



N732: Geothermal Drilling Technology and Engineering

Instructor(s): Kevin Gray

Format and Duration

Classroom - 5 Days

Summary

Drilling is one of the most critical and costly phases of a geothermal project. This course provides a comprehensive understanding of geothermal drilling technology and engineering principles, ensuring that participants can design, plan, and execute geothermal wells efficiently and safely.

This course provides a detailed technical understanding of drilling technology, equipment, and engineering strategies required for successful geothermal well planning and execution. Participants will explore the key differences between geothermal and conventional oil & gas well drilling, with specific focus on metallurgy, well control, and high temperature operational challenges for both surface and downhole equipment. The metallurgy required to deal with high temperature corrosive brine environments will be explained to develop a best value approach to the selection of materials to withstand geothermal conditions. Whilst not conventionally considered a Geothermal issue, well control and safety considerations will be explained to allow the students to be able to manage high pressure and high enthalpy geothermal wells. The course will cover drilling challenges that are unique to geothermal wells including High temperature fluid handling, lost circulation, and wellbore thermal stability. The differences between geothermal and oil & gas drilling will be examined and the course will explain how industry best practices can be adapted for geothermal projects. By the end of the course, participants will have a holistic perspective on geothermal drilling, understanding its unique challenges, technology requirements, and project execution strategies.

This is a Foundation to Skilled level course designed for professionals involved in geothermal drilling, well design, and project execution.

This course is delivered in partnership with Black Reiver Consulting Ltd.

Learning Outcomes

Participants will learn how to:

1. Understand the key technologies and engineering strategies required to design and execute successful geothermal wells.
2. Analyse metallurgy requirements for geothermal wells – High temperature casing, tubulars, and corrosion resistance.
3. Differentiate geothermal drilling from oil & gas drilling, recognizing the challenges and adaptations required.
4. Select and apply the correct tools and equipment for efficient geothermal drilling operations.
5. Mitigate specific drilling challenges related to geothermal wells, including lost circulation and high temperature wellbore stability.
6. Improve operational efficiency and reduce drilling costs through proper well planning and execution strategies.



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Training Method

This is a classroom course comprising a mixture of lectures, discussion, case studies, and practical exercises.

- Instructor led technical sessions covering real-world case studies and geothermal drilling projects.
- step-by-step guidance on geothermal well planning, drilling technologies, and safety considerations.
- Hands-on demonstrations and simulations of geothermal drilling challenges and solutions.
- Interactive discussions and Q&A sessions to explore real-world operational challenges.
- Comparative analysis of geothermal vs. oil & gas drilling to highlight key industry adaptations.

Who Should Attend

This course is ideal for:

- Oil & gas companies venturing into geothermal drilling.
- Drilling engineers, wellsite supervisors, and rig managers involved in geothermal well planning and execution.
- Geoscientists & reservoir engineers seeking better collaboration with drilling teams.
- Geothermal drilling & engineering companies working on well design and execution.
- Contractors & service companies providing drilling and well engineering solutions.
- Venture capital groups, civil engineering firms, and energy authorities assessing geothermal drilling investments.

Course Content

1. Fundamentals of Geothermal Drilling

- Introduction to Geothermal Wells
- Understanding Geothermal Energy
- Geothermal definitions and classification of geothermal wells.
- Origin of geothermal heat and sources of subsurface heat transfer.
- Types of geothermal energy exploitation – Hydrothermal, Petrothermal, and Enhanced Geothermal Systems (EGS).
- Global geothermal hotspots and resource potential.

2. Comparing Geothermal & Oil & Gas Drilling

- Differences in well construction, drilling objectives, and operational challenges.
- The geothermal drilling performance gap – Limitations and efficiency improvements.
- High-enthalpy vs. low-enthalpy geothermal wells.

3. Geothermal Resource Valuation & Economics



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- Estimating the value of a geothermal resource.
- Exploration costs, drilling investments, and long-term project feasibility.
- Financial incentives and regulatory frameworks affecting project viability.

4. Basics of Rotary Drilling for Geothermal wells

- Drilling Rigs & Equipment for geothermal wells
- Types of drilling rigs & fit for purpose urban rigs
- Key rig components – Derrick, hoisting, and rotating systems.
- Drilling fluid circulation systems and solids control.
- Cooling equipment and options

5. Rig Personnel & Operational Roles

- Wellsite organization and hierarchy.
- Roles of the drilling team – Drilling engineers, wellsite supervisors, tool pushers, rig managers.
- Geothermal well planning and execution responsibilities.

6. Rig Capabilities & High-Temperature Adaptations

- Rig power requirements and system efficiency.
- Equipment modifications for high-temperature geothermal drilling.
- Challenges in maintaining rig performance in extreme geothermal conditions.

7. Drilling Fluid Systems & Heat Management

- High-temperature drilling fluids and thermal stability.
- Cooling systems for geothermal drilling fluids.
- Fluid selection, additives, and environmental considerations.

8. Downhole Tools & Equipment

- Bottom Hole Assembly (BHA) Components
- Overview of BHA configurations for geothermal drilling.
- Drill collars, stabilizers, and heavy-weight drill pipe.
- High-temperature motor and turbine technology.

