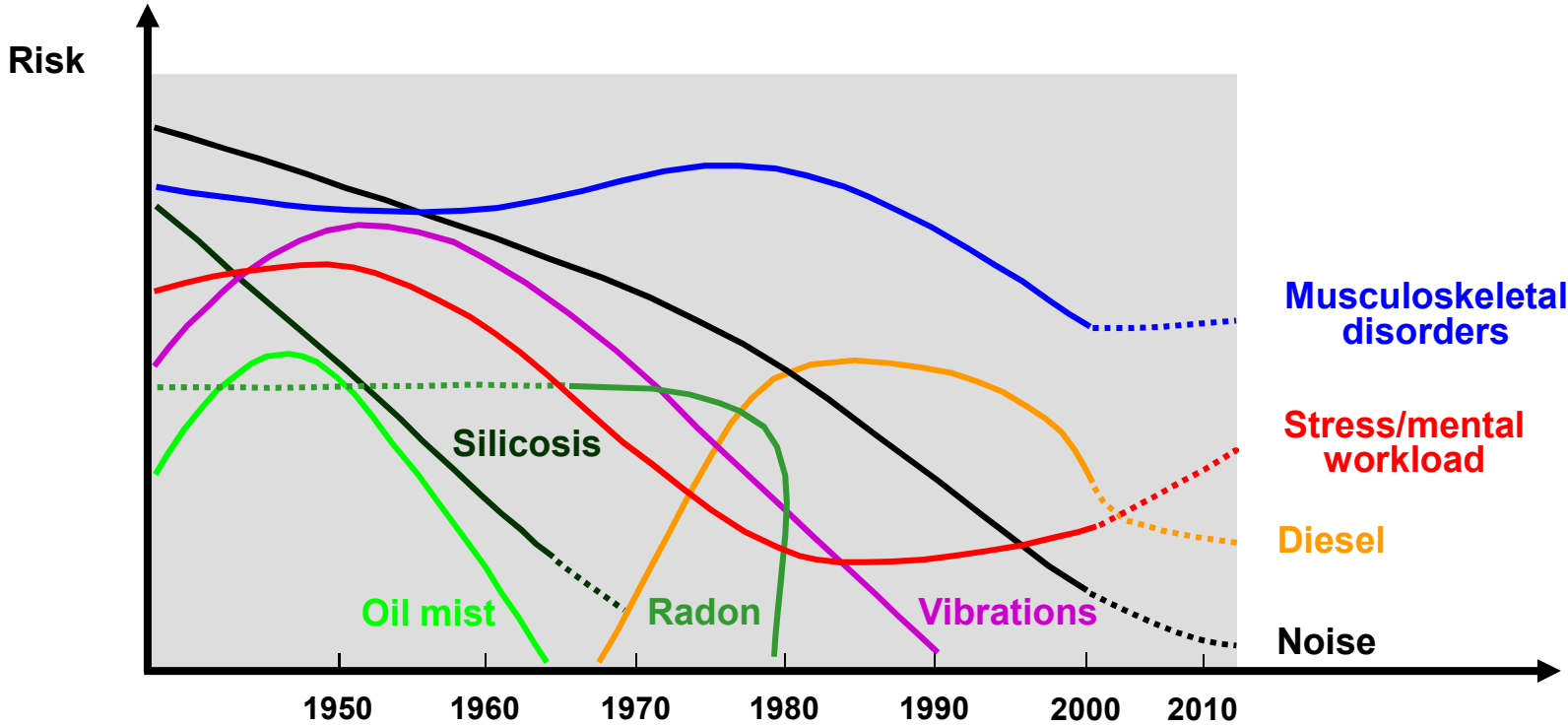
- *work related accidents for:*
    - ✓ *mobile equipment*
    - ✓ *hazardeous work areas*
  - *emissions control*
  - *noise control*
  - *dust control*
  - *fly rock / charging / straight-hole drilling*
  - *falling rocks / wall control*
- ⇒ *safety is linked as much to equipment as it is to attitudes*
- ⇒ *health, safety and environmental issues are everyone's concern*
- ⇒ *the ultimate safety target is zero harm – not just a minimum occurrence of accidents*





