This research is funded by the European Union
(EIC, Pathfinder Programme, G.A. 101046937)



# Deep U-tube heat exchanger breakthrough:
## combining laser and cryogenic gas for geothermal energy exploitation

**PROJECT DURATION**

***START DATE***
01/03/2022
***END DATE***
28/02/2025

**COORDINATOR**
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Deep U-tube heat exchanger breakthrough: combining laser and cryogenic gas for geothermal energy exploitation

# THE DeepU PROJECT CONCEPT

**Optimising access to deep geothermal resources with new state-of-the-art drilling technologies to unleash clean, abundant energy from the Earth**

## Goals

- Geothermal energy accessible anywhere
- Extract energy from deep (>4 km) U-shaped closed-loop geothermal heat exchangers (HE)
- Reduce the costs of well drilling and provide HE immediately developed after drilling

## Key project figures

**6**
Partner organizations

**3**
Involved countries

**36**
Months duration
starting on March 1, 2022

## Key project actions

- Drilling technology design and development
- Validation at the lab scale
- Compliance with legal and environmental aspects
- Closed-loop scenario definition
- Cost-effectiveness assessment

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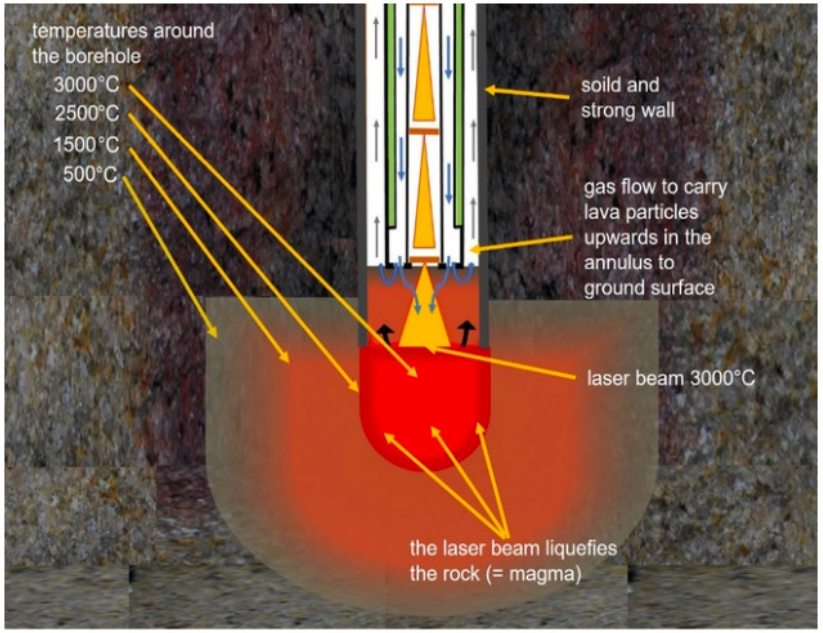
# INNOVATIVE DRILLING TECHNOLOGY

A **laser** propulsion drilling method is combined with **cryogenic gaseous flushing** for cooling the laser drill head.

**Improved ROP**
**Reduced drilling time and cost**




In case a glazed layer is formed on the borehole walls, the obtained systems are physically isolated from the surrounding formations and immediately developed after drilling without requiring further casing activities.

**Reduced time and cost for setting up the HE**

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# THE DeepU PROJECT OBJECTIVES

- **Develop and calibrate the drilling technology** by:
  - selecting a cryogenic gas able to cool in a controlled manner the rock melted by a laser;
  - developing an innovative lightweight drill string able to host the gas and the laser at the same time;
  - developing specific temperature control analysis and innovative laser lenses able to convey the heat and to sustain multilateral drilling;
- **Determine the physical-thermal phenomena** affecting different kinds of rocks to assess the borehole wall vitrification and integrity;
- **Evaluate the legislative aspects and environmental standards** related to the innovation proposed;
- **Define the DeepU geothermal exploitation potential**, including economic analyses, based on case studies modelling.

