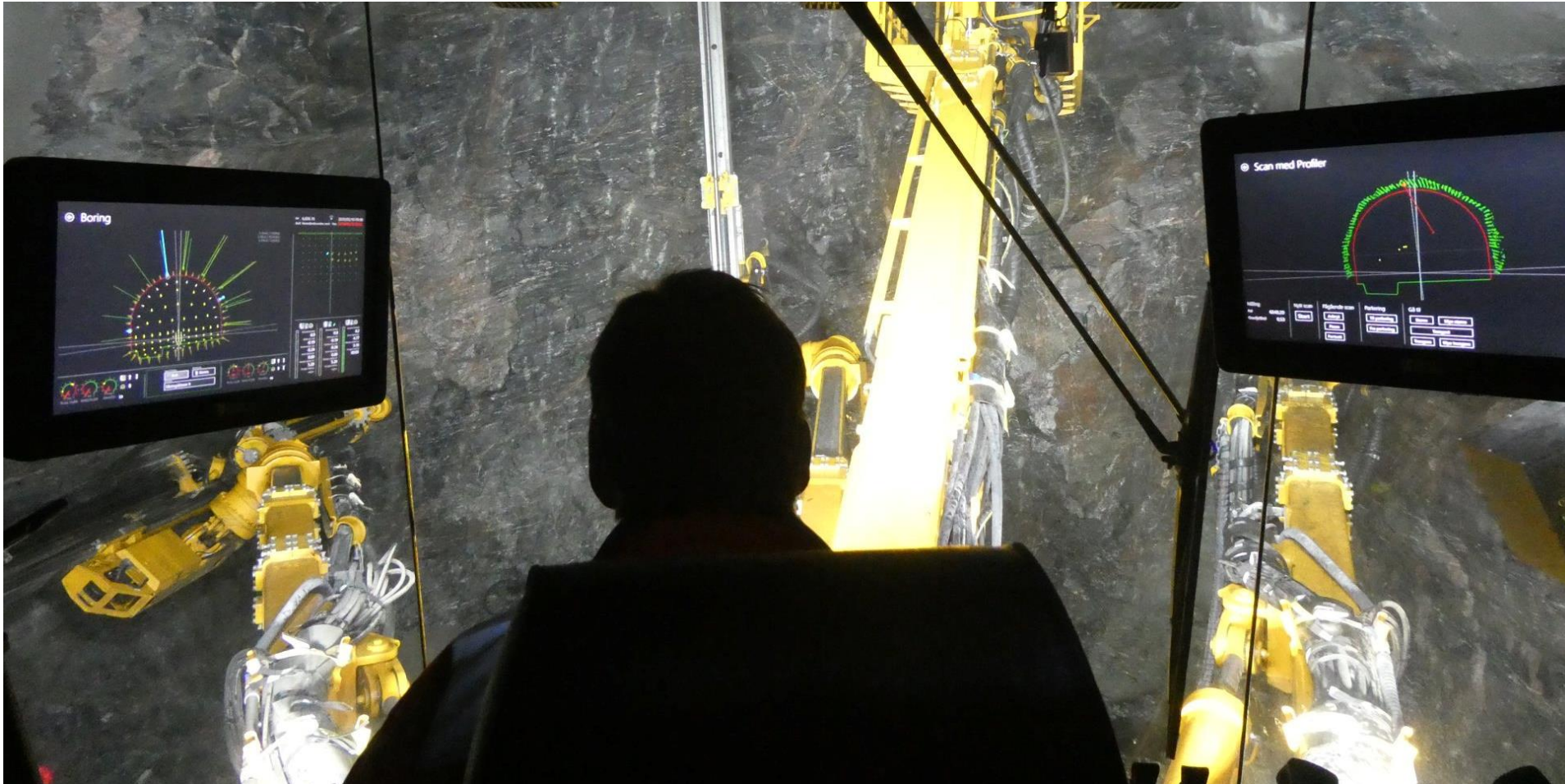


COMPUTERIZED TUNNELING

CLOUD BASED MANAGEMENT OF DRILL AND BLAST OPERATIONS

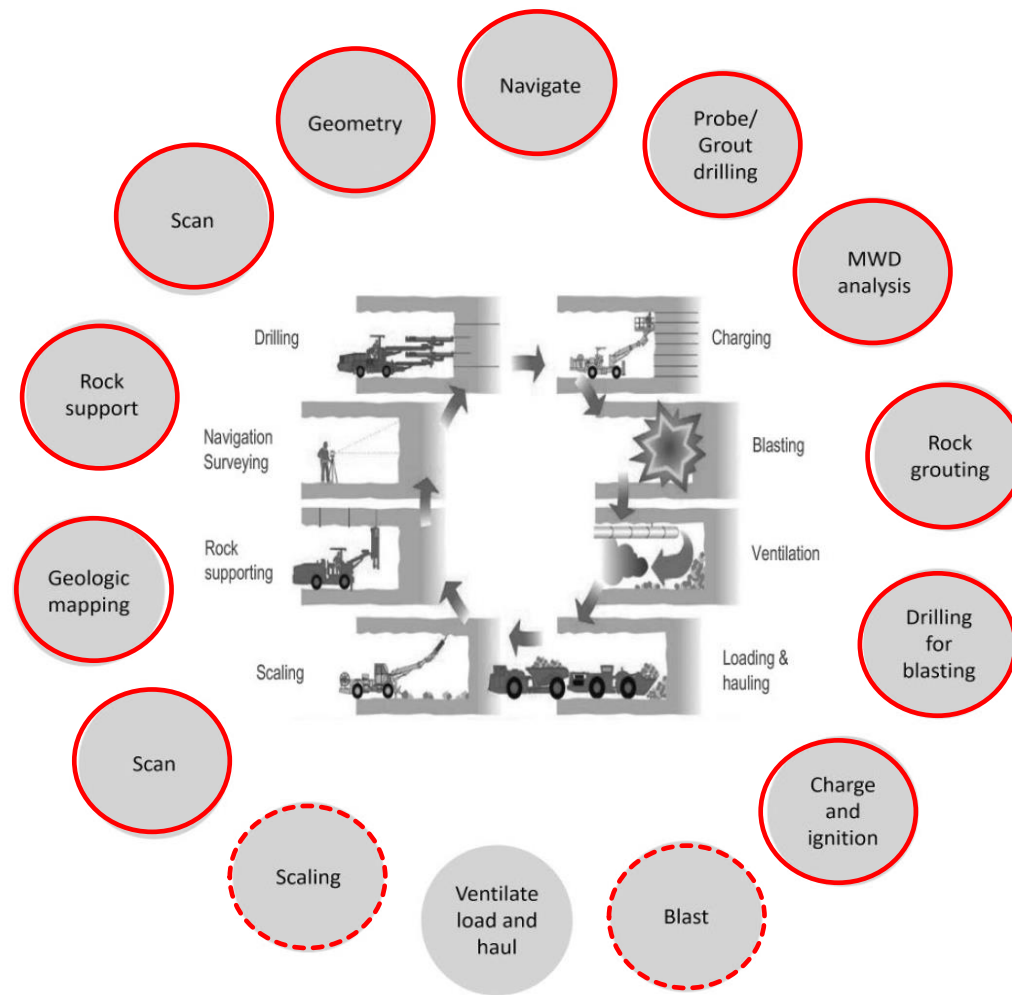
MEASURE – CONTROL – OPTIMIZE - DOCUMENT



Bever Control

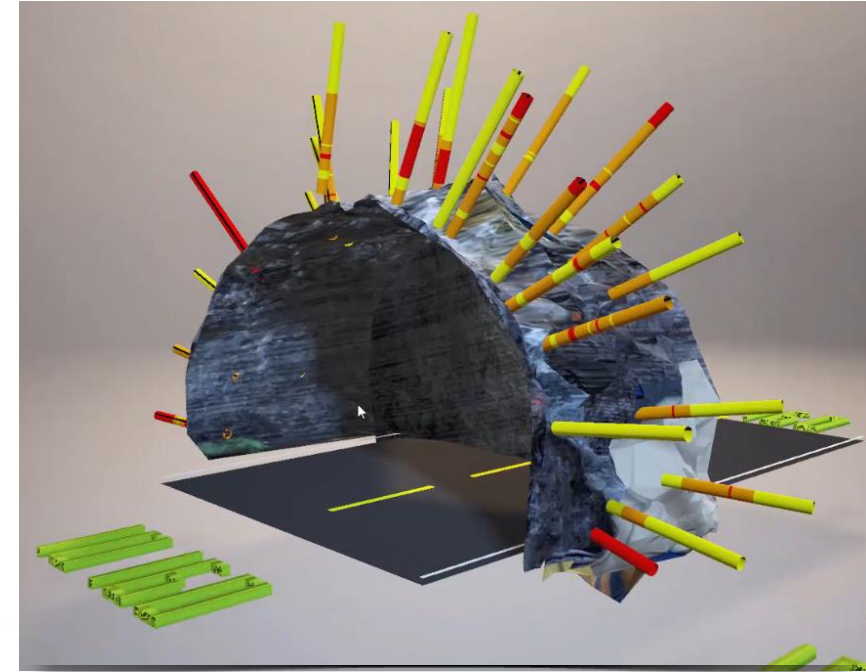
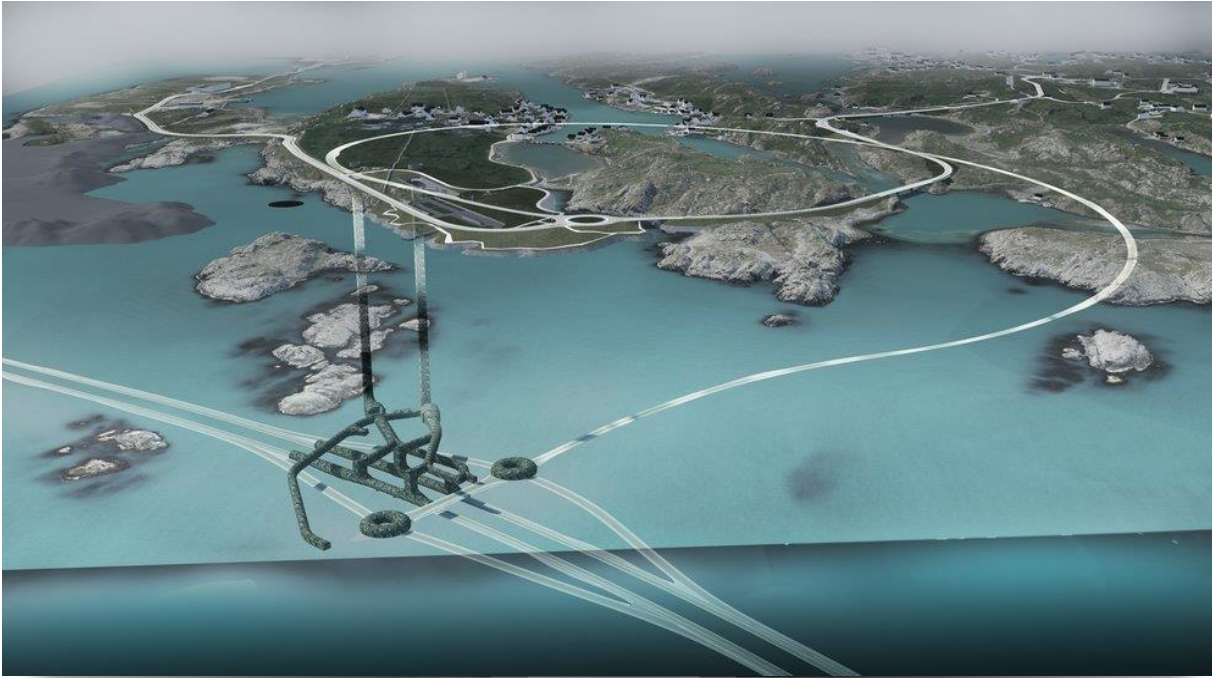
- Founded 1982
- Pioneered computerized drilling
- Software and automation technology for underground applications
- Independent company
