



# Microhole Drilling

Jiann Su

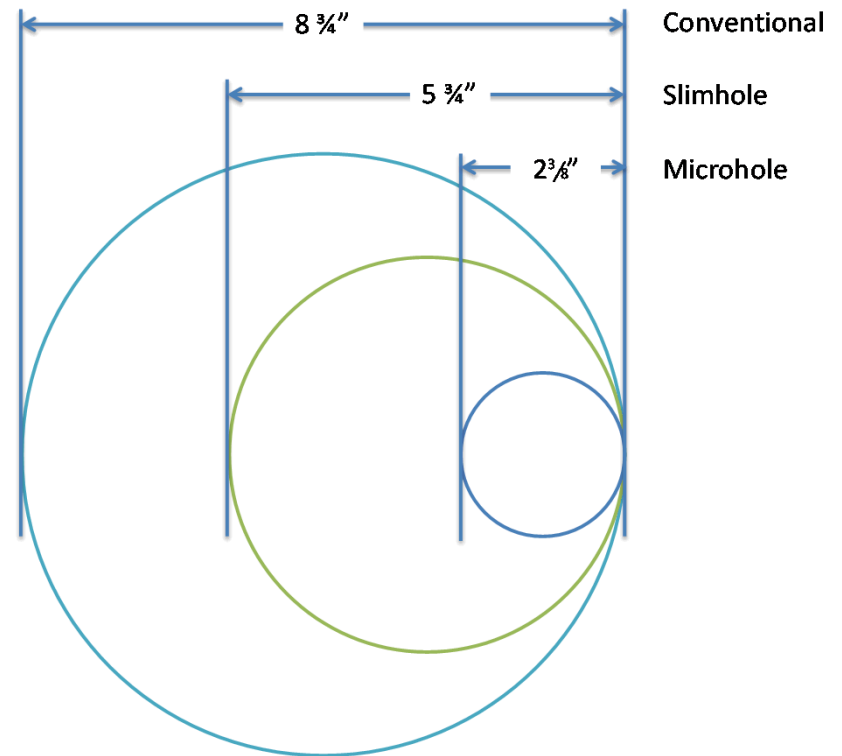


# Outline

- Project overview
- Status
- Future work

# Project Overview

- Microhole uses
  - Exploration
  - Monitoring & evaluation
- Microhole benefits
  - Smaller footprint
  - Rapid mobilization/de-mob
  - Higher-resolution imaging
  - Lower cost



# Previous Work

- Slimhole drilling in the 1950's
- NETL Micro-Hole Technology (MHT) funded work in early 2000's
- LANL microhole drilling
- EGS JASON Report

# Project Goals & Objectives

- Validate and establish proof-of-concept low WOB drilling technology
- Develop WOB control strategies & techniques for microhole drilling
- Develop downhole rotation for low WOB drilling
- Help to realize economic and technical promise of microhole drilling
- Build on previous microhole drilling efforts
- Leverage previous DOE investments

