



# Does Deep Drilling Need A Revolution?

*Drilling Deeper, Faster.*

*An overview of State-of-the-Art  
Drilling Technologies & Geothermal Resources  
Developments*

*Kevin Mallin – 4° April 2025*



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA



*Geoserv*





## Mechanical Drilling Processes

- Weight applied to a drill bit, that is rotated to remove formation, to create an open wellbore space, for the circulation of fluids (in simple terms).
- Formations subjected to gouging, crushing and shearing, depending on bit type; sometimes a combination of processes.
- Bits rotated so the drilled formations (cuttings) can be removed from the base of the wellbore.
- Cuttings moved to the surface by flushing – fluids or air/gases.
- Energy input required for lifting and lowering drill strings, to rotate the drill string (and/or downhole motors), to pump fluid or air/gases through the drill string to flush the well.

**KEY OUTCOME: A USEABLE WELLBORE**



## Main Drilling Technologies

- Rotary percussion – Down The Hole Hammers!
  - Air Powered
  - Fluid Powered
- Roller Cone
- Fixed Cutter



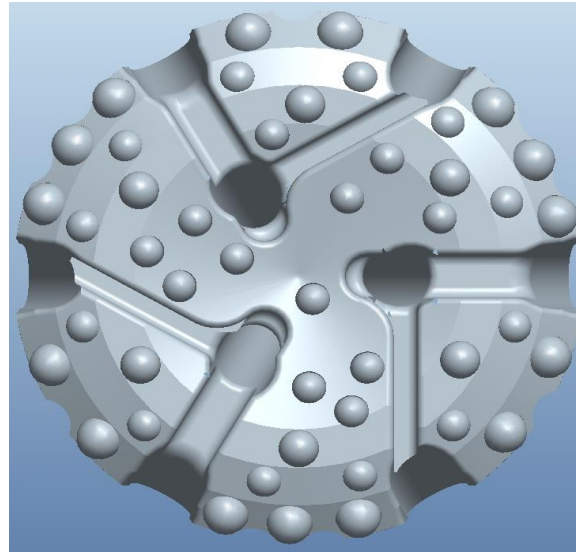
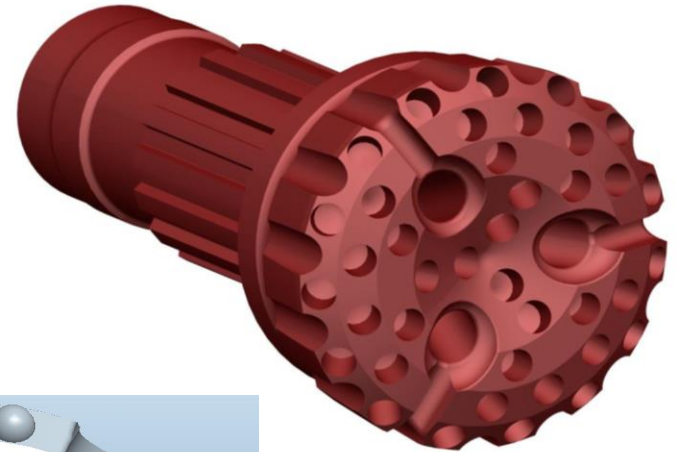
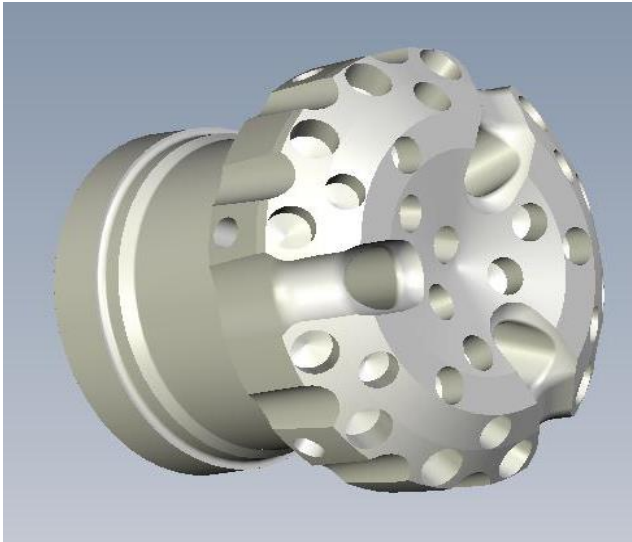
Deep U-tube heat exchanger breakthrough: combining laser and cryogenic gas for geothermal energy exploitation

## Down The Hole Hammers





## Down The Hole Hammers – Bit Types





Deep U-tube heat exchanger breakthrough: combining laser and cryogenic gas for geothermal energy exploitation

