Does Deep Drilling need a Revolution?
Webinar held on 4th Apr. 2025
Event summary

Introducing the Webinar and the DeepU Project

The webinar, held on April 4, 2025, was organized as part of the European DeepU project. Luc Pockélé (RED s.r.l.), the project coordinator of DeepU, opened the event with a general introduction to the initiative.

After a brief round of welcomes and introductions, Luc presented the objectives and scope of the DeepU project – a European initiative focused on developing new drilling technologies that utilise lasers and cryogenic gas. The primary goal of the project is to reduce drilling costs and enable access to geothermal energy from greater depths.

Luc explained how the technology works: a laser heats and fractures the rock, while cryogenic gas clears away the debris. The project involves designing and developing the drilling head and drill strings, validating the technology on a laboratory scale, and thoroughly examining its legal, OHAS and environmental implications.

The introduction concluded with an overview of the webinar agenda and the lineup of speakers, who would later explore various technical, regulatory, and environmental aspects of the DeepU technology.

Drilling Deeper Faster: an overview of State-of-Art Drilling Technologies

Kevin Mallin (GEOSERV) presented a comprehensive overview of current drilling technologies, focusing on potential non-mechanical methodologies for the future. As explained, mechanical drilling relies on applying weight and rotation to break rock, necessitating significant energy inputs for lifting, lowering, rotating of drill string components, and pumping fluids. The primary current technologies include rotary percussion (down-the-hole hammers), roller cone bits, and fixed cutter bits.

Kevin highlighted the recent advancements in PDC (polycrystalline diamond compact) bits, which have extended drilling capability to harder formations. He also emphasized the importance of rotary steerable systems for directional drilling.

Looking ahead, Kevin examined non-mechanical drilling methods, such as electro-pulse boring (EPB), plasma, microwave, and laser drilling. While acknowledging their potential, he emphasized that these technologies are not yet commercially viable for deep drilling and identified the gaps that need to be addressed.

Drilling rocks with laser, the experience of DeepU

Pawel Slupski (University of Padua) presented findings from a comprehensive study on laser drilling technology and the technological demonstration of the DeepU project. His presentation examined various laser-rock interactions, including absorption, reflection, melting, vaporization, and thermal spallation phenomena.

The research team conducted experiments on various rock types, including granite, sandstone, and limestone, using fiber lasers. The results demonstrated the effectiveness of laser drilling, revealing that thermal spallation was the most efficient method for creating larger diameter boreholes, achieving penetration rates of 5 to 15 meters per hour, depending on the rock type.

Supercritical Nitrogen for Deep Borehole Drilling

Maciej Chorowski (Wrocław University of Science and Technology) presented his team's findings on using supercritical nitrogen as a flushing fluid for deep borehole drilling. This choice was driven by nitrogen's thermodynamic properties and its effectiveness in removing drilling debris (cuttings). A numerical model was developed to determine the necessary pressure and flow rates for various borehole depths, validated with a dedicated test rig. The proposed system includes storing liquid nitrogen, compressing it to high pressures (up to 350 bar), and delivering it down the borehole through a specially designed channel with vacuum insulation. The team is facing significant technical challenges, including material selection for cryogenic temperatures, thermal load management, and mechanical stability.
In addition, a prototype coupling system is being developed to test the mechanical and cryogenic aspects of the design, ensuring its feasibility and reliability under extreme operating conditions.

Environmental and Regulatory Aspects

Riccardo Pasquali (GEOSERV) presented an in-depth analysis of the development of DeepU technology and its related challenges, focusing on environmental aspects and regulatory compliance. He highlighted the need for further research and development to integrate DeepU technology with existing drilling practices and regulations. The significant challenges associated with implementing DeepU technology include the use of industrial lasers and cryogenic fluids, as well as the necessity for seamless integration with established drilling equipment and procedures. He stressed the importance of addressing these issues to ensure the environmental sustainability and regulatory compliance of DeepU technology.