# Drilling Management

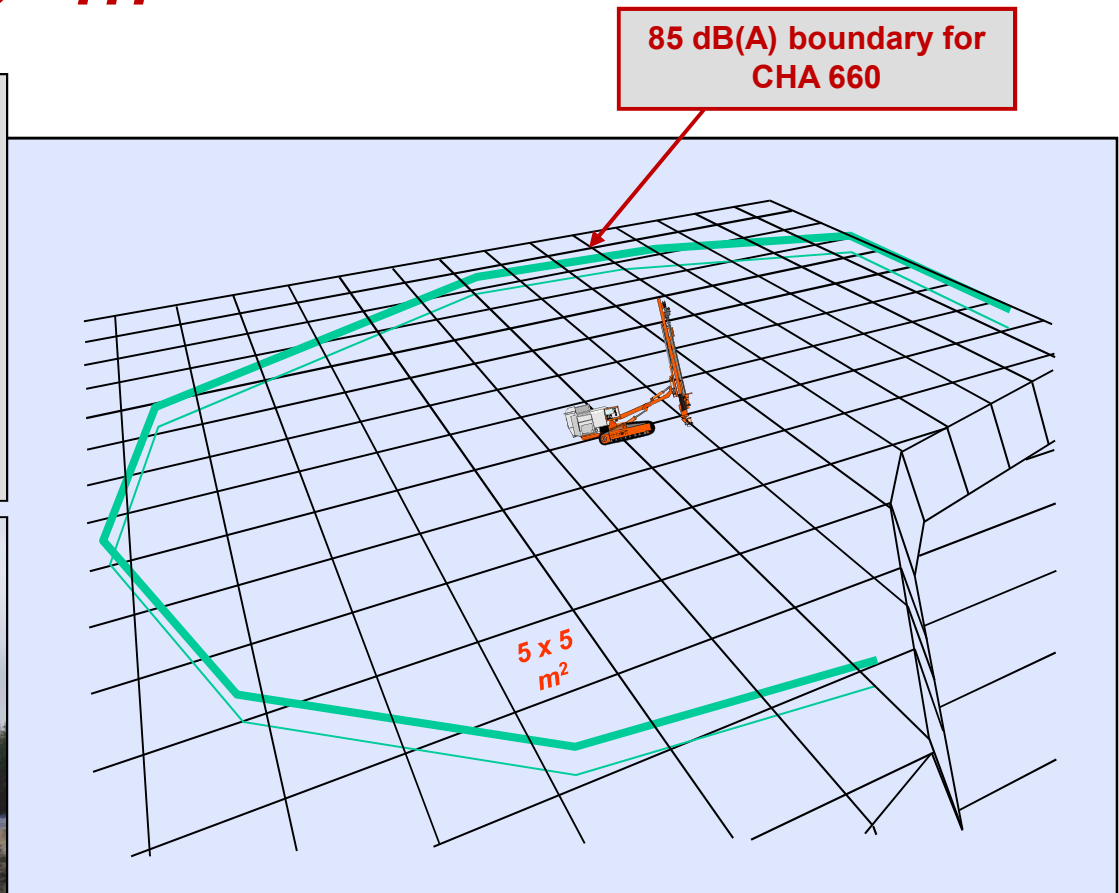
*General assessment of some health risks by Swedish authorities (UG + SF)*



# 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



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**



# Drilling Management

## Selecting drilling tools - TH

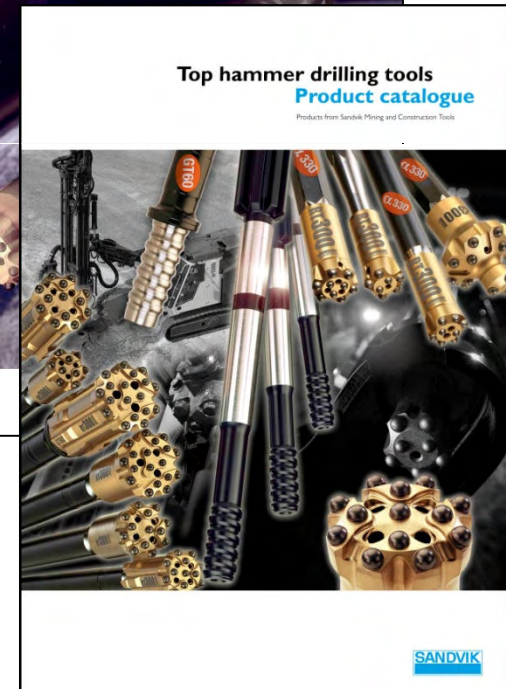
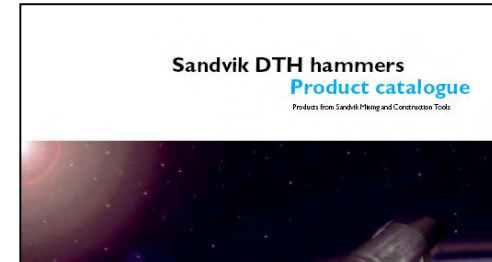
- bit face and skirt design
- button shape, size and cemented carbide grade
- drill string components
- grinding equipment and its location at jobsite