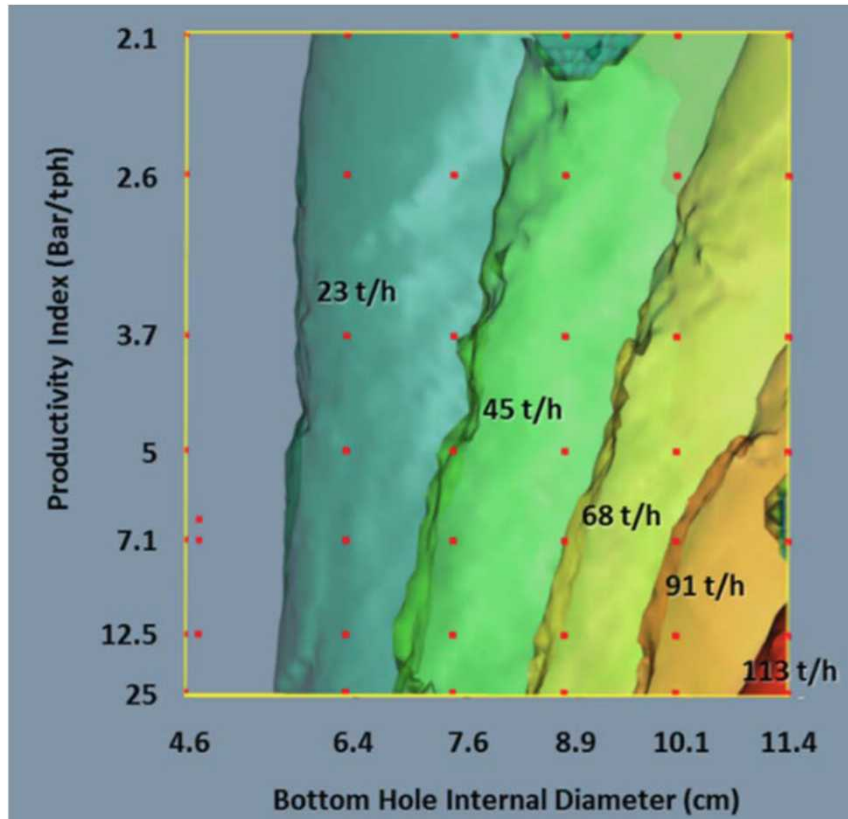
# Microhole Resource Assessment

- Geothermal Resource Group
  - Modeling production and injection uses of microhole
  - 2.5" – 4.5" borehole
  - Depths: 3000 ft, 6000 ft