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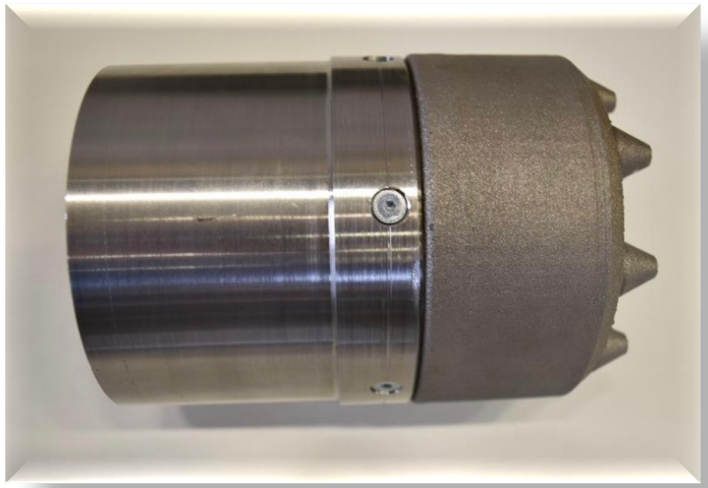
# A NOVEL PROCESSING HEAD FOR LASER DRILLING

With the help of the processing head, the cryogenic gas stream is directed onto the rock, which is melted by a high-power laser beam.

The first operational prototype consists of the titanium alloy Ti-6Al-4V in order to meet the requirements for the component in terms of mechanical strength and temperature resistance.

It has been 3D printed for rapid prototyping and to simplify printing the gas channels directly into the component.



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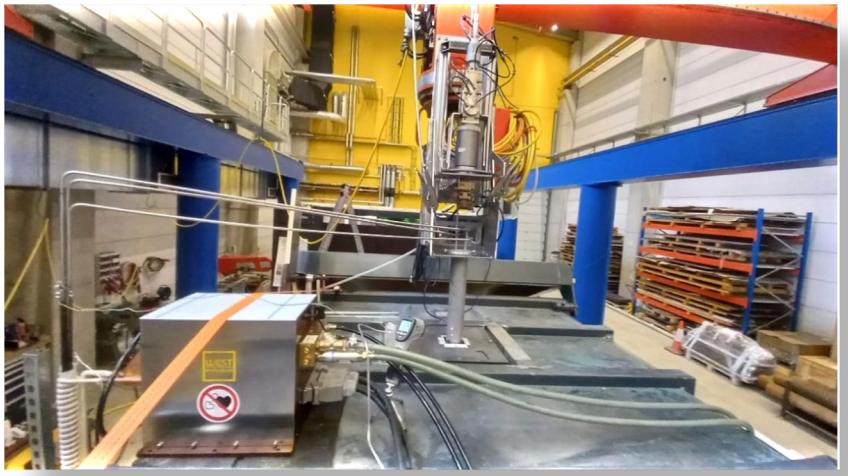
# LABORATORY TESTS

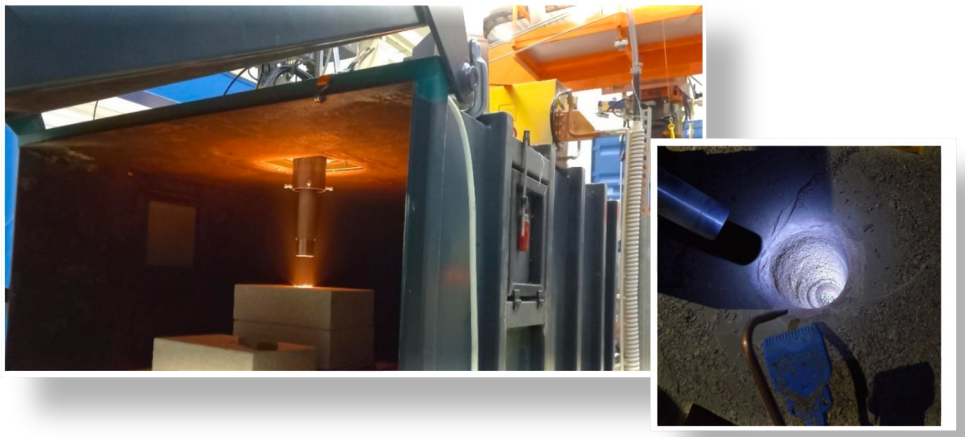
A lab for experimental development and testing of the new laser drilling process