**Bench drilling**  
T51 (2")

Buttons	Front		Rear		Skirt	Angle	Material	Part No.
	No. Dia	No. Dia	No. Dia	No. Dia				
Button bit	3/12	1/8	3/12	1/8	3/8	12°	MCV	T08-2098-S45
Button bit, Drop-Center	4/17	1/8	4/17	1/8	3/8	12°	MCV	T08-2099-S45
Button bit, Retrac.	4/17	1/8	4/17	1/8	3/8	12°	MCV	T08-2098-S45
Button bit, Retrac., Drop-Center	4/17	1/8	4/17	1/8	3/8	12°	MCV	T08-2099-S45
Button bit, Retrac., Flat-Back	4/17	1/8	4/17	1/8	3/8	12°	MCV	T08-2098-S45

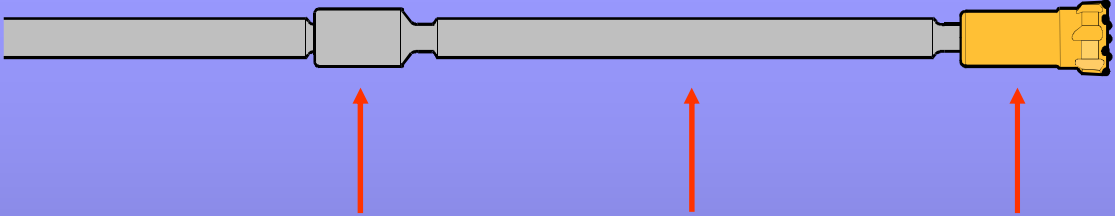
**Bench drilling**  
T51 (2")

Dimensions	L	B	D	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	D <sub>6</sub>	Part No.	
										Material	Part No.
Guide tube	100	100	25	25	25	25	25	25	25	25	T08-2098-S45
Extension rod	100	100	25	25	25	25	25	25	25	25	T08-2099-S45
Button bit	100	100	25	25	25	25	25	25	25	25	T08-2098-S45



# Drilling Management

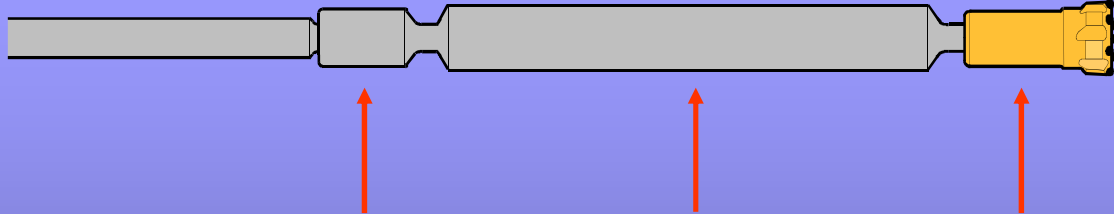
## *Optimum bit / rod diameter relationship - TH*



Thread	Cross section coupling	Cross section	Optimum bit size
R32	Ø44	Ø32	Ø51
T35	Ø48	Ø39	Ø57
T38	Ø55	Ø39	Ø64
T45	Ø63	Ø46	Ø76
T51	Ø71	Ø52	Ø89
GT60	Ø82	Ø60	Ø92
GT60	Ø85	Ø60/64	Ø102

