IADC DEC Q2 2021 Tech Forum, "Geothermal Drilling Challenges"

June 30, Wednesday, 08.30-12.15

The IADC Drilling Engineers Committee will hold its Q2 Technology Forum on 30 June under the theme "Geothermal Drilling Challenges." While the idea of drilling for geothermal has been around for some time, and some work has been done in that area, increasing concern for climate change and the associated increasing interest in clean, renewable energy sources as an alternative to petroleum, especially for power generation, has brought geothermal drilling to the forefront. Universities, government think tanks and private companies are all involved in geothermal drilling projects.

What special drilling concerns come with that application? What advances in technology are required for it to achieve its full potential? How can the existing talent pool and equipment be adapted to exploit this opportunity? This Technology Forum will explore the answers to these questions and more.

This event will be held online via Zoom. To attend, make sure to register on IADC's website to get your Zoom link/password. Log-in information cannot be shared; each log-in passcode will be unique to the registered attendee.

Minutes:

08.30-08.35 Welcome – Dennis Moore, Chairman; Roy Long and Robert Estes, DEC Board members

08.35-09.05 **"Geothermal Wells and Drilling Challenges,"** Ozgur Balamir, GeothermEx
Click here to view the powerpoint.
Click here to view the recording.
Drilling for geothermal resources generally utilizes petroleum drilling technology and equipment, but several characteristics of geothermal resources cause problems with current technology, significantly increasing the time and costs required to drill geothermal wells. This presentation will present several different types of geothermal drilling settings and the typical nonproductive time criteria and well construction essentials in geothermal wells. The presentation will then focus on the more demanding types of geothermal wells and the drilling challenges endemic to hydrothermal geothermal resources. The remainder of the presentation introduces the root causes of drilling challenges in geothermal wells and then ties these up to specific challenges, such as losses, high temperature, hard and fractured formations, and their effects on geothermal drilling.

09.05-09.35 **"Geothermal Drilling Challenges & Concerns,"** Hani Ibrahim, Drilling Performance SME
Click here to view the recording.
Geothermal drilling entails an elevated state of risk above and beyond the traditional oil & gas drilling operations. These specific risks are either unique to the geothermal wells, or have a higher occurrence combined with a raised severity. Several issues can jeopardize the quality of the well: accurate geological information, wellbore stability, drilling breaks, temperature, lost circulation, formation strength and abrasiveness, and directional planning. Adoption of existing techniques and tools can shorten the waiting time for specialized equipment; however, precautions should be implemented to minimize failures. DWOP meeting is a good venue to

exchange the concerns of the campaign and have clear awareness of the risk, provided it is held at an ample time prior to the intended spud day allowing for the mitigations to be implemented and the proper tools to be ordered, particularly as the lead time for the non-standard design is prolonged.

09.35-10.05 **"Lessons Learned and Performance Improvement: Drilling Case Study from Sarulla Geothermal Operation, North Sumatra,"** Hadi Permana, Halliburton
Click here to view the powerpoint.
A lessons-learned and continuous improvement approach was used to significantly improve drilling performance during a five-well drilling campaign on one drilling pad at the Sarulla geothermal development field in North Sumatra, Indonesia. Drilling challenges on this pad included severe lost circulation, high vibration when drilling the surface hole sections, soft and swelling clays in shallow sections, along with sloughing paleosol formations in the deeper section, and a corrosive drilling fluid environment, which resulted in drill pipe washouts and twistoffs. Optimized intermediate casing setting depths were developed to manage the sloughing formation issues. The use of nested liners was employed to stabilize the difficult hole sections already drilled but allowing drilling to commence safely with smaller hole sizes deeper. To help prevent intercepting previous wells and kickoff issues in the soft clay formation, the 26-in. surface hole section was "nudged" using directional drilling techniques. Formation clay samples were tested using the linear swelling method and X-ray diffraction to optimize drilling fluids formulations.

