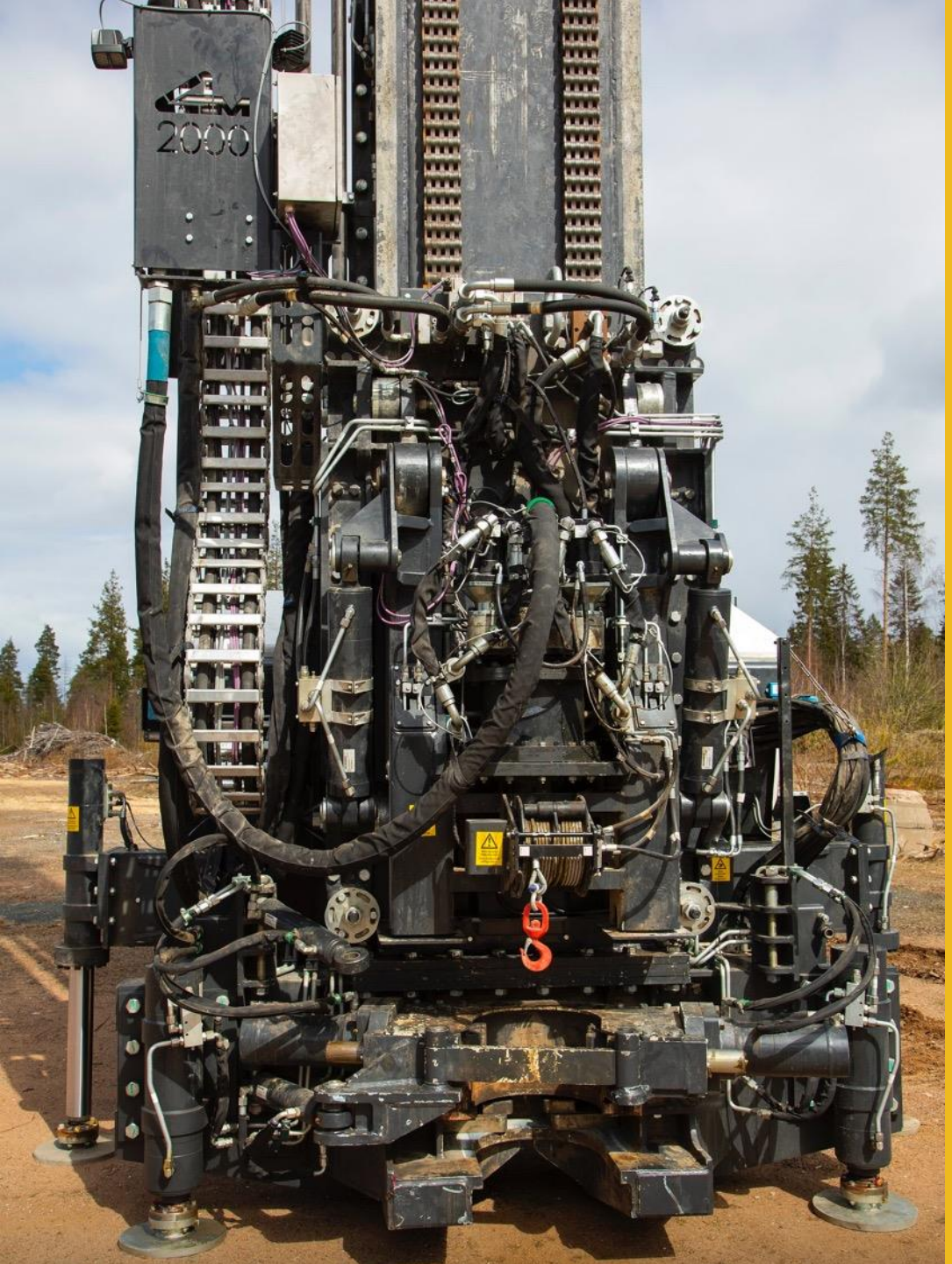
Geomachine

GM2000
– Geothermal Drilling



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