- Headquarter Oslo, Norway

Fiskumskiftet på Færøyene



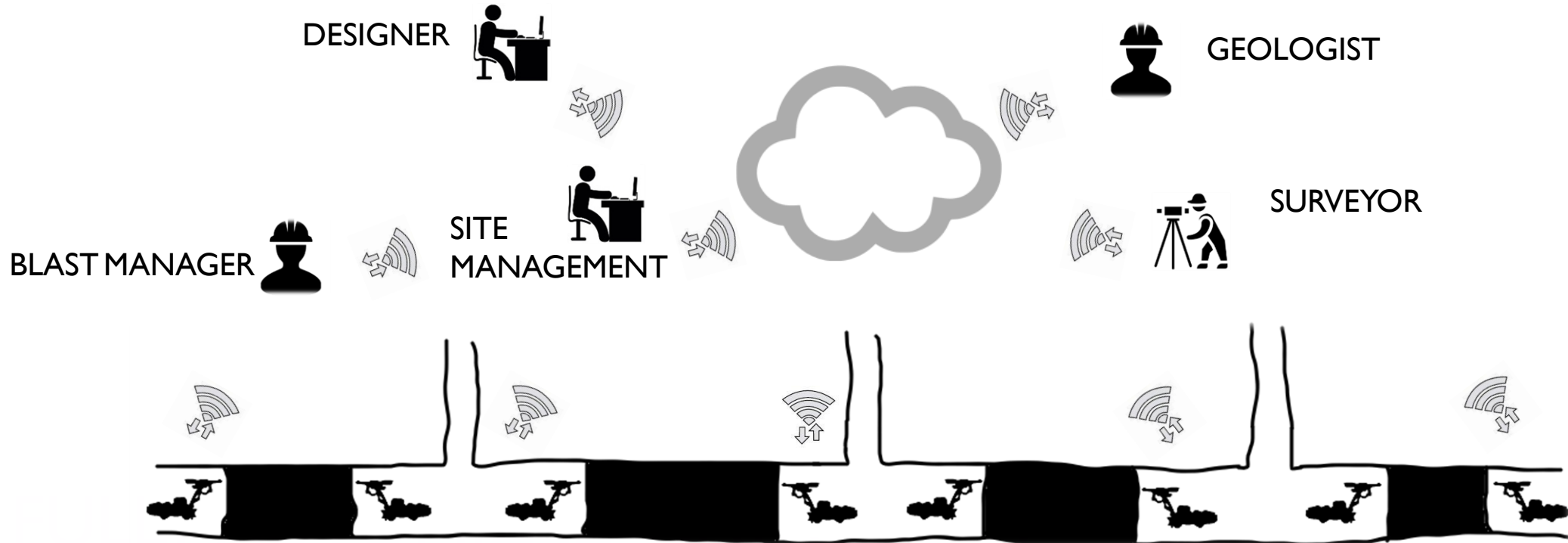
CONTENT

- Digital twin
- Connected machinery
- Web platform – cloud solution
- Production planning
- Data capturing, flow and analysis
- Quality control
- Productivity analysis
- Artificial intelligence in drill and blast operation



DIGITAL TWIN

- Planning
- Construction phase
- As-Built
- MOM – Management, operation and maintenance.