# Microhole Modeling Results

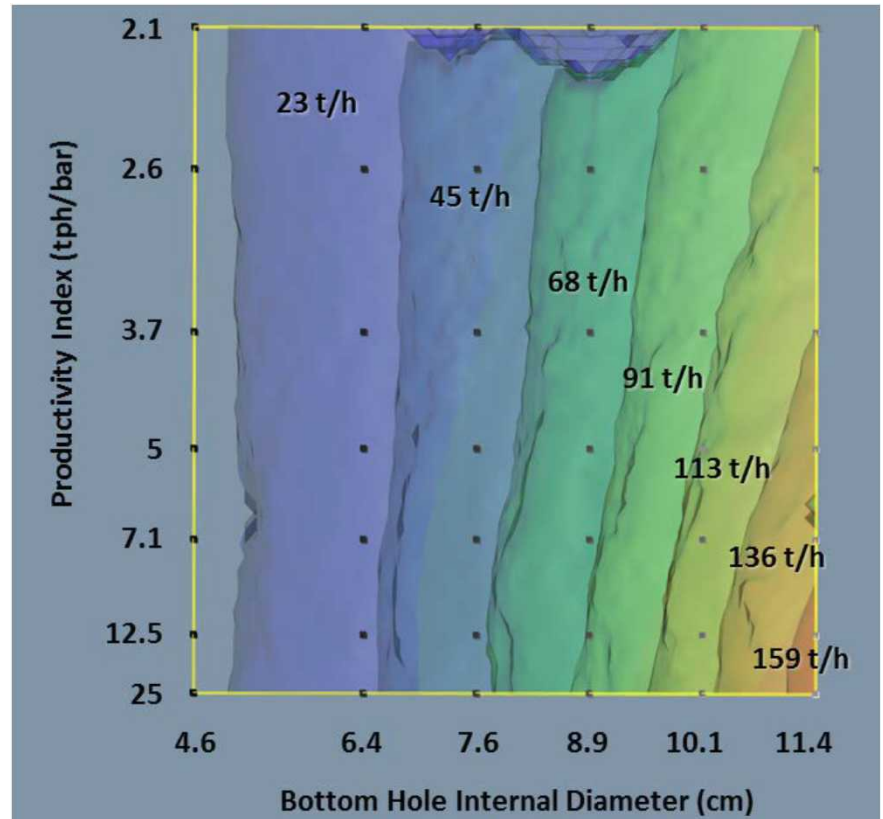
## Productivity Index

### 3000 ft borehole



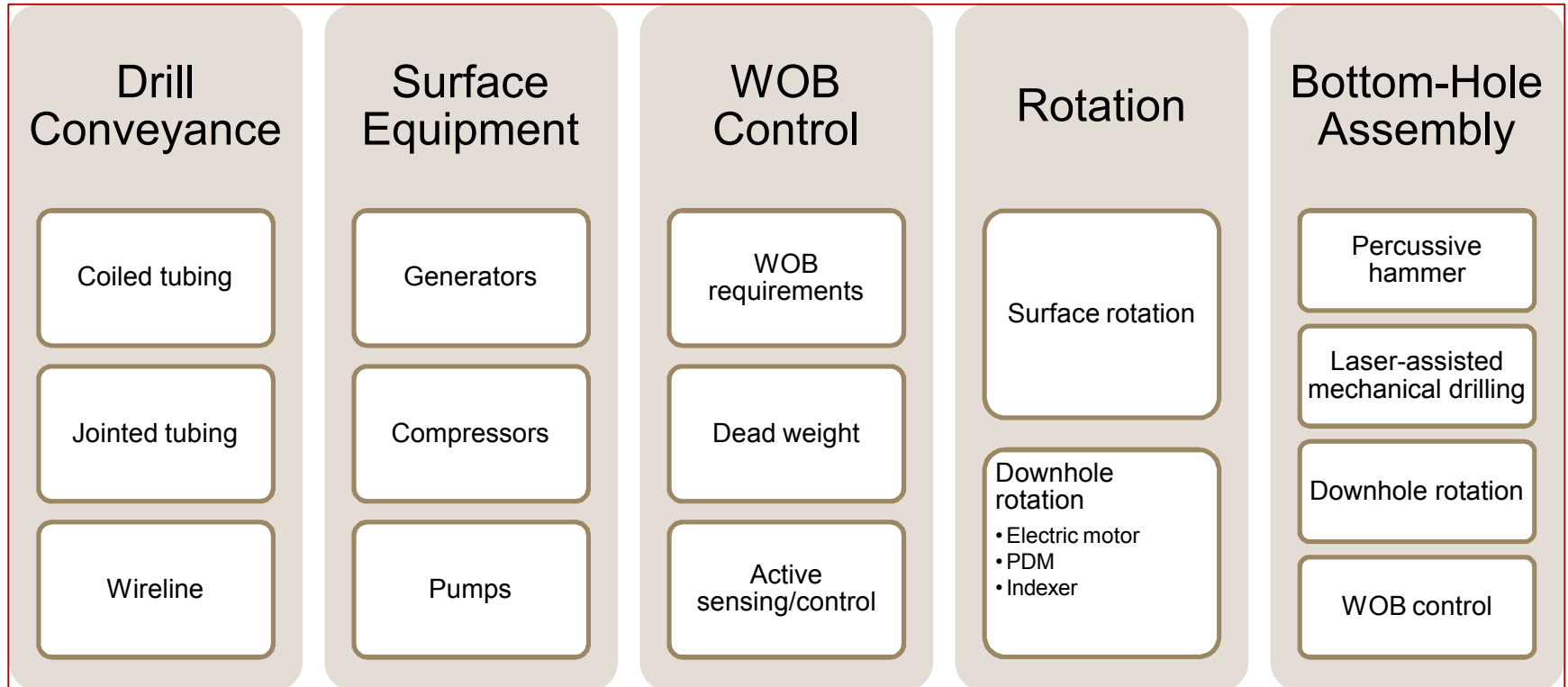
>3.0" borehole required for scalable PI

### 6000 ft borehole



> 4.5" borehole required for scalable PI

# System Level Requirements Definition



# Percussive Hammer

- Utilizing COTS hammers to establish low WOB drilling requirements
- 2 7/16" OD HAMMER
- 2 3/4" BIT, 3 3/4" BIT
- Path towards elevated temperature operation