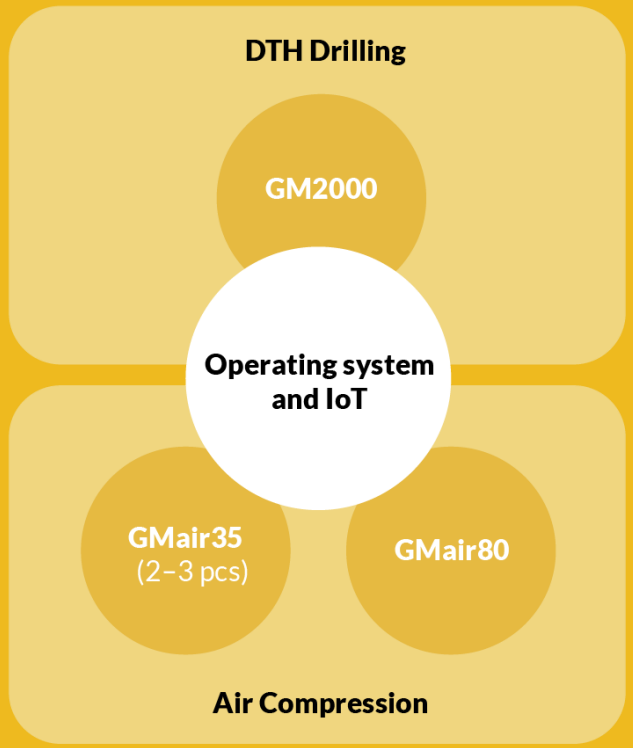
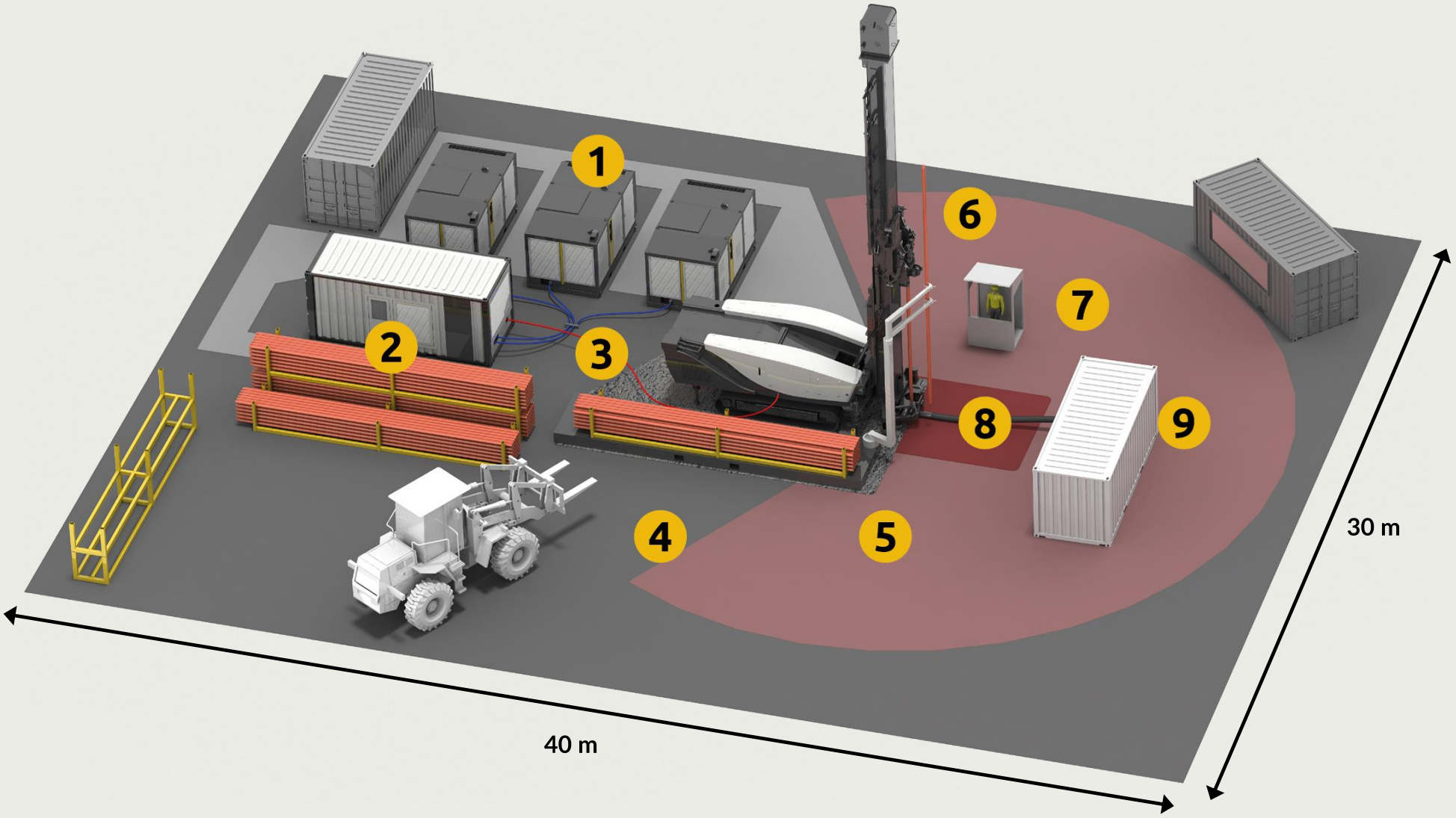
Geomachine integrated geothermal solution



