



# High Temperature 300° C Directional Drilling System

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# Mandatory Overview Slide



- Timeline
  - Project Start Date: 12/29/2009 (6/15/2010 est.)
  - Project End Date: 12/28/2012 (6/14/2013 est.)
  - Percent Complete: 0%
- Budget
  - Total project funding: $6,363,900
  - DOE share: $5,000,000
  - Baker Hughes Share: $1,363,900
  - Funding 2009: $0
  - Funding 2010: $690,000 (est.)
- Barriers
  - EGS Well Construction Capability:
    - The inability to drill and complete wells meeting EGS requirements (high temperature, high flow rate, low cost) results in a greater risk of impairing production or even losing wells when drilling

# Relevance/Impact of Research



- Objective:
  - provide a directional drilling system that can be used at environmental temperatures of up to 300° C, and at depths of 10,000 meters.
- Drilling System Components:
  - Drill Bit:
    - Will investigate PDC, Roller Cone and Impreg Diamond bits, matched to motor and fluid
  - Steerable Motor
    - Will investigate PDM (positive displacement motors), technical fallback is turbine but issue matching with drill bit.
  - Drilling Fluid / Equipment
    - Will develop a drilling fluid & lubricant for 300C
- Impact
  - Capability (directional wells) and efficiency (goal is 50 hours plus on-bottom).