# Drilling Management

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



Thread	Cross section coupling	Cross section	Optimum bit size
T38	Ø55	Ø56	Ø64
T45	Ø63	Ø65	Ø76
T51	Ø71	Ø76	Ø89
GT60	Ø85	Ø87	Ø102
GT60	Ø85	Ø102	Ø115

# Drilling Management

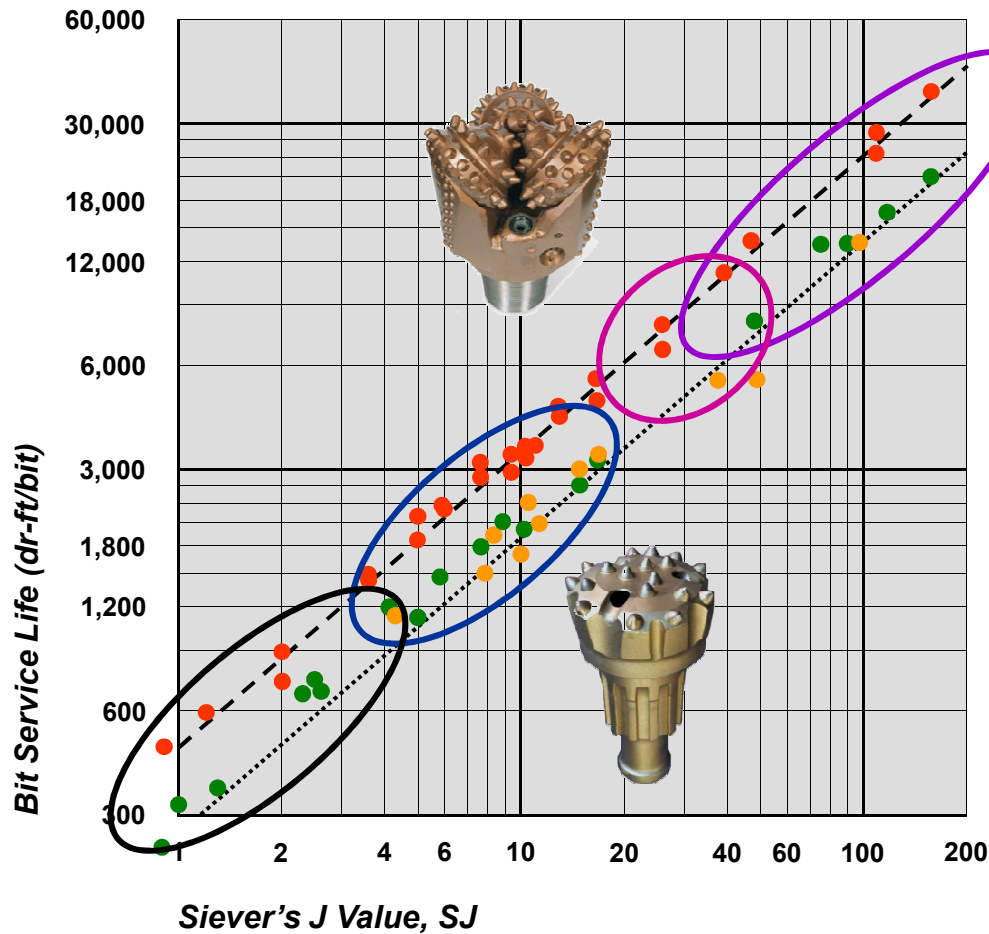
## *KPI's for drill steel follow-up work*

- *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<sup>3</sup>*



# Drilling Management

## Trendlines for bit service life



- Rotary Drilling -  $\text{Ø}12\frac{1}{2}''$  / Std.
  - DTH \*
  - Tophammer \*
- \* Bit service life highly dependent on regrind intervals – regard curve as toplimit