9. Measurements While Drilling (MWD) & Logging Tools

- Importance of MWD and survey type in geothermal well placement.
- Temperature limitations and sensor durability in extreme heat.
- Formation evaluation techniques for geothermal reservoirs.

10. Drill Bits for Geothermal Wells



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- Drill bit types – PDC, tricone, and hybrid designs.
- Selection criteria based on formation hardness and temperature resistance.
- Impact of temperature and wear on bit performance.

11. Directional Drilling & Wellbore Positioning

- Fundamentals of Wellbore Steering
- Methods of directional drilling in geothermal wells.
- Comparing conventional rotary drilling vs. steerable systems.
- Techniques for reducing tortuosity in high-temperature environments.
- Challenges in High-Temperature Directional Drilling
- How extreme temperatures impact well trajectory control.
- Limitations of rotary steerable tools in geothermal drilling.
- Advanced Wellbore Surveying & Positioning
- Wellbore trajectory monitoring and survey tools.
- Uncertainty analysis and well collision avoidance.
- Injection-production loop wellbore intersection planning.
- Advanced Geothermal Well Design
- Geomechanics of Geothermal Wells

12. Rock Stress & Wellbore Stability

- Understanding far-field stresses and their impact on wellbore integrity.
- Thermal stress effects on casing and formation strength.

13. Hydraulic, ERS & Thermal Fracturing in Geothermal Wells

- Induced fracturing for reservoir enhancement.
- Applications of Extended Leak-Off Tests (ELOT/XLOT).
- Electrical Reservoir stimulation.
- System design for Electrical Reservoir Stimulation.
- Managing stress regimes in geothermal stimulation.

14. Formation Damage & Well Productivity

- What is Formation Damage?
- Understanding skin factor and permeability reduction.
- Factors contributing to formation damage in geothermal wells.
- Strategies to Minimize Formation Damage
- Drilling fluid selection and formation protection.
- Managing filter cake deposition and wellbore stability.
- Acidizing and chemical stimulation techniques.

15. Tubular Design & Metallurgy



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- Casing & Tubing Selection
- OCTG tubulars and casing design for HPHT geothermal wells.
- Casing sizes, weights, and material specifications.
- Burst, collapse, and tension limitations for geothermal casing.

16. Metallurgy & Corrosion Challenges

- High-temperature material selection and cost considerations.
- Effects of corrosion on well components and flowlines.
- Thermal de-rating of tubular strengths and reservoir fluid souring.

17. Well Control & Safety Considerations

- Basics of Well Control for Geothermal Wells
- Hydrostatic pressure principles and overpressure risks.
- Conventional overbalance drilling and geothermal well kicks.
- Blowout Preventers (BOPs) and geothermal-specific safety systems.
- Dissolved toxic gasses
- Condensation and bullhead kill operations
- Well Integrity & Barrier Envelopes
- Double barrier principles for geothermal well integrity.
- Managing pressure and temperature fluctuations in high-enthalpy wells.
- Regulatory compliance and safety protocols.

18. Drill Bit Design, Performance & Drilling Problems

- Drill Bit Selection for Geothermal Applications
- Understanding drill bit wear mechanisms.
- New technologies in bit design for improved performance.
- Drilling approach for performance drilling in hard rocks.

19. Common Drilling Problems & Mitigation Strategies

- Stuck pipe and hole cleaning issues.
- Torque and drag considerations for high-temperature drilling.
- Wellbore instability and differential sticking.

20. Shock, Vibration & Drilling Optimization

- Understanding Shock & Vibration (S&V) in Geothermal Drilling
- Axial, lateral, and torsional vibration mechanisms.
- Design considerations to reduce S&V impact on drilling performance.

21. Drilling Fluid Selection & Thermal Stability



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- Measurement and control of drilling fluid properties.
- Loss circulation control and fluid management.

22. Legislative Frameworks & Risk Management

- Regulatory Considerations for Geothermal Drilling
- Current EU geothermal legislation and upcoming frameworks.
- Licensing, permitting, and environmental compliance.
- Public perception and stakeholder engagement challenges.
- Risk Assessment & Project Management
- Building risk registers for geothermal drilling operations.
- Defining Key Performance Indicators (KPIs) for drilling success.
- Managing team competencies and training for high-temperature drilling.

This comprehensive training course provides participants with the technical expertise and problem solving skills required for successful geothermal drilling operations. By the end of the course, attendees will have:

- A strong understanding of geothermal well planning and execution.
- The ability to differentiate geothermal drilling from conventional oil & gas drilling.
- Knowledge of geothermal specific well control, metallurgy, and tubular selection.
- Practical skills to solve drilling challenges such as high temperatures, lost circulation, and wellbore instability.
- A holistic view of geothermal drilling as part of an overall energy project.

Participants will leave with the skills and confidence to engage in geothermal well planning, execution, and problem solving, ensuring safe and efficient drilling operations in high temperature environments. This course can be tailored to regional policies, local geothermal resources, and specific industry challenges.