AUTOMATIC TRANSFER OF DATA TO AND FROM UNDERGROUND SITE

CONSTRUCTION PHASE

- Full internet connectivity on face

Drill rig



Grouting rig



Scanner / profiler



Charging unit

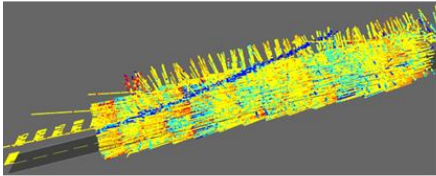


Shotcrete robot

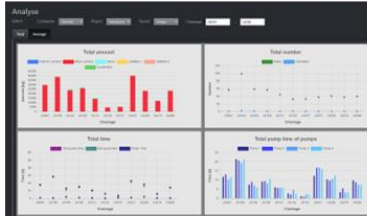


Data processing

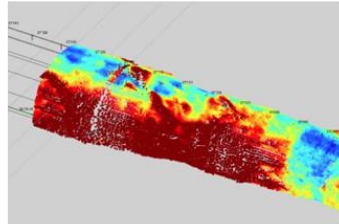
MWD



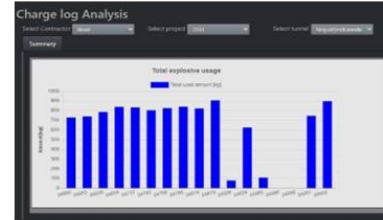
Grouting data



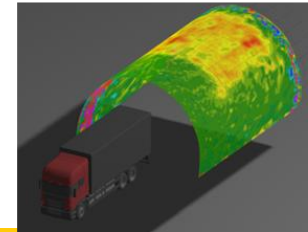
Scan



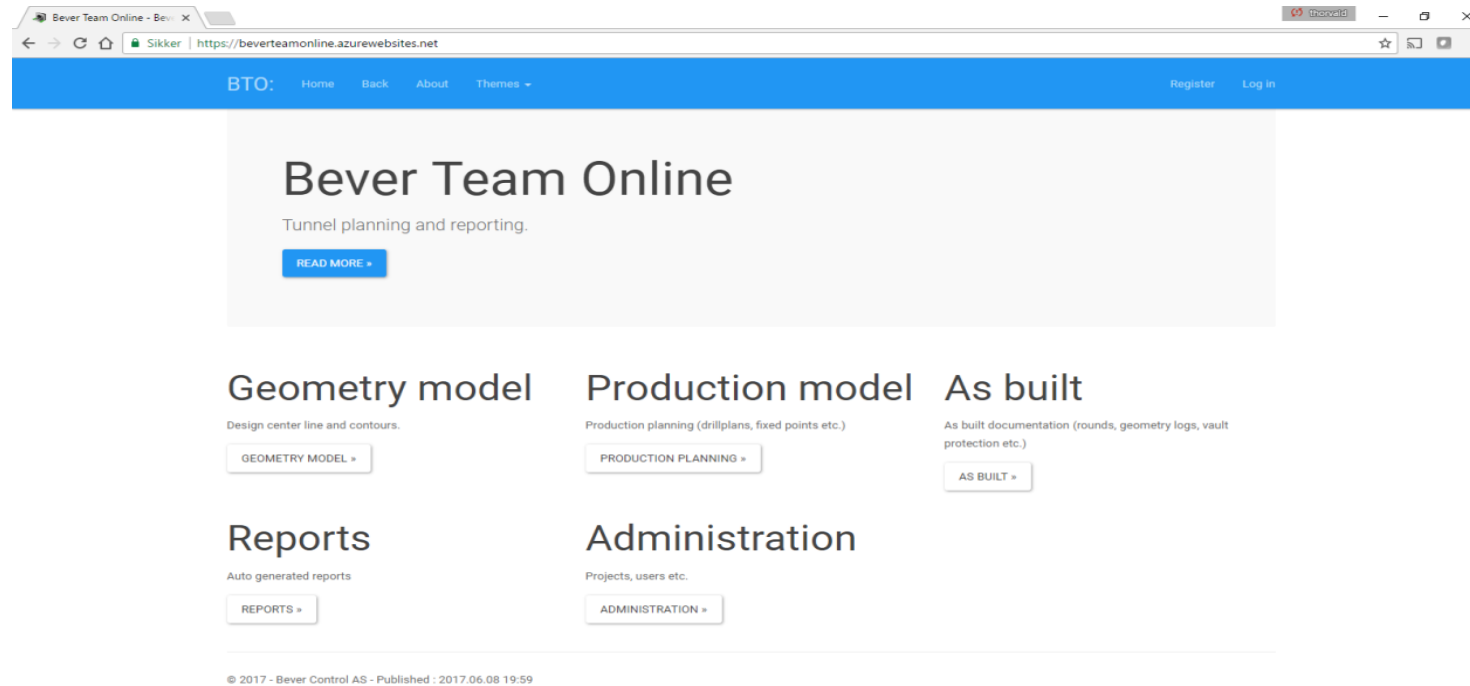
Charging



Shotcrete thickness



- Collecting all data to central data center
- Near real time online presentation
- Automatic report generation

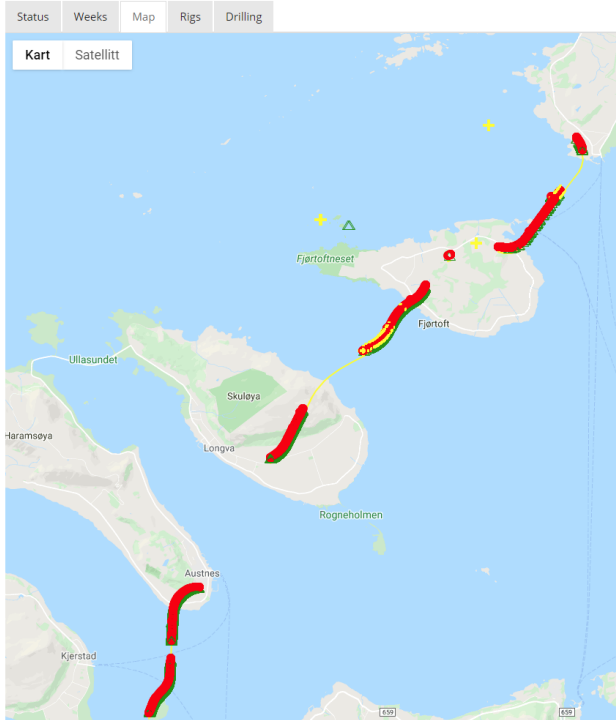


SECURE WEB PORTAL

- SaaS - cloud computing
- Automatic dataflow
- Automatic reporting
- Suitable for small and big scale projects

TUNNEL GEOMETRY

Project



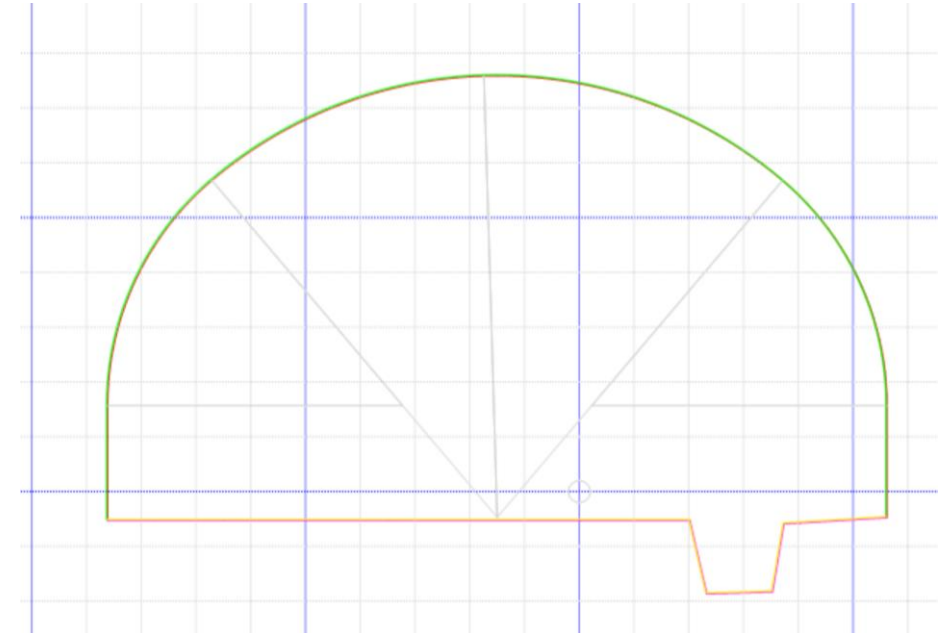
Bever Team Online - Be- X
 Sikker | <https://beverteamonline.azurewebsites.net>

Tunneler

Legg til | Kartverket / NGU

Tunnel navn	Type tunnel	Delta (m)	Konturer Alias Horizontal Vertikal Dosering Rediger Slett Detaljer
10400N	Hovedlep	5.000	Konturer Alias Horizontal Vertikal Dosering Rediger Slett Detaljer
10500S	Hovedlep	5.000	Konturer Alias Horizontal Vertikal Dosering Rediger Slett Detaljer
Tek_bygg	Annet	5.000	Konturer Alias Horizontal Vertikal Dosering Rediger Slett Detaljer
TT1-71300	Rammingsstunnel	5.000	Konturer Alias Horizontal Vertikal Dosering Rediger Slett Detaljer
TT2-71200	Rammingsstunnel	5.000	Konturer Alias Horizontal Vertikal Dosering Rediger Slett Detaljer
TT3-71100	Rammingsstunnel	5.000	Konturer Alias Horizontal Vertikal Dosering Rediger Slett Detaljer
TT4-71000	Rammingsstunnel	5.000	Konturer Alias Horizontal Vertikal Dosering Rediger Slett Detaljer