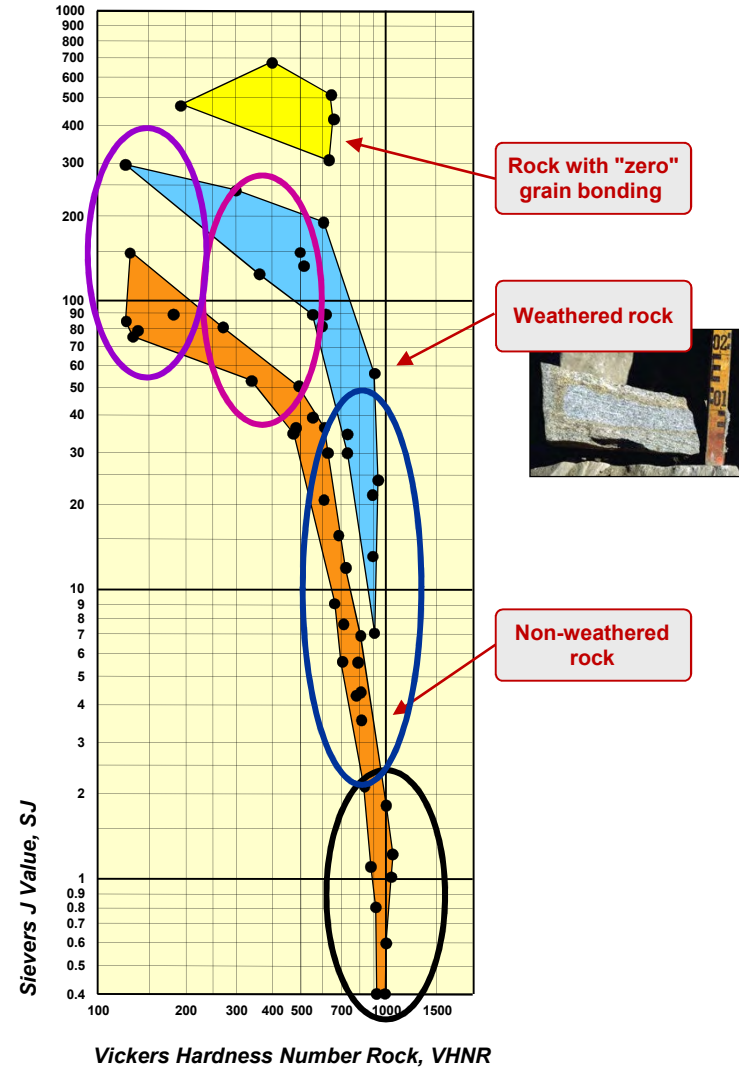
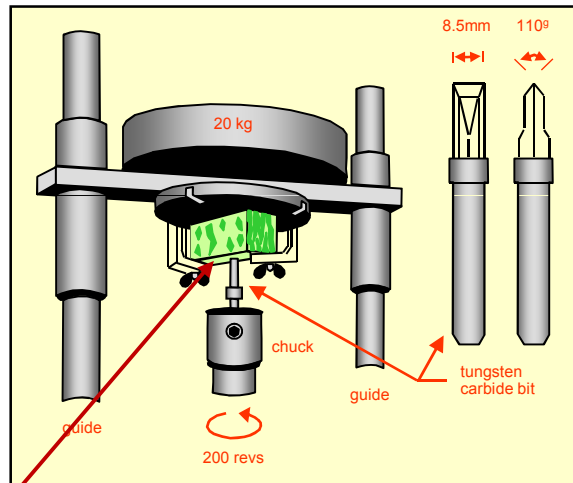
- Limestone
- Dolomite
- Granite
- Quartzite