# Down The Hole Hammers – Flushing/Power Mediums

Air / Gas







# Down The Hole Hammers – Flushing/Power Mediums

## Water





## Strada - Dual Circulation Mud Hammers



- **Model Name:** DCWH-100
- **Barrel OD:** 10.0" [254mm]
- **Length excl bit:** 3.75m [147.6"]
- **Operating Parameters:**
  - **103 bar [1500psi]**      **l/min**  
**[400 GPM]**
  - **Frequency 10- 18 Hz (BPS)**
  - **Water Cleanliness < 50**  
**Microns**
  - **Connection, Strada DC-8 Box**





Deep U-tube heat exchanger breakthrough: combining laser and cryogenic gas for geothermal energy exploitation

## Percussion Enhanced Rotary Drilling



# GeoVolve



## Percussion Enhanced Rotary Drilling

- ❖ Proven the capability of the GeoVolve HAMMER to provide consistent and configurable output forces necessary for effective percussion drilling on test and in field
- ❖ Drilled very high UCS Rock (Inc Granite), interbedded and ductile formations while delivering a step change in drilling performance (ROP)
- ❖ Designed, developed and created case history with own bespoke range of drill bits. The TerraBit
- ❖ Case history with 4-3/4", 6-3/4" and 8-1/4" tools
- ❖ Single longest drilling time of 252 Hrs on bottom
- ❖ Single longest circulating hours of 352 Hrs, 1 month BRT
- ❖ Maximum BHT deployed to date at 225C
- ❖ Established interfaces and drilled with M/LWD in the string without data compromise
- ❖ Drilled shoetracks and casing shoes
- ❖ Multiple, repeat clients for pilot wells - globally





## Roller Cone (TriCone) Drill Bits

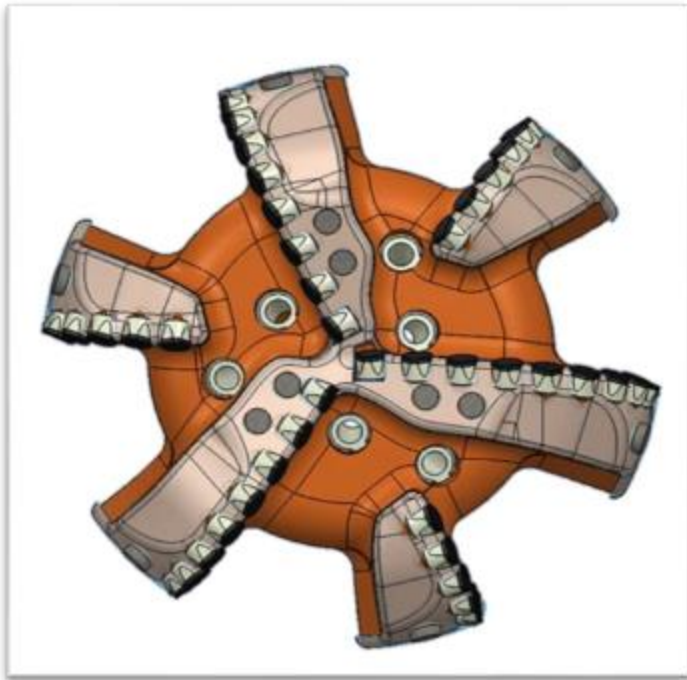


Baker Hughes 





# ZerdaLab - PDC



## Objectives

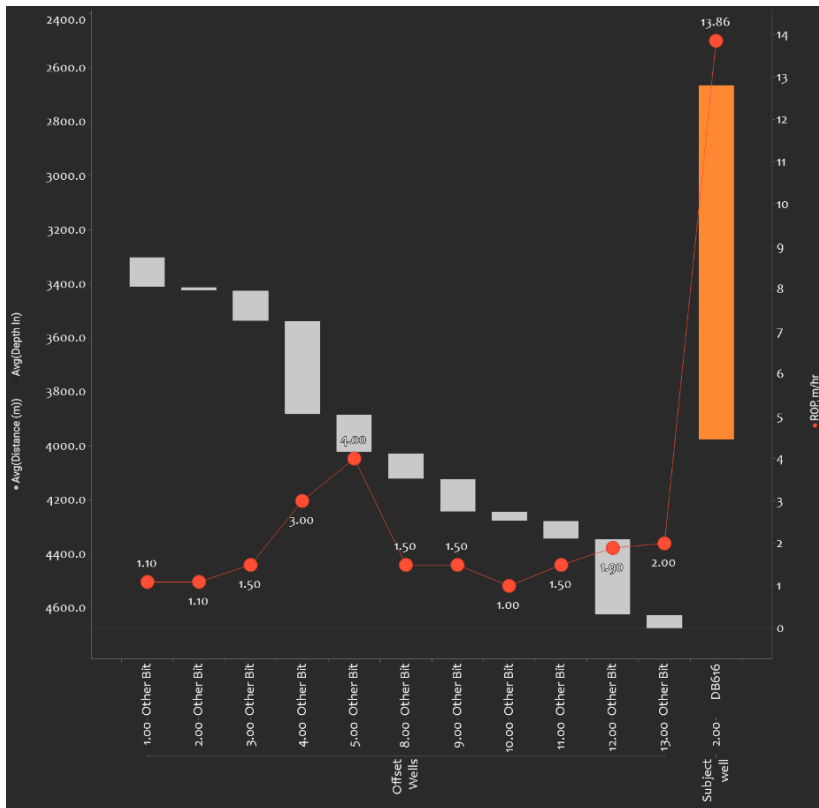
- Drill out of casing shoe
- Achieve 8-10m/hr ROP, doubling the offset average performance
- Finish the section with no more than 2 drill bits
- Maintain tangent 49deg trajectory on motorised push-the-bit RSS BHA