Skala: 200:1 m



DRILL PLAN

Drillplan - Bever Team

https://beverteamonline.azurewebsites.net/Drillplans/Drillplan/15234

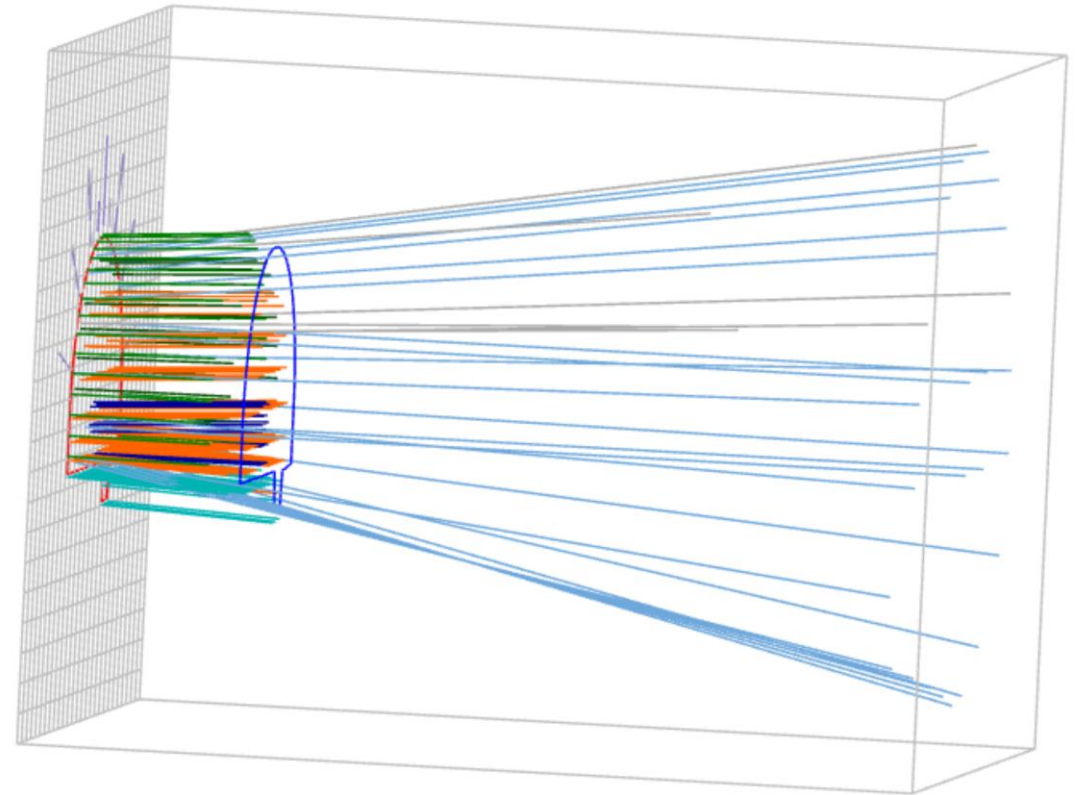
BT: E39 Lyngdal Øst - Ly Home Back About Themes

Select method: Velg...
 Select what: Holes

Alt Move
 Ctrl Move collar
 Alt + Ctrl Adjust lookout
 Alt + Ctrl + Shift Measure

Add View all XYZ Copy Paste Delete all Cancel Apply

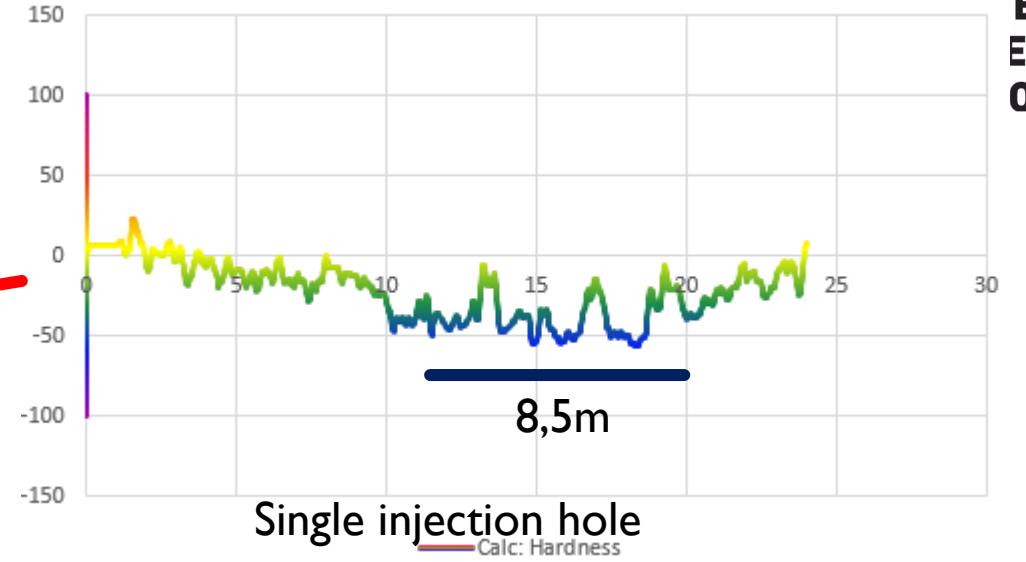
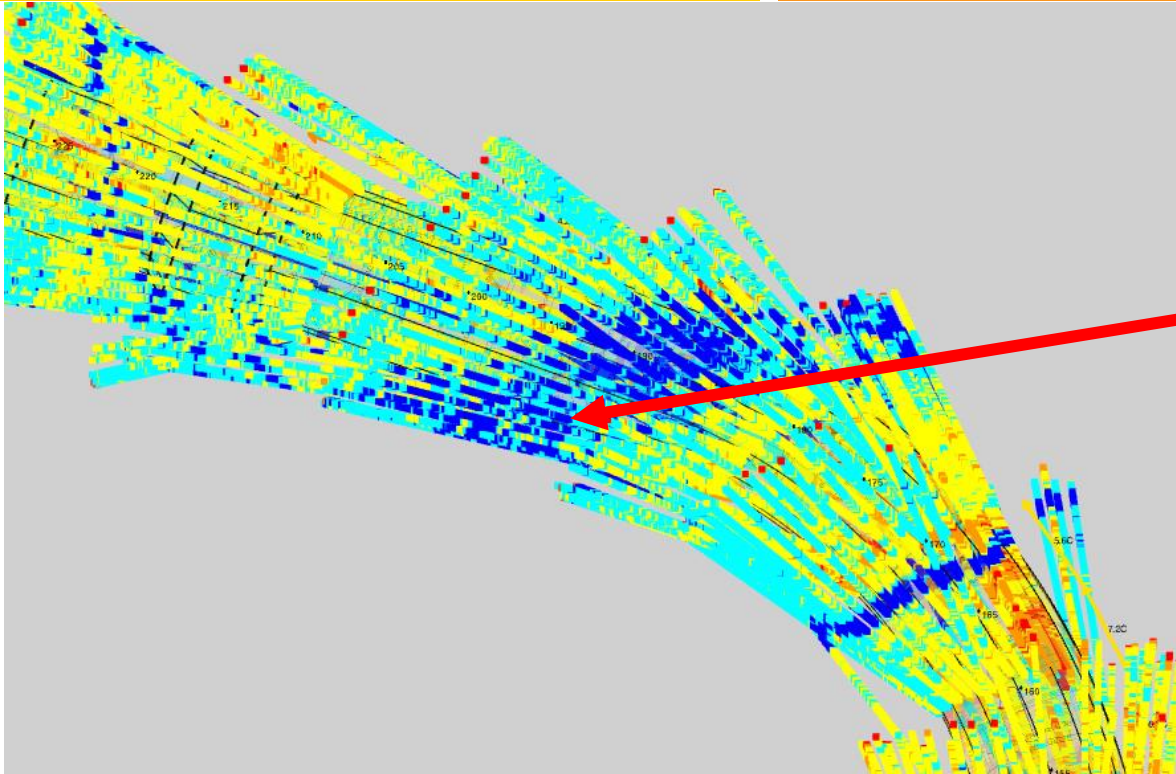
Right (m)	Up (m)	Lookout (m)	Length (m)	Direction (deg)	Holetype
1.354	6.519	5.003	29.500	106.124	Injection ▼ Delete