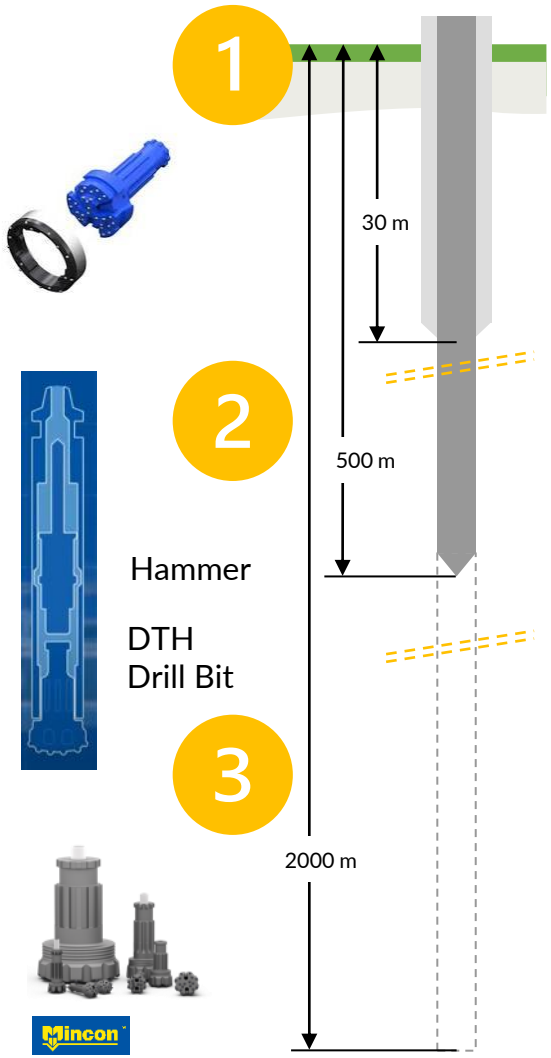
Integrated solution makes it easy to operate and get support

Drilling equipment



1. GMair35 Compressors
2. GMair80 Booster
3. Pressurized air
4. Automated drill rod handling system
5. Drill string:
   - Adapter
   - Drilling guides
   - Drill rods
   - DTH Hammer
   - Drill bit
6. GM2000 Drilling Rig
7. Digital process control, data logging and cloud service
8. Cuttings
9. Debris container with water separation

