Intersecting Wells with AMR for a Closed-Loop Geothermal System

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Geothermal Universe

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Closed-Loop Geothermal Well

Current project in Germany:
- Use Active Magnetic Ranging
- Connect 12 pairs of 3,000m laterals
- Form the 82,000m closed lateral loop for heat harvesting

**Closed System**

- No need for permeable aquifer
- Driven by natural thermosiphon, no pumping required
- No fracking required, no induced seismicity
- No GHGs or CO₂
- Minimal continual water use, no brine production
- OPEX is ~80% less than traditional geothermal
- Low thermal output risk or uncertainty
- Project cycle time 3 to 5 years
- Baseload and Dispatchable
Wellbore geometry and placement challenges

8km MD
4.5k TVD
62/65m TVD/Lateral separation
Surveying tool limits
Ranging limits
Following the target well
AMR solutions in Germany

Short-range (near-bit) and long-range magnet tools in the BHA.

Parallel drilling with AMR checks along tangent sections.

Unique solution to intersect two wells with the motorized RSS BHA.

Gyro-MWD and survey corrections in laterals to reduce the EOU.

Pump down wireline-conveyed AMR sensors.

Customized ranging algorithms and procedures.
Rotating magnet subs in Germany

Long-range parallel drilling up to 100m DoD

Intersection with a near-bit RSS-integrated sub.
Long-range parallel drilling up to 100m DoD
Parallel drilling with AMR along tangent sections

100m Depth of Detection after landing.

30m C-to-C before intersection section.

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Intersecting with AMR surveys at 7450-7800m MD

Delta HightSide, m
Vertical Separation

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Intersecting with AMR surveys at 7450-7800m MD

Delta RightSide, m

Horizontal Separation

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Results

1st-attempt intersection of two horizontal wells with AMR at 7,805m MD / 4,633m TVD.

Instantaneous hydraulic communication between two wells with hot fluid circulation due to a thermosyphon effect.

Coordinated teamwork of two rig crews and services.

Lessons learned for AMR operations in multi-lateral wells.
Results

The 1st lateral loop is finished.

Currently drilling and ranging the 2nd lateral loop.
Next steps in AMR

Deploy a collar-mounted sensor as a part of the drilling BHA, to replace a wireline-conveyed sensor.

Prototypes manufactured and tested, in partnership with Gunnar Energy Services, Erdos Miller, SLB.

Enhanced downhole processing capacity of raw magnetometer and accelerator data sets.

Improved active magnetic ranging algorithms for trajectory optimization of two wells in real-time.
Field Test April 2024

Demonstrate Active Magnetic Ranging system and services as a viable ranging-while-drilling and well intersection solution in a live drilling environment with horizontal wellbores.

Without wireline conveyance.
Field Test April 2024

In partnership with: Eavor™

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Questions?