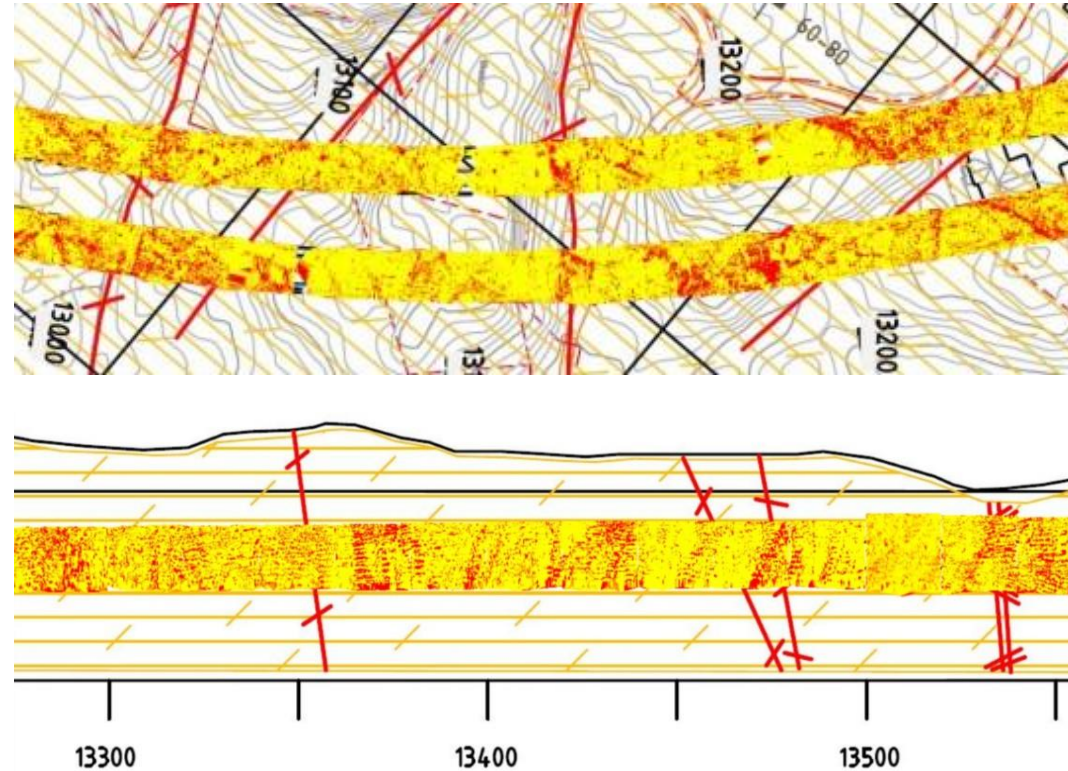
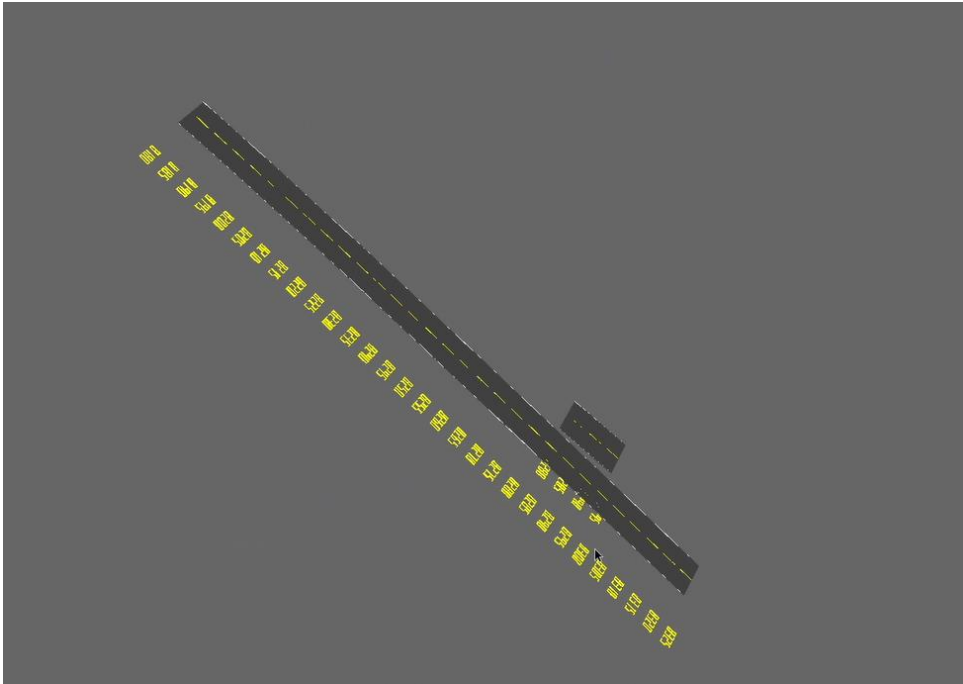
COMPUTERIZED DRILLING



- Less over and underbreak
- Faster production
- Reduced material cost
- Lower environmental impact
- Accurate documentation



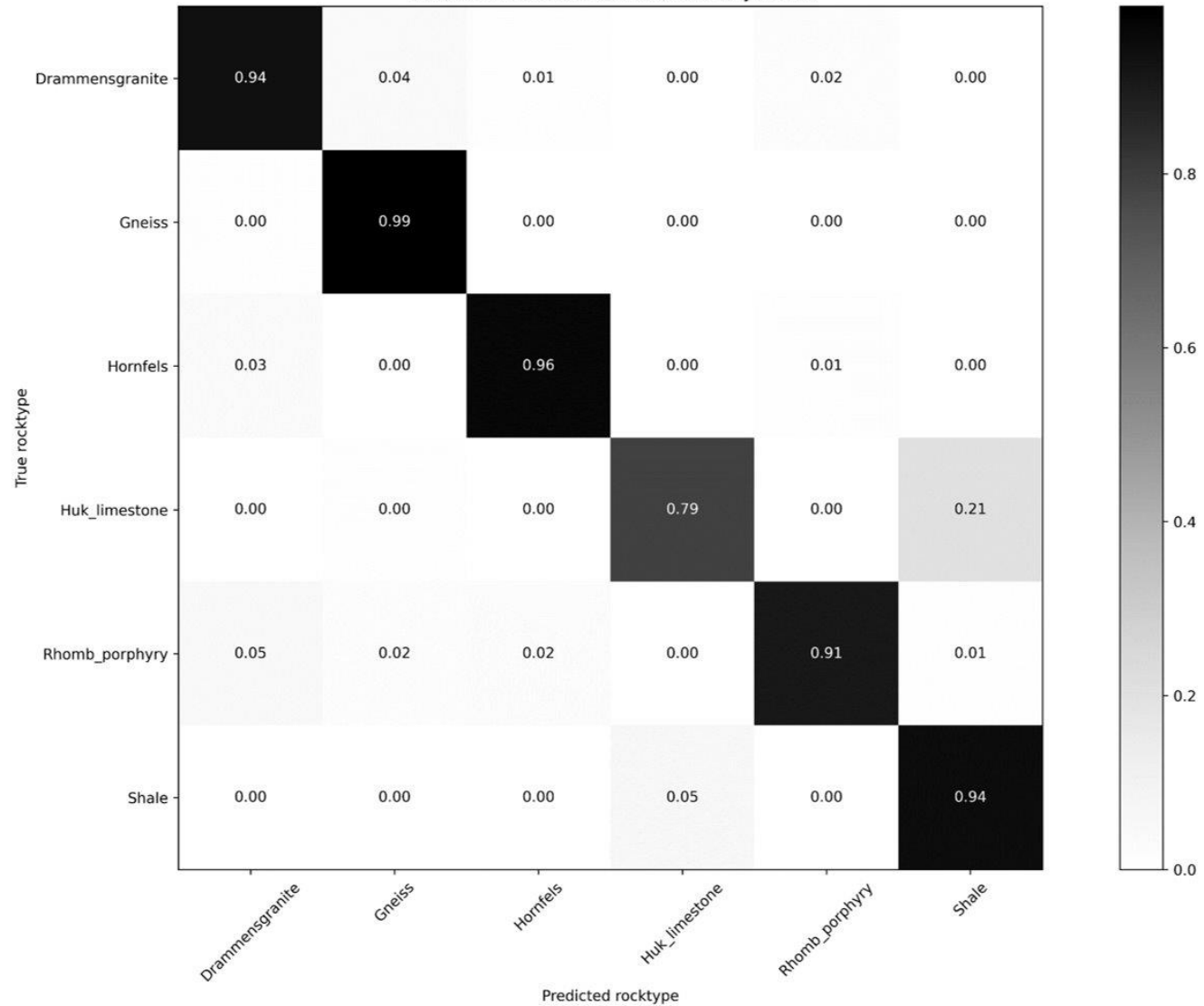
- Large intrusion that causes stability problems
- Melting zone, very fractured rock