# Drilling Management

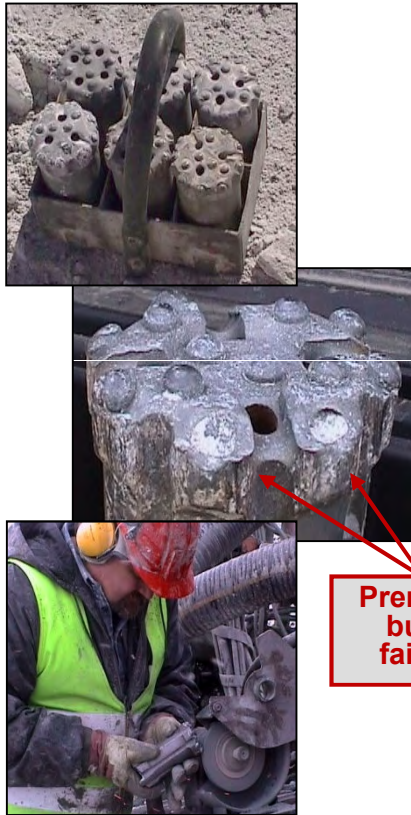
## Relationship SJ and VHNR

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

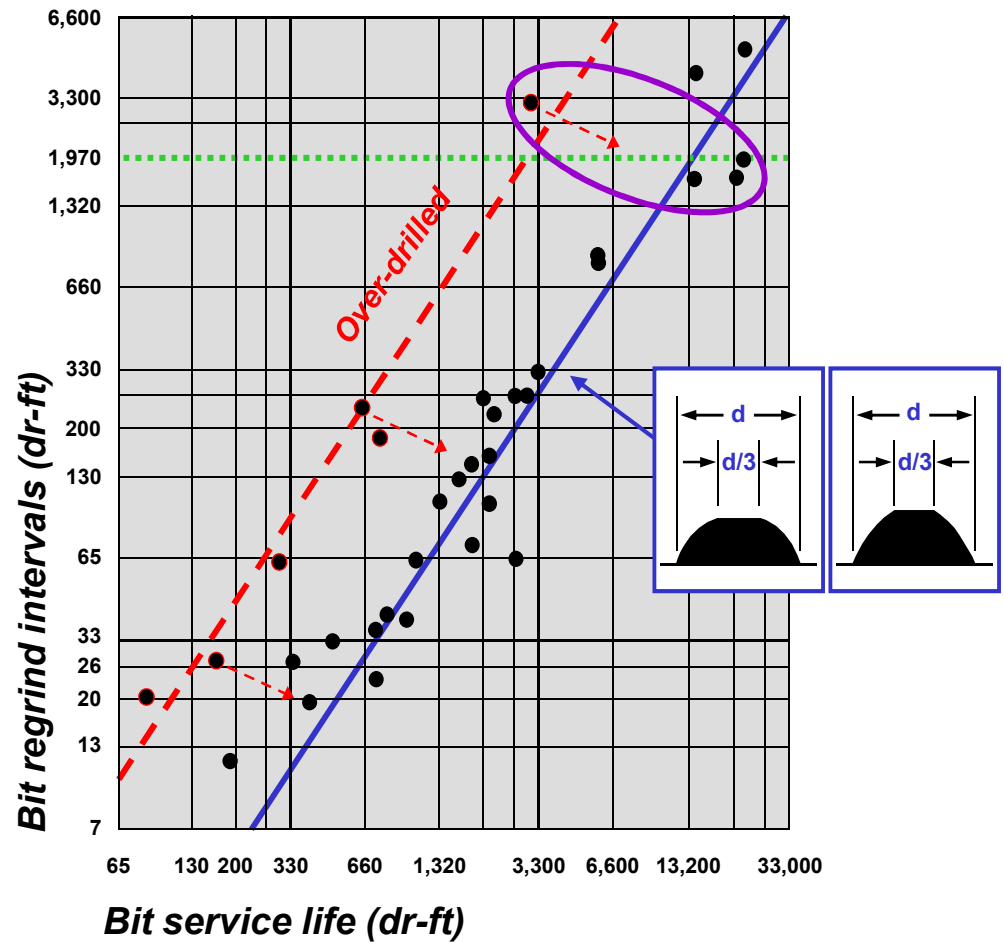


# Drilling Management

## Bit regrind