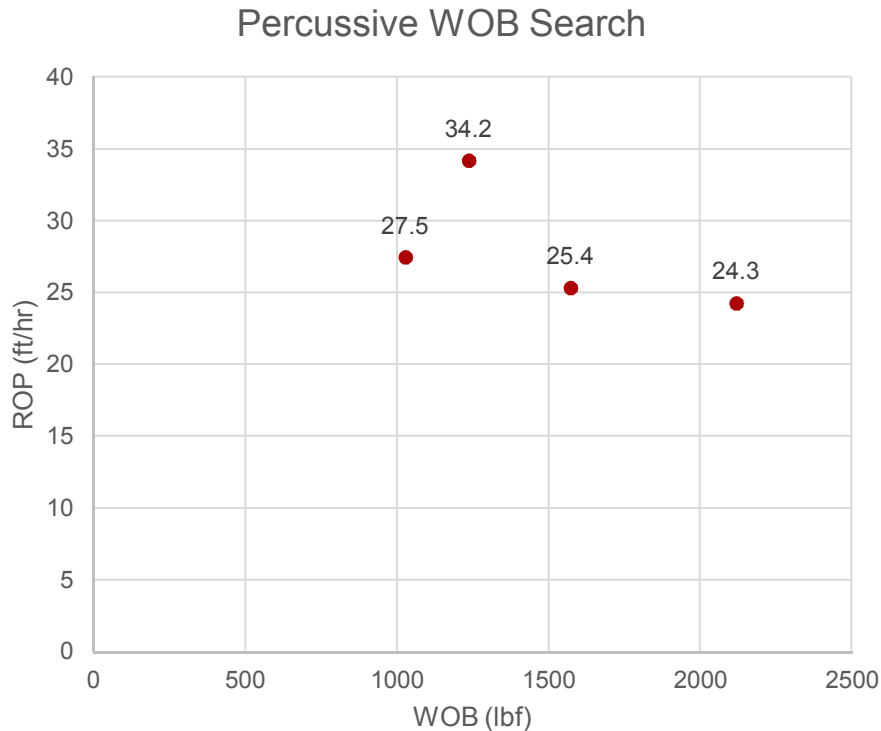


# High Operating Temperature Facility

- Capacities
  - Weight on Bit (WOB) – to 6000 lbf
  - Rotation speed – up to 60 rpm
  - Rotation torque – up to 2500 ft -lbf
  - Hammer heater – up to 300 C (9kW heater)
  - Process gas heater – up to 300C (190 kW heater)
- Features
  - Remote operation
  - Automated drilling
  - Automated rock positioning
  - Closed-loop control of drilling parameters
  - Cuttings collection system with dust management



# WOB Search Algorithm Results

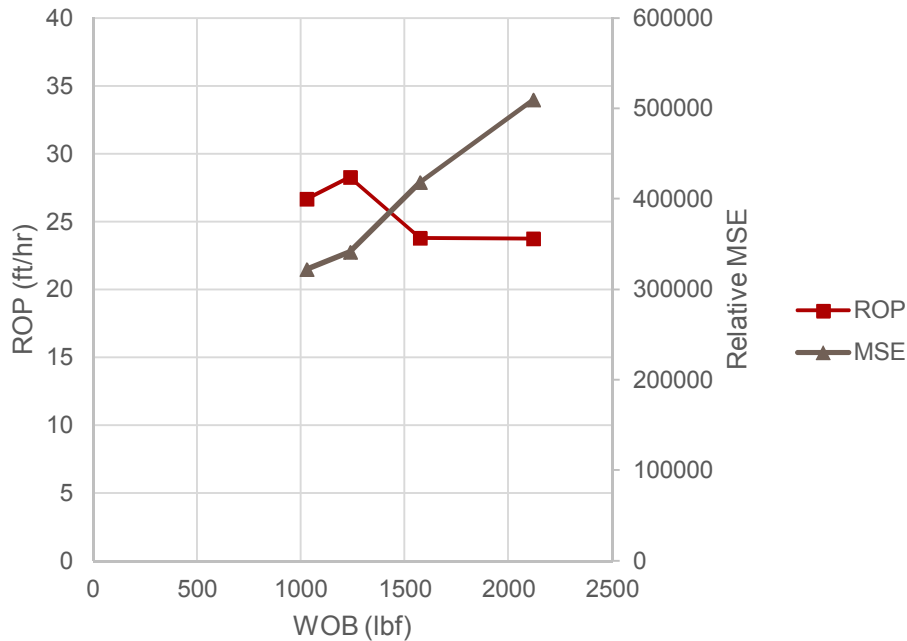


- Drill-off (man vs. machine)
  - Depth: 39"
  - Pressure: 175 psi
- Static WOB Setting
  - WOB: 4000 lbf
  - ROP: ~27 ft/hr
- GS Optimized WOB
  - WOB: GS optimized
  - ROP: ~33 ft/hr