MEASUREMENT WHILE DRILLING (MWD) ANALYSIS – NEAR REAL TIME RESULTS AVAILABLE

- Using drilling data to calculate models for
 - Hardness
 - Fracturing
 - Water disturbances
- Usage
 - Optimize drill and blast
 - Precise geological mapping
 - Planning of rock support and grouting

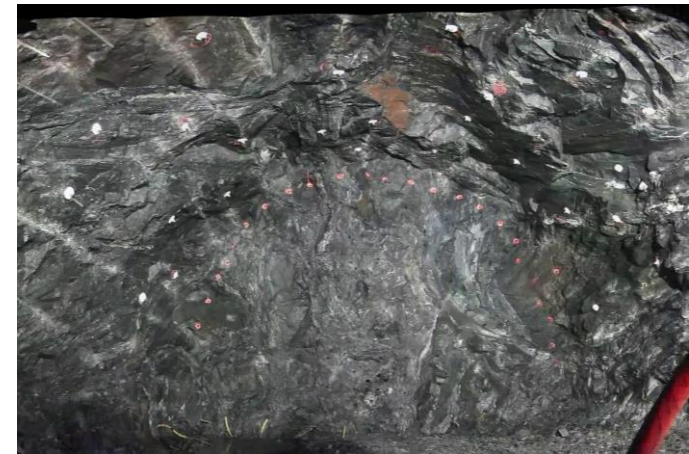
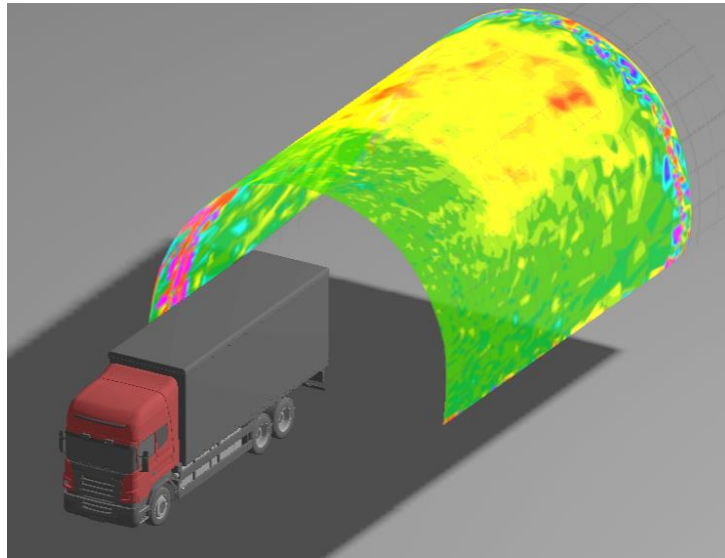
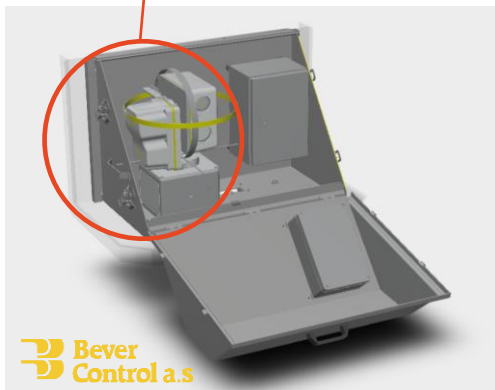
Dataset: blastholes. Balanced accuracy: 0.926



**MWD – INTERPRETATION WITH
 ARTIFICIAL INTELLIGENCE**

- 10 tunnels / 2360 rounds
- Predicts rocktype with > 90 % accuracy

SHOTCRETE THICKNESS MEASUREMENTS



Shotcrete thickness verification

- Safer rock support
- Less material cost
- Reduced environmental impact

NAVIGATION AND SCANNING



Etabler rigg navigering med profiler og mål kontrollpu

Velg kontrolpunkt 1
P1

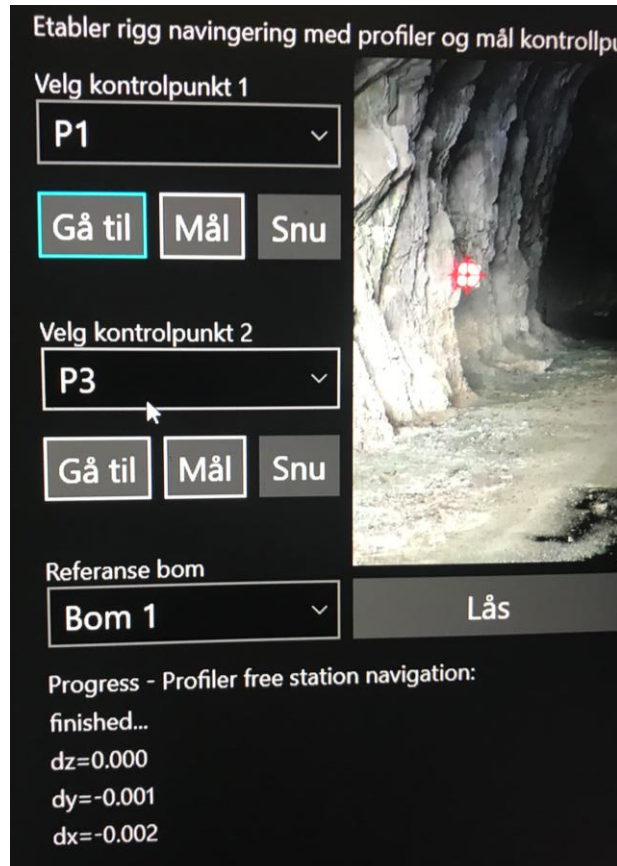
Gå til Mål Snu

Velg kontrolpunkt 2
P3

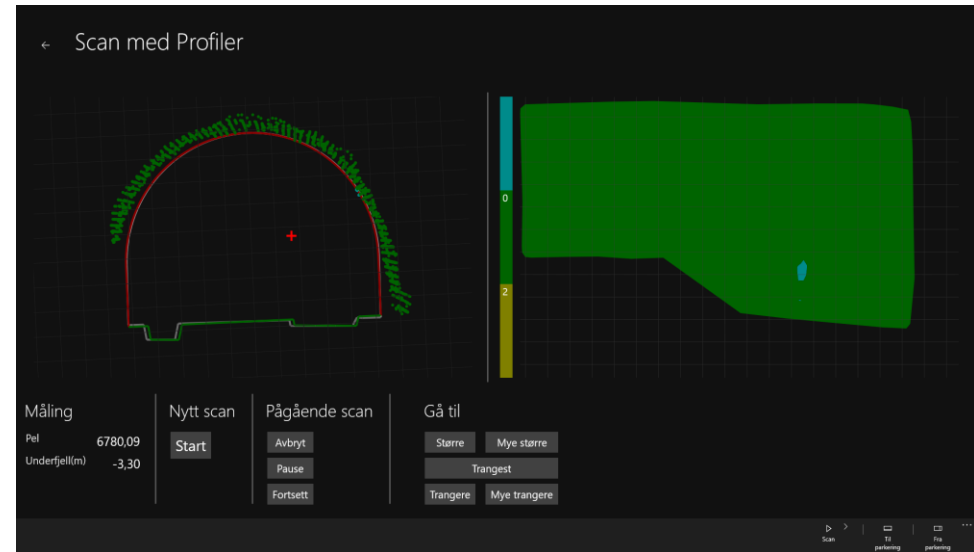
Gå til Mål Snu

Referanse bom
Bom 1 Lås

Progress - Profiler free station navigation:
finished...
dz=0.000
dy=-0.001
dx=-0.002