10.05-10.35 **"It's Just a Hole in the Ground (or is it?): Physics-based Practices Achieve Ground-breaking Performance in Geothermal Drilling Application,"** Sam Noynaert, Texas A&M University
Click here to view the powerpoint.
New technology and novel practices are often discussed as the solution to generally poor geothermal drilling performance. The reality is that significant performance gains can be made through application of physics-based drilling practices and workflows without the need to develop new tools or advanced technology. Texas A&M trained and advised the drilling team for the Department of Energy FORGE project on physics-based practices for a complex geothermal test well. All of the last 6,000 ft of the well, much of it drilled at 65-degree inclination, was high compressive strength granite. The resulting performance was over 50% better than expected. The presentation will cover the unique aspects of the well design, the limiters to drilling performance and several of the key findings and highlights. Due to multiple pre-planned trips for data purposes (logs, cores, DFIT), bit forensic data is particularly good for this well as bits were often pulled in very early stages of damage. High frequency downhole data was also gathered, which when coupled with the surface data and bit pictures, create a one-of-a kind dataset for those planning future geothermal or hard rock formations of any type.

10.35-10.45 BREAK

10.45-11.15 **"3 Things I Wish I Knew Transitioning from O&G to Geothermal,"** George Stutz, US Department of Energy
Click here to view the powerpoint.
Click here to view the recording.
This presentation addresses the differences between geothermal drilling and oil and gas drilling, starting with a discussion of resource difference and the fundamental value proposition where hot brines are typically worth $0.10s per bbl while hydrocarbon liquids are $10s per bbl,

high temperatures, rock hardness and occurrence of naturally occurring fractures, and cost conscious decision making. These factors and challenges are brought together to discuss how this has shaped approaches and cost conscious decision making within the geothermal industry. Low well counts has led to a lack of quality data to apply data analytics approaches in geothermal. Focusing on lessons learned and direct observations from Utah FORGE, this presentation will provide context on how best to share and adapt oilfield technology to challenges unique to geothermal drilling.

11.15-11.45 **"A Comprehensive Tubular Design and Materials Selection Approach for Geothermal Wells,"**
Suri Suryanarayana, Blade Energy Partners
Click here to view the powerpoint.
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Lifetime integrity of geothermal wells is an important consideration in their design. The authors developed a comprehensive design approach addressing all the threats to well integrity in geothermal wells. The foundational element of this approach is a post-yield, low cycle fatigue based design for the design of geothermal well tubulars. This approach addresses some of the major threats to well integrity in geothermal wells: low cycle fatigue, brittle failure, and connection failures. Other commonly reported threats to well integrity include tension-collapse (or "cold collapse"), inelastic buckling of short unsupported sections, and collapse induced by annular pressure buildup in trapped fluid pockets in cement. We discuss each mechanism and how tubulars may be designed to avoid these failures. Finally, despite appropriate design, tubulars may succumb to various corrosion mechanisms, as well as typical corrosion mechanisms in geothermal wells, and presents an approach to analyze corrosion and consider it in the design of tubulars, and in the selection of materials. Examples will be included.

11.45-12.15 **"Making 'Geothermal Anywhere' a Reality: Drilling Technology Capabilities, Gaps & Needs,"**
Eric van Oort, UT Austin
Geothermal drilling and well construction has traditionally been restricted to areas with very high geothermal gradients (in the range of 50-100°C/km) as encountered in areas with active volcanism, along plate boundaries, etc. Wells have typically not exceeded 5 km TVD and have been drilled with rather conventional drilling technologies. Recently, however, the idea of "Geothermal Anywhere" has attracted a lot of attention. This will require drilling deeper, i.e. 7-10 km TVD, and getting more reservoir access and exposure by drilling high deviation tangents and horizontal lateral sections at depth in rocks with very high compressive strengths (e.g. basalt, gabbro and granite with 25,000 – 50,000 psi UCS). The significant associated challenge is to drill cost-effectively in such a hard/abrasive rock environment at ultra/extreme HPHT conditions. This presentation will outline where we are today in terms of meeting this challenge, and how geothermal drilling can benefit from recent oil and gas drilling advances, as well as some new insights. In addition, it will touch upon the remaining gaps and needs that will need to be in the areas of directional drilling tools and dynamics, geomechanics and completions, fluids and cementing, MWD/LWD sensors and telemetry, casing and their connections, cost estimating, and capitalizing on machine learning and artificial intelligence.

12.15 Adjournment