**The technical equipment includes**

- a high-power laser system
- processing optics
- a drill string with the special 3D printed drill head
- a gas feeding system, with which the process gas can be tempered

The drill string is mounted on a robot.



The process application takes place inside a press container, which acts as a safety enclosure

Constant ROPs upwards of 20m/hr have been achieved, with relatively low energy inputs and no component wear.

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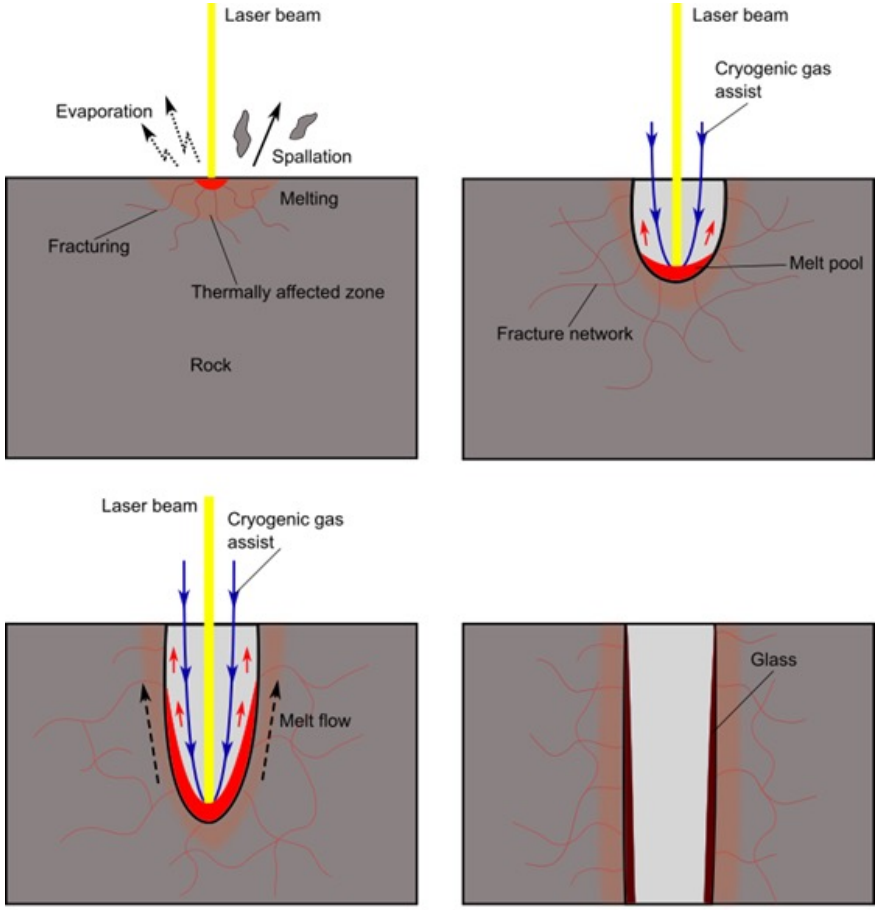
# CHARACTERIZATION OF THE ROCK SAMPLES

The petro-thermo-mechanical phenomena affecting different rocks are being analysed, also to assess the borehole wall vitrification and integrity.