intervals, bit service life and over-drilling

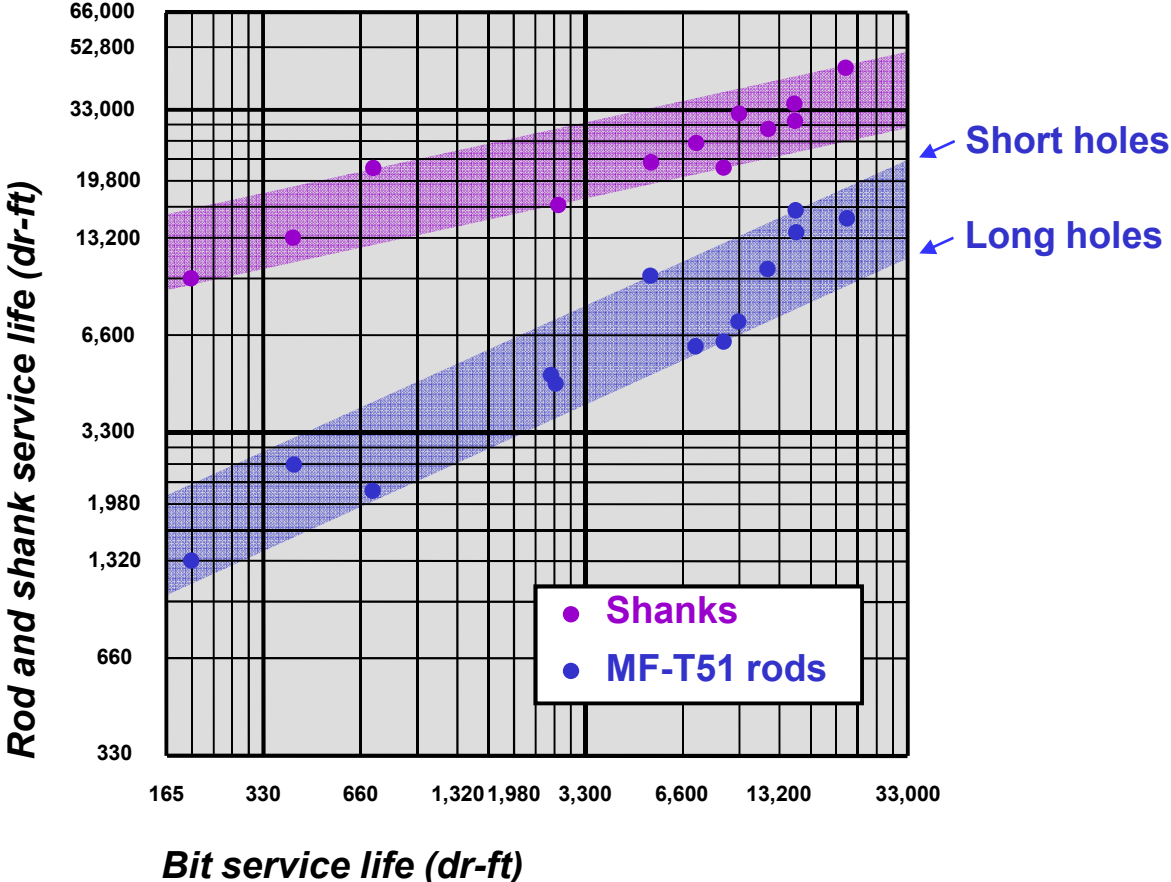


Premature  
button  
failures



# Drilling Management

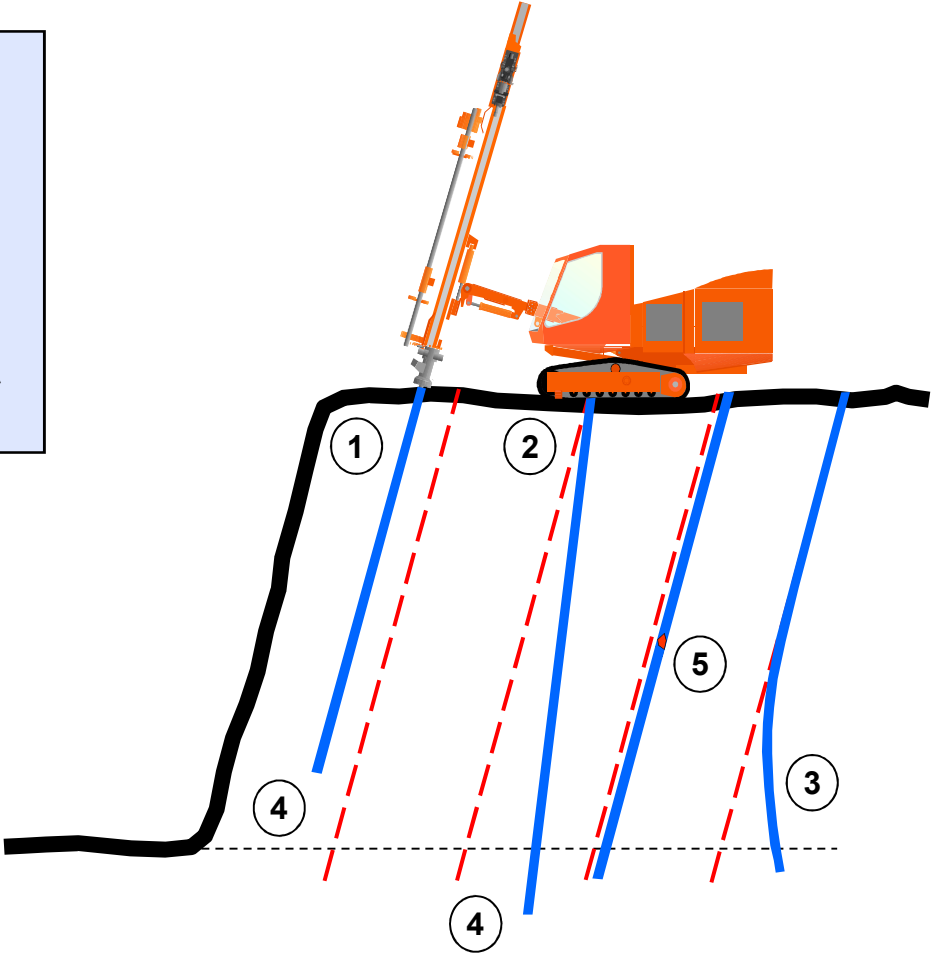
## Example of drill steel followup for MF-T51