Scan med Profiler



Måling
Pel 6780.09
Underfjell(m) -3.30

Nytt scan Start

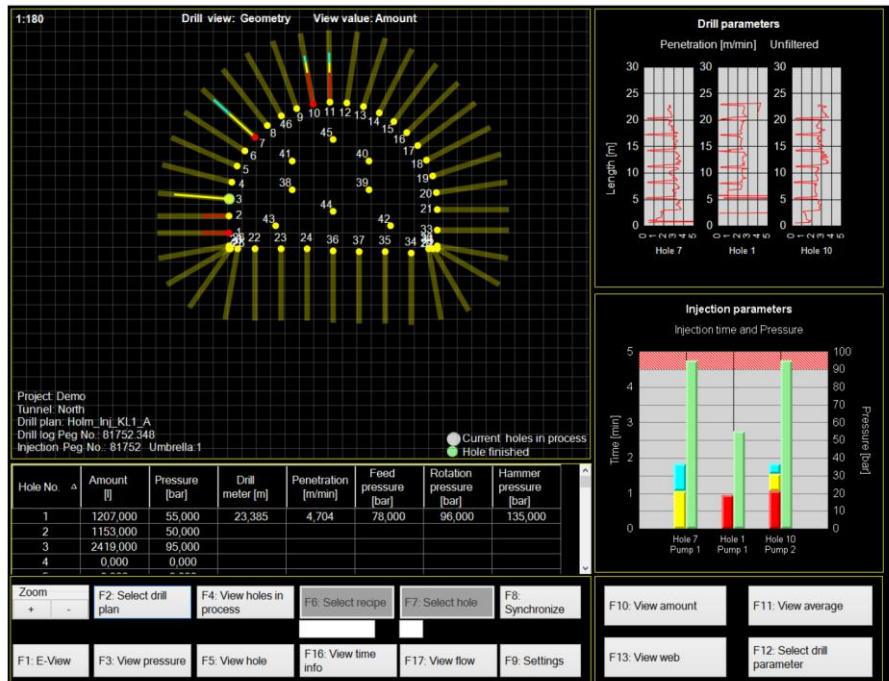
Pågående scan Avbryt Pause Fortsett

Gå til Større Mye større Trangest Trangere Mye trangere

Quick and accurate positioning

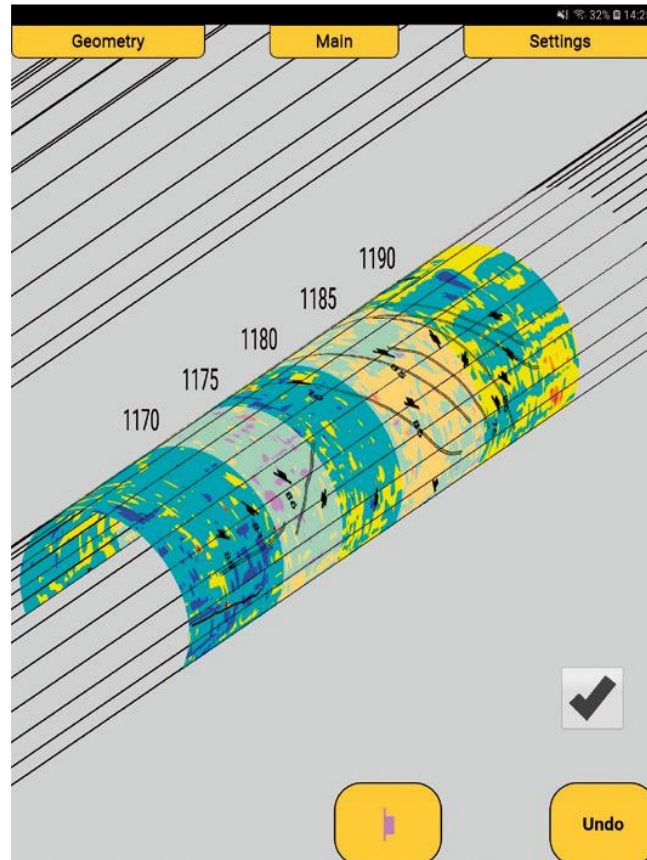
Navigation and scanning can be managed by jumbo operator

COMPUTERIZED GROUTING – MONITORING AND ANALYSIS



- Accurate calculation of consumption
- Optimization of grouting strategy

GEOLOGICAL MAPPING – APP BASED



Registration of geology and rock support

Efficient and accurate digital documentation

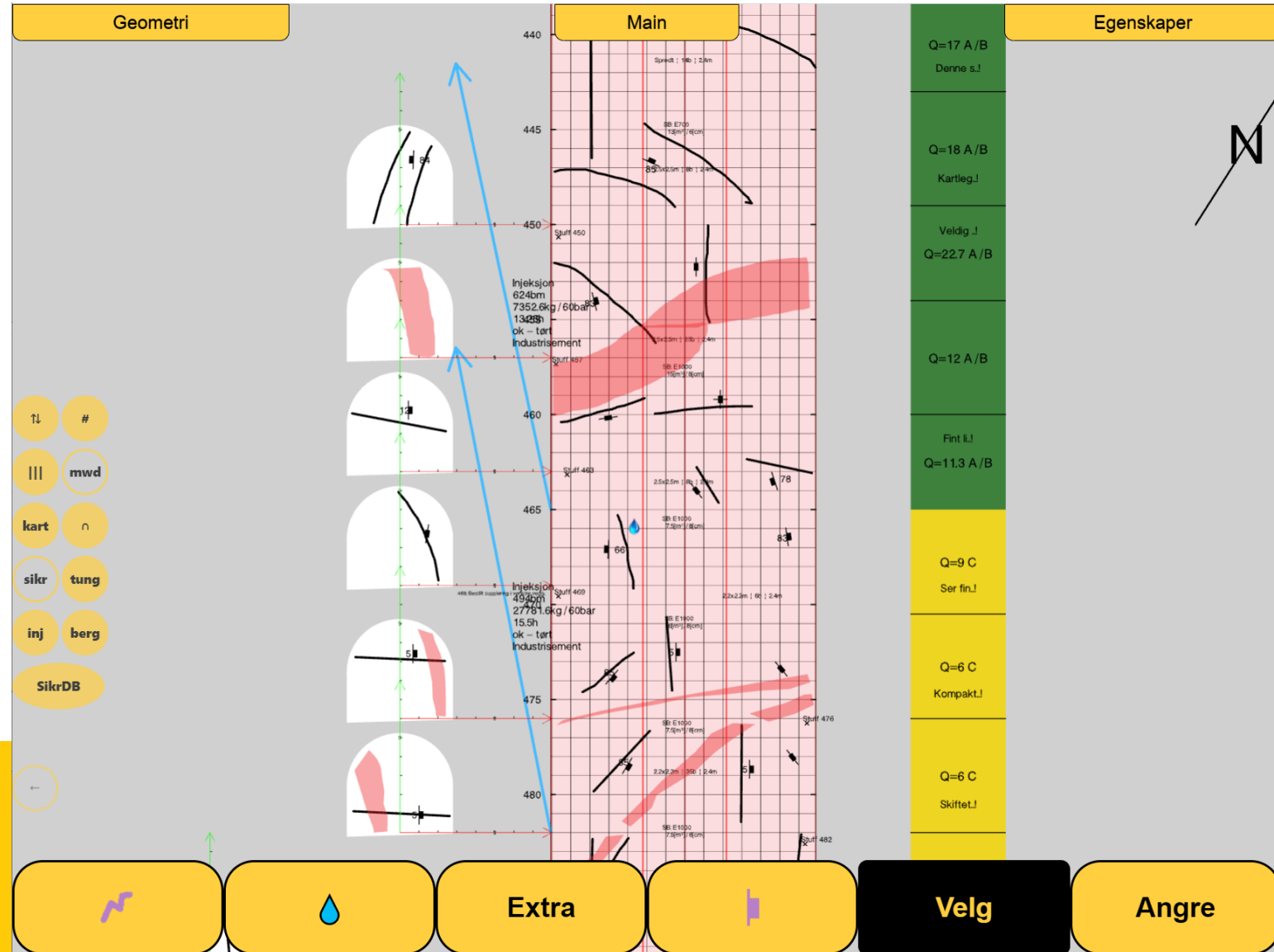
Usage of machine data – complemented with controller's registrations

Ready for statistical analysis and reporting

Registration of geology and rock support

- Rock type
- Weakness zone
- Q-value
- Water ingress
- MWD interpretation
- Photos
- Laboratory tests
- Rock support