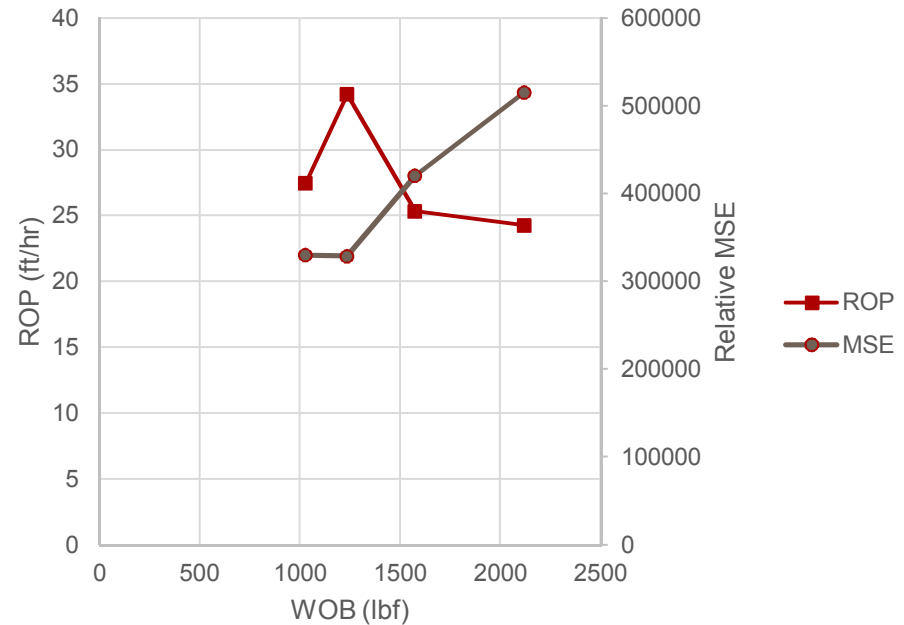
~20% improvement in ROP

# MSE vs. ROP Optimized

## ROP Optimized



## MSE Optimized



# WOB Tool Options

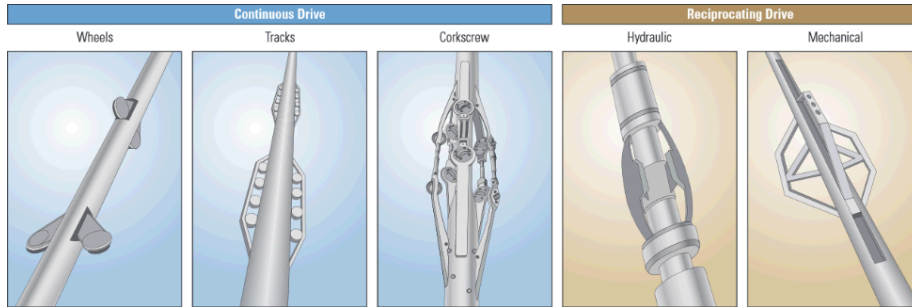
## Dead Weight



- Advantages
  - Passive component
  - Flexible configuration
- Disadvantages
  - Potentially long BHA
  - Dense material may be brittle (e.g. Tungsten)