## Challenges:

- Interbedded high contrast lithology consisting of limestone, claystone, marl and sandstone stringers
- Low ROP and high abrasive wear in the latter part of the section



# ZerdaLab

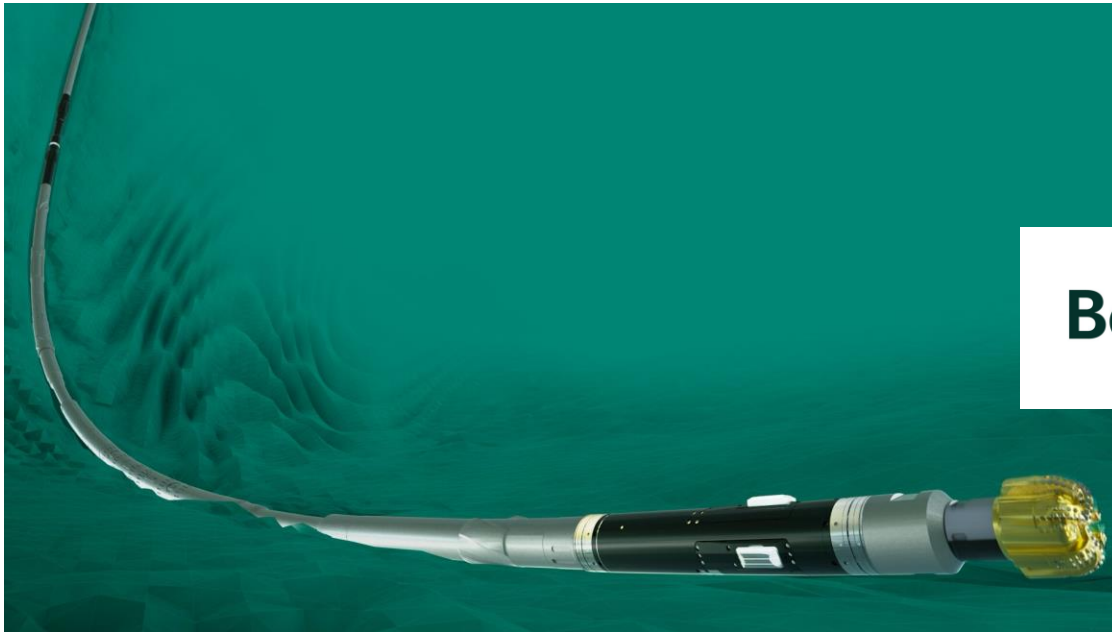


- The bit successfully drilled out the casing shoe and into new formation all the way to section TD. Including an extended 70m+ dictated by geologist. Total interval drilled 1314.0m
- Average ROP of 13.86m/hr
- All directional objectives were met



# Rotary Steerable Systems

## Helping Geothermal Turn A Corner



**Baker Hughes** 





# Rotary Steerable Systems





# Non-Mechanical Technologies

A wellbore is created without the use of mechanical interaction between a drill bit and the formation.

Formations are broken or altered to allow a wellbore to be formed.

Formation material needs to be removed (flushed).

No bit wear, so reduced down-time when having to change bits.

Formation property dependent?



# Non-Mechanical Key Technologies

Electro-Pulse-Boring (EPB)

Plasma Technology/Flame Jet Spallation Drilling

Hydrothermal Spallation

SuperDeep-Fusion Drilling

Micro-Wave Drilling

Laser



# Electro-Pulse-Boring

*Journal of Earth Science, Vol. 26, No. 1, p. 037–046, February 2015 Printed in China*

DOI: 10.1007/s12583-015-0519-x

**EPB – applies an electro-pulse to the formation and hence energy!**



# Plasma Technology

**GA Drilling**

**<https://www.gadrilling.com/plasmabit/>**



# Microwave Drilling

**Our (Quaise Energy) gyrotron-powered drilling platform vaporizes boreholes through rock and provides access to deep geothermal heat without complex downhole equipment.**

Based on breakthrough fusion research and well-established drilling practices, we are developing a radical new approach to ultra-deep drilling. First, we use conventional rotary drilling to get to basement rock. Then, we switch to high-power millimeter waves to reach unprecedented depths.

**<https://www.quaise.energy>**





# Laser Drilling

**Over to my colleague and friend Pawel Michal Slupski – University of Padua**

**Thank you**