Efficient and accurate digital documentation



<input type="checkbox"/>	+	Godkjent	509	503		1,7 x 1,7 m	13	3	Kombinasjonsbolt
<input type="checkbox"/>	+	Godkjent	509	503		2,0 x 2,0 m	6	3	Kombinasjonsbolt
<input type="checkbox"/>	+	Godkjent	509	503		2,0 x 2,0 m	6	3	Kombinasjonsbolt
<input type="checkbox"/>	+	Godkjent	513	509		2,2 x 2,2 m	18	3	Kombinasjonsbolt
<input type="checkbox"/>	+	Godkjent	518	513		2,2 x 2,2 m	17	3	Kombinasjonsbolt
<input type="checkbox"/>	+	Anvist	469	464		1,7 x 1,7 m	27	3	Kombinasjonsbolt
Ingvild 26 07:05	2 m i vegger								
<input type="checkbox"/>	+	Anvist	474	469		Spredt	17	3	Kombinasjonsbolt
Ingvild 26 07:05	Avtalt på stuff å bolte på fjell, semi systematisk								
<input type="checkbox"/>	+	Anvist	533.8	540		1,5 x 1,5 m	11	3	Kombinasjonsbolt
<input type="checkbox"/>	+	Anvist	533.8	540		1,5 x 1,5 m	11	3	Kombinasjonsbolt
<input type="checkbox"/>	+	Anvist	533.8	540		1,5 x 1,5 m	43	4	Kombinasjonsbolt
<input type="checkbox"/>	+	Anvist	456.5	450.8		1,7 x 1,7 m	30	3	Kombinasjonsbolt

Geometri
Main
Geologi

Add
Reports
Delete

Bolter
Sprøytebetong
Forbolter
Fjellbånd
Buer
Injeksjon

Ps
300

Pe
350

Step
25

Med kommentarer

Current
Preview
PDF

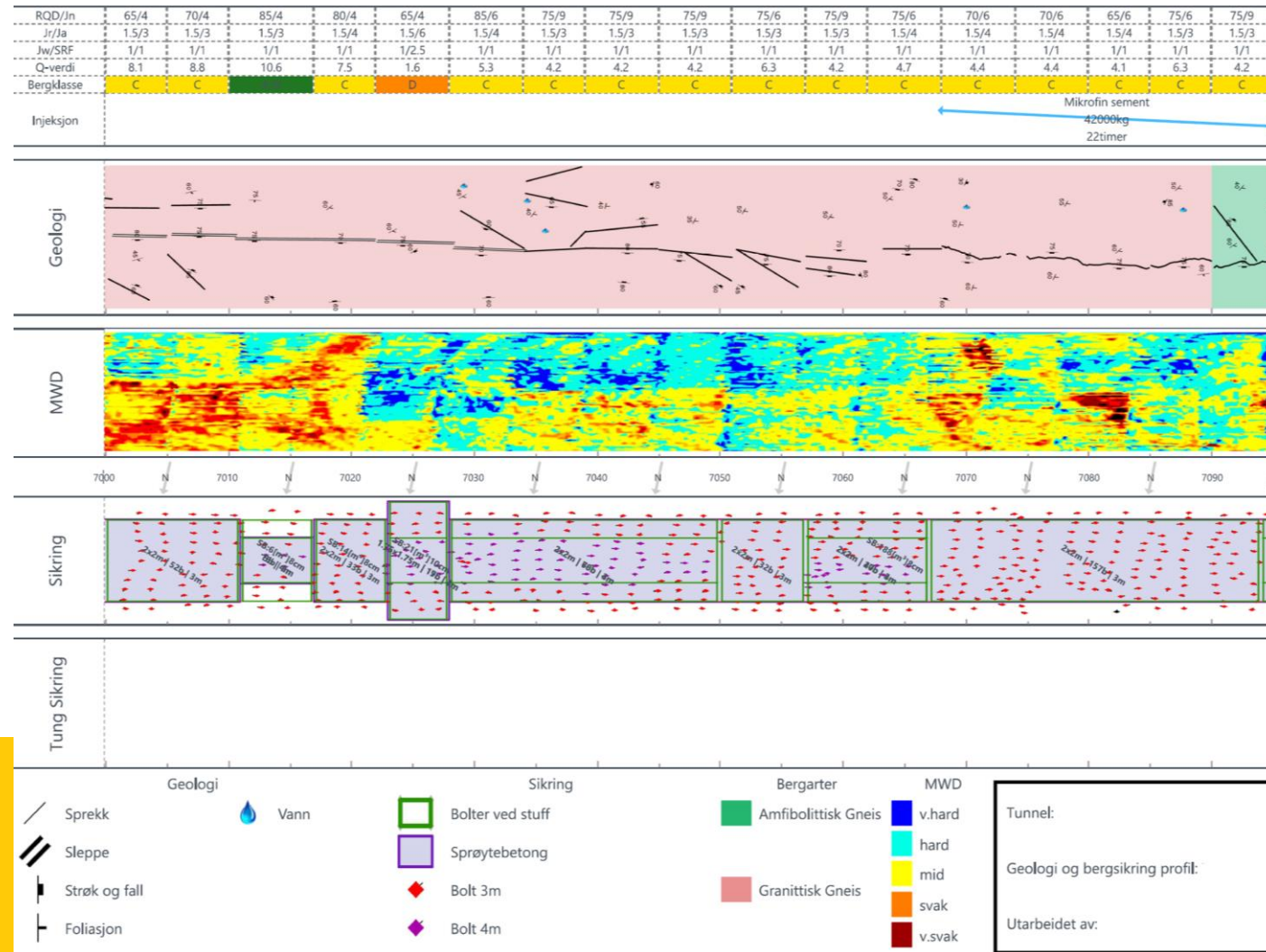
Uke
17

Sikr/Inj.csv

Strøk/Fall

Rock support documentation:
 Requested - > Approved
 Detailed weekly reporting

- Q values
- Geological mapping
- MWD interpretations
- Rock support



MONITORING PROGRESS AND PRODUCTIVITY

BT: E39 Lyngdal Øst - Ly Home Back About Themes ▾ Hello thorvald! Log off

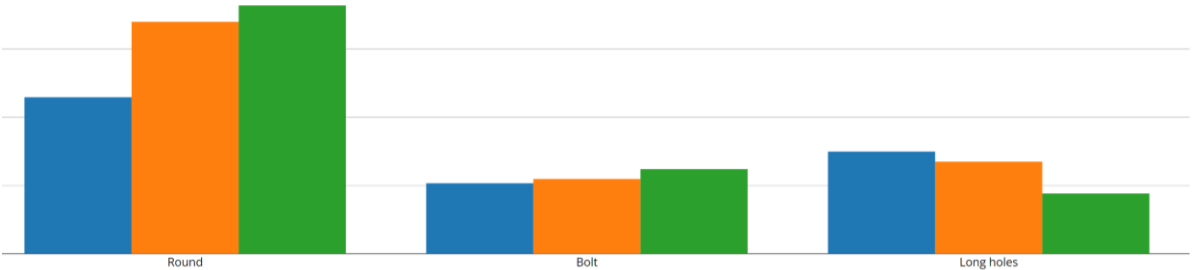
Project

Status Weeks Map Rigs Drilling

E39 Lyngdal Øst - Lyngdal Vest



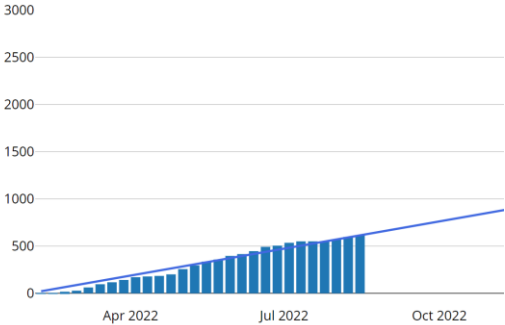
Capacity (m/hour)



BT: E39 Lyngdal Øst - Ly Home

Project

Status Weeks Map Rigs Drilling



NORWEGIAN EXPERIENCES

- Internet connectivity at face
- Client requires immediate access to all production data
- Client requires documentation in digital formats, such as
 - Geological mapping and rock support including photos
 - Shotcrete thickness
 - Grouting process
 - MWD interpretation
- Data transparency during construction phase increases common understanding and reduces the number of conflicts

RESULTS

- Monitoring and optimisation
 - Computerized drilling → >20% less overbreak
 - Charge control – reduced overloading → >20% less consumption of grout and shotcrete
 - Shotcrete scanning
 - Grouting control
- Cloud based data management
 - Reduced man hours for data management → Reduced number of staff
 - Better production data quality → Reduced number of mistakes
 - Better project overview → Less conflicts
 - Complete documentation available
 - Increased transparency between contractor and client



MUCHAS
GRACIAS!

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MAIL@BEVERCONTROL.COM