Well design and drilling process



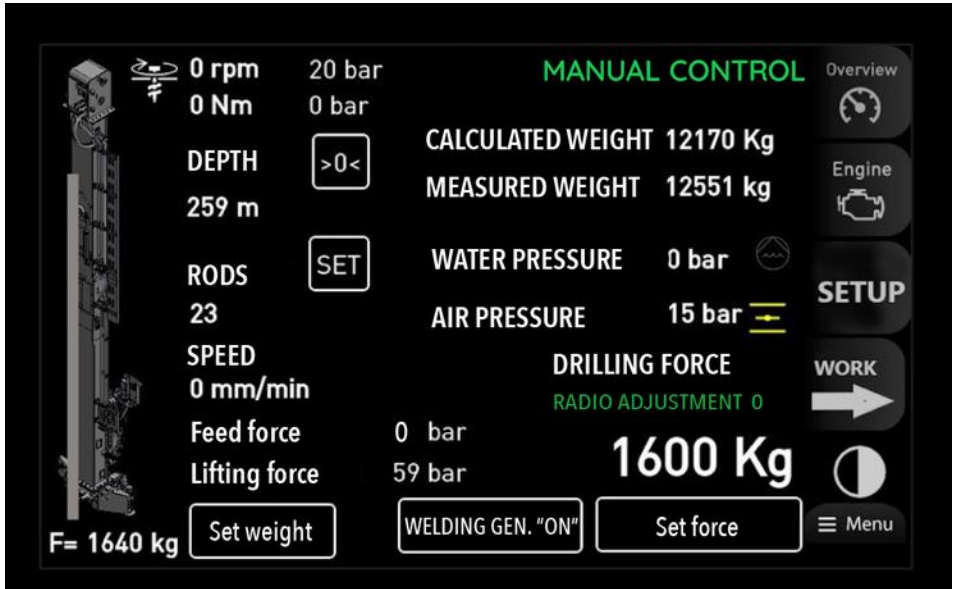
1. **Overburden drilling**
   - Surface casing is drilled with a ring bit system through overburden into few meters deep in the bedrock.
   - Used tooling: **10” hammer** with a **406 mm ring bit system**.
2. **Drilling, casing and grouting to 400-800 meters depth**
   - After passing the overburden layer, the hole is drilled into 400-800 meters depth, depending on the ground water flow intensity into the well.
   - Used tooling: **10” hammer and 355 mm (300)** (first) drill bit. Next bits are with the same size.
   - After reaching the depth where no longer heavy ground water flow is detected, the water sealing casing is installed. 25 mm grouting space is left between the rock and the casing. In this example of ca. **350 (300) mm** rock hole, a **300 (245) mm** outer diameter casing is optimal.
   - The hole is **grouted by** pouring and pressurizing predefined amount of **fine concrete** into the well (inside casing). Concrete rises up outside the casing and seals the space between the rock and the installed casing.
3. **Drilling to the targeted depth**
   - After grouting has reached a sufficient hardness, the drilling continues with drill bit that fits inside the casing, e.g. **273 mm bit**. Next drill bit is always **2-3 mm smaller** than the previous one. Number of drill bits required varies heavily on the rock formation. In difficult conditions, **200 m is a good performance**, in softer rock type, up to 800 m can be achieved with one bit.
   - The diameter at the bottom of the well needs to be around 200 mm, **preferably 250 mm**.

60 Ton lifting capacity with DTH Technology

Lifting capacity	**60 ton**
Feed force	20 ton
Rotary head max. torque	14 kNm
Rotary head max. rpm	100
Rotary head tilting	90 degree forward with 30 kN torque
Opener to release hammer/drill bit	Hydraulic
Drill Rods	**9 m**
Drill rod diameter	**89–140 mm**
DTH Hammer	**6–12 inch**
Traverse speed of the rotary unit	1 m/s
Max. diameter of casing pipe	406 / 610 mm
Rotary head travel range	10.5 m
Mast vertical movement	-0.6 m... +0.4 m
Mast support legs	Hydraulic, 2 pcs with -0.5 m movement
Auxiliary winch	2 tons
Drilling control	**Automation and Weight-on-Bit**
Weight	**42 tons**
Length	**15.2 m** (transport)
Width	**3 m**
Engine	Cummins B6.7 Stage V
Power	243 kW
Tractive force	225 kN
Max. speed	**2.6 km/h**
Water pump	**100 bar**
Hydraulic support legs	4+2
Other	Oiler, webasto, hyd. generator, safety radars

From a driller to a process controller

- With GM2000 drilling process is automated.
- Drilling parameters monitoring keeps the driller constantly aware of the specific drilling parameters – even when the work occurs several hundred meters deep.
- GM2000 is operated with a CAN-bus control system. System enables automated drilling with GM Weight-on-Bit (WoB) control.