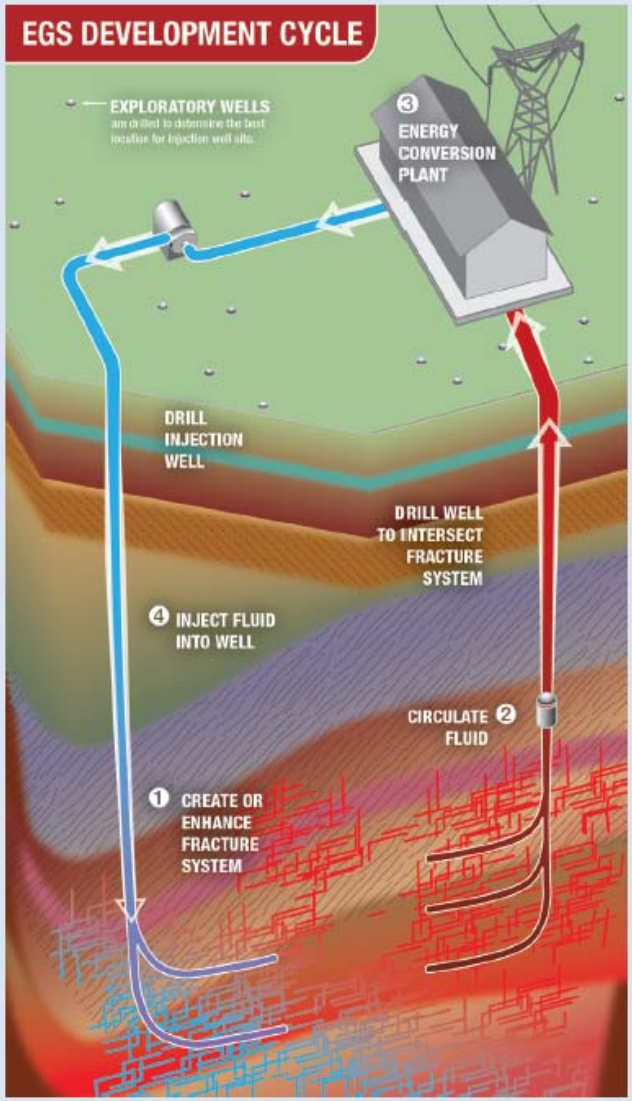


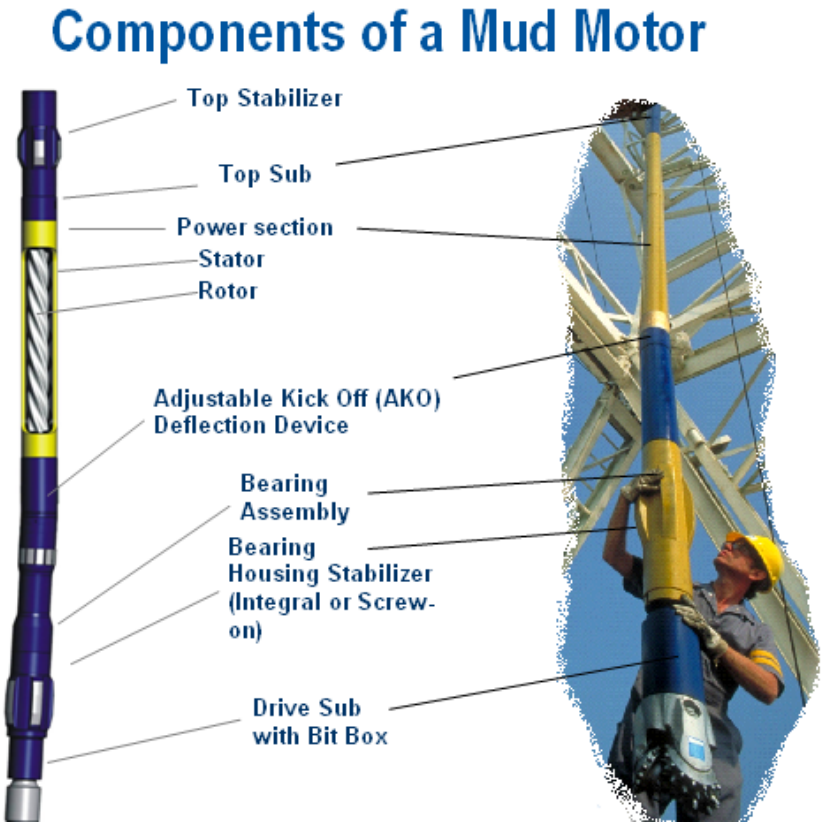

Figure 1.2. Enhanced Geothermal Systems

# Scientific/Technical Approach

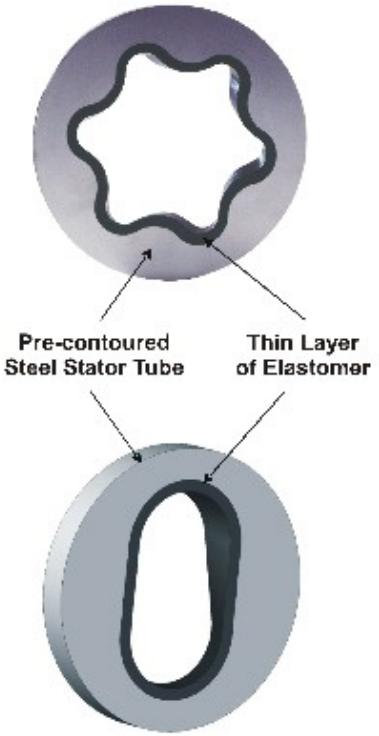


- Project divided into 3 phases for each component:
  - Concept: with go/no-go decision point after 1 year
  - Design, manufacture, assemble and laboratory system test
  - Testing: controlled, commercial
- Bit Concepts:
  - Roller Cone
    - Challenges: seal technology
  - PDC Bit
    - Challenge: Compact thermal stability
  - Impreg bits
    - Challenge: Drilling efficiency

- Positive Displacement Motor
  - Challenge: Elastomer, bearings, material corrosion




**190 C**



# Scientific/Technical Approach



- Drilling Fluid Challenges:
  - Thermal stability of products and drilling fluid system
  - Stability of rheological properties / mud gellation
  - Stability of filtration control products / poor filter cake quality & high fluid loss
  - Loss of lubricity
  - Contamination – Ability to tolerate a moderate amount of contamination (drilled solids, salt, hardness, cement, $CO_2$ and $H_2S$)
  - Increased mud weights for hole stability at greater wellbore depths and possible abnormal pressure
  - Suspension of weighting agents
  - Lost Circulation

- Progress:
  - Early days, signed patent waiver received, putting together team and resources.
  - Principal investigators / project managers
    - Aaron Dick: Principal investigator, technical lead drill bit and material science. Extensive experience in drill bit design, especially seal technology, materials.
    - Carsten Freyer: Project management, inter-divisional geothermal programs. Extensive project management experience in MWD systems.
    - Mike Otto: Technical lead, drilling fluids. Over 30 years experience, primary expertise with HTHP fluid applications including geothermal drilling fluids.
    - Kyle Taylor: Technical lead, steerable motors. Extensive MWD and wireline mechanical design experience, including both mud motors and turbines.

# Project Management/Coordination



*Major Project Deliverables & Milestones*


2 Project launch during Q2 2010

3 End of prototype testing during Q2, 2013

# Future Directions



- FY10:
  - Assemble teams, develop working concepts
  - Analysis of hard rock drillability data
  - Conceptual layout of bits
  - Laboratory Evaluation of Drilling Fluid
  - Evaluate Waste Management Equipment
  - Laboratory Verification of Drilling Performance
  - Evaluation of Alternative Downhole Drive and Steer Concepts
  - Match Motor Performance with Drill Bits
- FY 11:
  - Prioritize Motor/Steer Concept Opportunity
  - Provide 300C DDS Integral Concept
  - GO/NO-GO Decision in Q2 FY 11 (1 year into project)

# Mandatory Summary Slide



- Objective:
  - provide a directional drilling system that can be used at environmental temperatures of up to 300° C, and at depths of 10,000 meters.
- Drilling System Components:
  - Drill Bit, Steerable Motor, Drilling Fluid / Equipment
  - Development of 3 prototype systems with field testing
- Impact
  - Capability (directional wells) and efficiency (goal is 50 hours plus on-bottom).
- Risk
  - Materials (elastomers, or absence thereof)
  - Complex system at 300C
- Currently starting teams, locating resources
- GO/NO-GO decision point after 1 year in a 3 year research project.