The importance of Drillers and Group Collaboration in Geothermal

Brock Yordy
Dynamics of the Drilling Industry

- Experience is Knowledge
- Science is Knowledge
- Project Specifications
  - Instincts
  - Physics
  - Application
  - Execution

but they don’t know jack about drillin’.
Reference for Drilling.
NO!
The book often experienced mid project on site.
As an industry how do we collaborate better together?
Goals of Borehole Creation.

<table>
<thead>
<tr>
<th>Open</th>
<th>Stable</th>
<th>Straight – in desired direction required</th>
<th>Gauge</th>
<th>Clean</th>
<th>Simple Product Installation</th>
<th>Efficient Product Extraction</th>
</tr>
</thead>
</table>
WARNING

Drilling is a Disruptive Process
What affects drilling success?

The Drilling System.
Unchangeable Factors

Mother Nature & Geology -

Type of soils
Soil formation
Hydraulics
Down hole pressures
Depth to water

Controlled Factors

Rig capabilities
• Rotation
• Pullback
• Pulldown

Fluid pumping capacity
• Mud pumps
• Air compressor
• Volume Requirements

Bit selection
• Type – cutting action
• Bit hydraulics
• Size - borehole diameter
Mother Nature’s cooperation is optional.

- Tribal Drilling Geology
  - Can I cut it?
    - Speed or Time
    - Volume Required
    - Volume Created
  - Can I break it?
    - Density
    - Reactivity
    - Stability
  - Can I get loop to bottom?
  - Can I get it fully grouted?

- Academic Geology
  - Local Logs
  - Depth to Water
  - Estimated Depth to Production Zone
  - Speculative quality of production zone.
  - Desired Production
Data that drives drilling timelines.

Oil field average days to drill an oil well in the United States.
Key Factors to Successful Drilling Execution.

- BOREHOLE DESIGN
- METHOD OF DRILLING
- DRILLING FLUID PACKAGE
- INCORPORATION OF DRILL SOLIDS
- METHOD OF SOLIDS CONTROL
- REQUIREMENTS FOR DISPOSAL

Annual Conference, December 14-16, 2021 – Nashville, TN
### Drilling Speed Rate of Penetration

<table>
<thead>
<tr>
<th>Type</th>
<th>Speed</th>
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<tbody>
<tr>
<td>Water-based drilling fluid (mud)</td>
<td>60 to 150 feet per minute</td>
</tr>
<tr>
<td>Air</td>
<td>3,500 to 7,500 feet per minute</td>
</tr>
<tr>
<td>Water + air + foaming agent (foam)</td>
<td>200 feet per minute</td>
</tr>
<tr>
<td>Specialty foam</td>
<td>100 feet per minute</td>
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</table>
Cutting Size & Creation
Drilling Fluids Vs. Water or MUD!

- Match Selection To Formation and Method
- Know primary and secondary functions of products
- Understand impacts to down hole conditions.
- Utilize product knowledge to your benefit
Density

- Percent solids
- Mud weight – weight of water
- Multiplied by 8 = % solids
- 9.0 – 8.34 = .66
- .66 x 8 = 5.28 % solids

<table>
<thead>
<tr>
<th>Mud Weight</th>
<th>% Solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.0</td>
<td>5.28 %</td>
</tr>
<tr>
<td>9.5</td>
<td>9.28%</td>
</tr>
<tr>
<td>10.0</td>
<td>13.28%</td>
</tr>
<tr>
<td>10.5</td>
<td>17.28%</td>
</tr>
<tr>
<td>11.0</td>
<td>21.28%</td>
</tr>
</tbody>
</table>
Geothermal Project
Solids Creation and Disposal

Residential 5 Holes: 6.25” x 300ft = 2.37 Cubic Yards per hole x 5 holes = 11.8 Cubic Yards Total

Commercial Geothermal: 5.5” x 400ft = 2.44 Cubic Yards
Drilling 4 holes a day = 9.76 Cubic Yards
Drilling Program & Project Book

- Prepares the team to answer unexpected questions.
- Includes Quote & Well Design
- Regulations
- Well Logs
- Rig and Tooling Specifications
- Hole Specifications
- Construction Specifications
The proper questions to ask.

- Equipment availability
- Geology
- Time to completion
- Product installation
- Product extraction
- Manpower
- Site management
- Clean up and disposal
Knowledge and Experience

“Experience is what you get when you didn’t get what you wanted.”

Randy Pausch “The Last Lecture”

1. Success is built upon a foundation of achievement and failures.

2. Regardless of Tribal Knowledge or Academic Knowledge completing a project is dependent on consistent results by the driller and collaboration by all parties.
Creating a Collaborative Process

- CHECK YOUR EGO
- Start conversations with defaulting to trust.
- Trust your methods and success rates.
- Question Everything with an open mind.
- Share Best Practices and New Methods
- Science
- Instincts
- Experience
- Knowledge
- WE ARE DISCOVERING THE UNKNOWN TOGETHER.
Success!
Drilling is discovering the unknown. With the right questions, expectations, and collaboration we as an industry can develop better processes.

Thanks

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