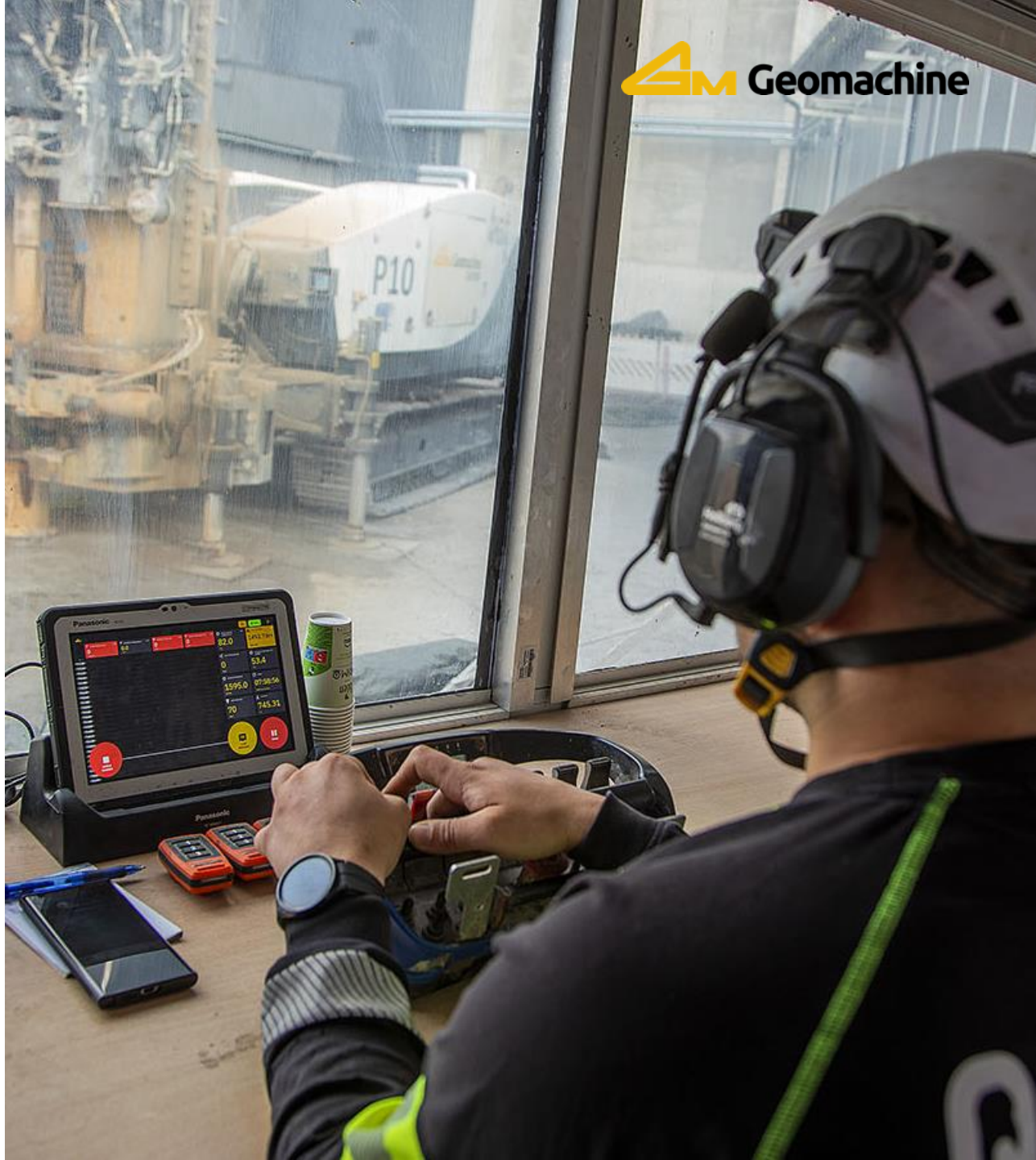
GM Tracker monitoring include e.g.:

- **Weight on bit**
- **Feed and rotation speed**
- **Feed / lifting force**
- **Torque**
- **Air valve position**
- **Fuel consumption**
- **Water pump pressure**

Note: Air pressure, air volume and compressor fuel consumption can also be logged in case of GM compressor units are in use.

Critical enablers going deeper

- There are several technological solutions to **improve** the performance of the **DTH drilling**
  - **Dual flush** DTH hammer is helping to reduce the **wearing** of the drill bit and in enabling **smoother air flow** for getting the water and the cuttings out from a deep hole with less energy.
  - Using **drilling foam** is another efficient method to increase the critical performance of **flushing** the fine cuttings **up**.
  - Using **hole control fluid** is efficient method to speed-up hole collaring, reduce collar sloughing and **stabilizing the well wall**.
  - Abundant use of **Hammer oil** reduces the risk of one of the most fatal in-hole failures, that is the breakdown of the drill bit neck. It also increases hammer service life significantly.
  - Deep hole hammers **without foot valves** are recommended to be used to prevent hammer/valve breakages.



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