# 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*



# Drilling Management

## Examples of drill-hole deviation

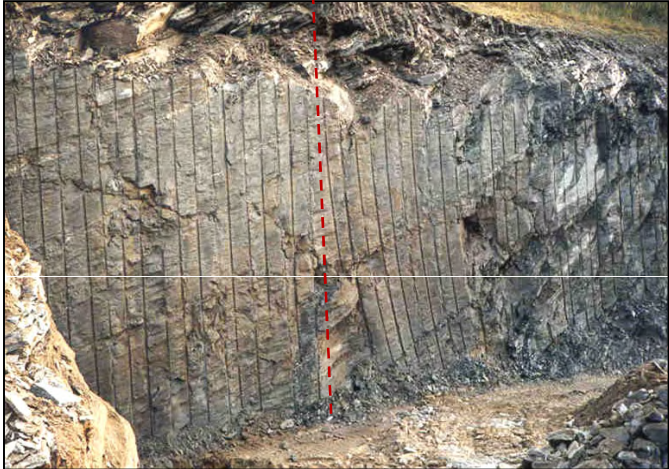


Directional error  $\text{Ø}3\frac{1}{2}$ " retrac bit / T45 in granite



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

Deflection with and without pilot tube for  $\text{Ø}3\frac{1}{2}$ " DC retrac bit / T51 in micaschist



# Drilling Management

## Lafarge Bath Operations, Ontario

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

### **Current program - Pantera DP1500**

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

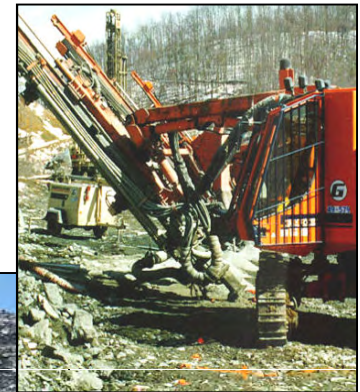


# Drilling Management

## I-26 Mars Hill Highway Project, North Carolina

*D & B excavation volume*  
*Contractor for presplitting*  
*Equipment for presplitting*  
*Bench height*  
*Drill steel*  
*Target accuracy at hole bottom*  
*Rock type*

*13.7 mill. m<sup>3</sup>*  
*Gilbert Southern Corp.*  
*3 x Ranger DX700 with PS feeds*  
*7.6 m with 40° inclined walls*  
*Ø3" retrac / T45*  
*152 mm at 10.0 m or 15.2 mm/m*  
*biotite-granite gneiss*



# Drilling Management

## I-26 Mars Hill Highway Project, North Carolina

*Drilling 2<sup>nd</sup> bench presplit with Ranger PS feed*

**Feed extension cylinder extended 500mm**  
380mm  
45°  
250mm

**Feed extension cylinder fully retracted**  
380mm  
45°  
1050mm

**Reference line arrangement**  
Superstructure turned 60°  
60°  
Presplit line

Sandvik Mining and Construction