# WOB Tool Options

## Tractors



### Advantages

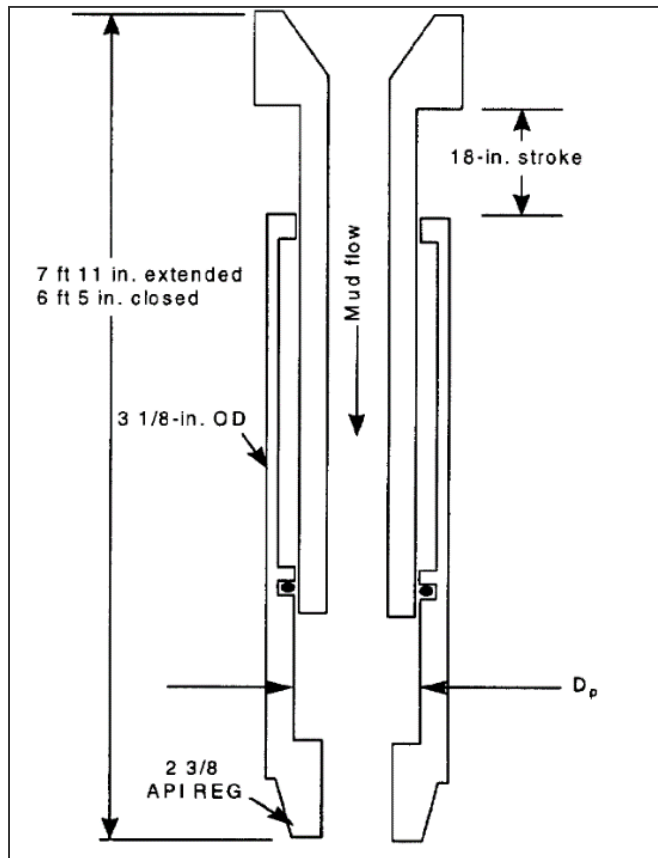
- Variety of power options (hydraulic, electric, and hybrid).
- Commercially available

### Disadvantages

- Difficulty traversing washout sections (use of multiple units can alleviate this)
- Decreased or inconsistent performance in situations of poor hole cleaning
- Potential for cuttings build-up
- Potential for lockup in instances of power failure (most, if not all, tractors have provisions that retract gripping units upon failure)
- Unproven durability/performance when subjected to drilling vibrations. According to PetroWiki, coiled tubing drilling (CTD) is currently 100% slide drilling.

# WOB Tool Options

## Bumper/ Hydraulic Thrusters



- Advantages
  - Smaller length in comparison to the WOB Equalizer
  - Ability to run bit to bottom with no WOB.
- Disadvantages
  - Positive feedback between WOB provided and differential pressure
  - Variety of operational nuances (i.e. fluid incompatibility)

# Current Status

- Completed system specification for requirements definition
- Completed borehole modeling with Geothermal Resources Group
- Tested small diameter COP 20 Atlas Copco percussive hammers at HOT facility
- Implemented weight-on-bit control algorithm for percussive drilling
- Working with commercial vendor to develop downhole rotation
- Developing downhole WOB control solutions

# Future Work

Milestone	Description	Completion Date
<b>FY17</b>	Design and complete build of small diameter, low WOB drilling tools. (3" diameter percussive hammer, 3 5/8" laser-mechanical optics package and drill) Verification Method: Inspection, analysis, limited lab tests	Q4 FY17
<b>Go/No-Go</b>	Quarterly Progress Measures <ul style="list-style-type: none"> <li>- Identify downhole rotation and WOB control options</li> <li>- Preliminary designs for downhole tools are complete and ready for fab</li> <li>- Designs for low WOB tools are in production</li> <li>- Low WOB tools production is complete</li> </ul>	Q1 FY17 Q2 FY17 Q3 FY17 Q4 FY17
<b>FY18</b>	Build, integrate, and conduct initial prototype lab test bottom hole assembly (BHA) (drill, rotation, WOB control) Verification Method: Demonstrate rapid ROP and path towards compelling commercial economics in a laboratory test frame.	Q4 FY18
	Quarterly Progress Measures <ul style="list-style-type: none"> <li>- Select and acquire rotation option for BHA</li> <li>- Implement WOB control</li> <li>- Successfully integrate BHA components</li> <li>- Test integrated low WOB BHA</li> </ul>	Q1 FY18 Q2 FY18 Q3 FY18 Q4 FY18
<b>FY18</b>	Submit final report to DOE	Q4 FY18