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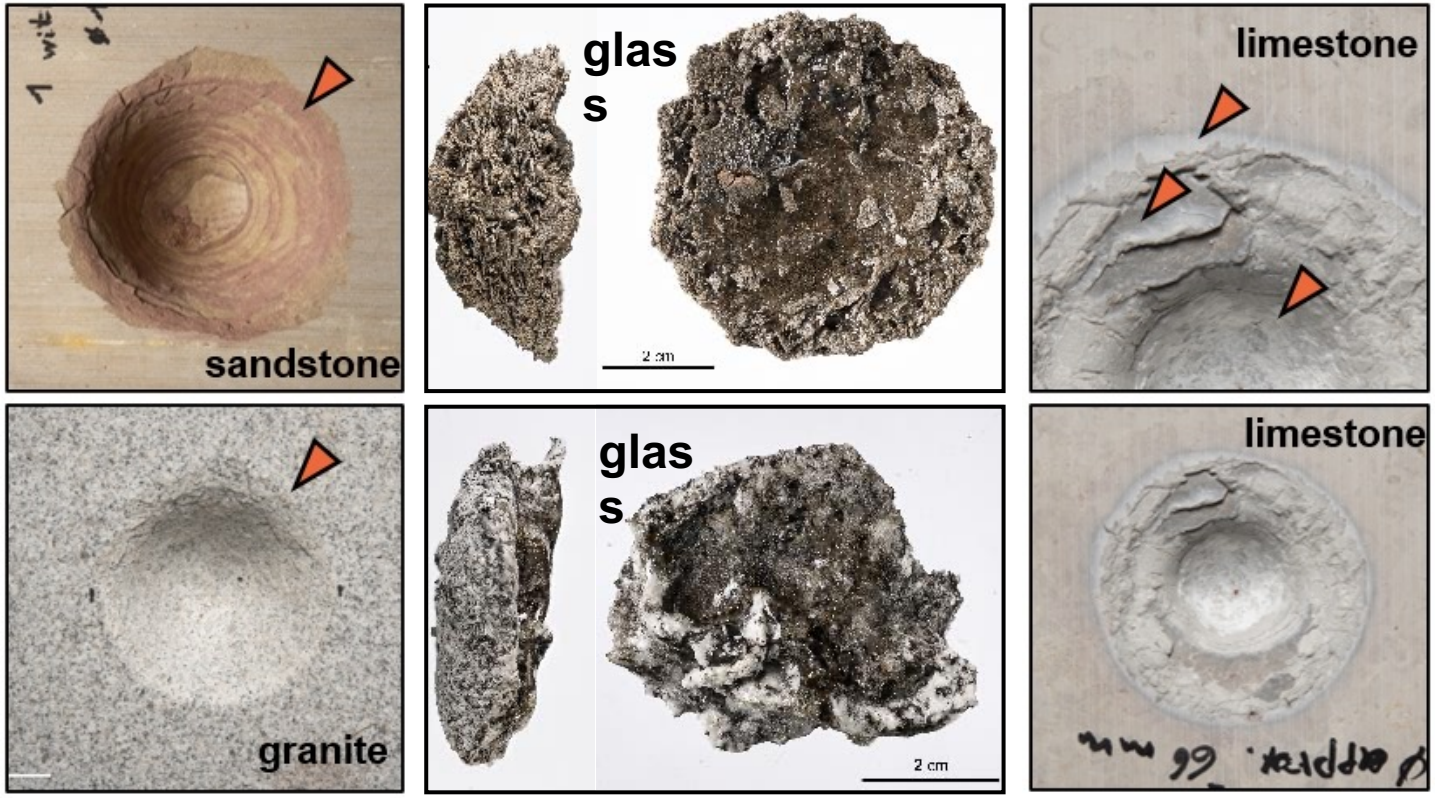

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# MARKET ANALYSIS FOR A SUSTAINABLE DEPLOYMENT

The project will analyse and assess:


The **exploitation potential**

The economics of the developed **drilling technology**

The **legislative** aspects and **environmental**

Health and safety (**EHS**) standards related to the proposed solution.

The **risks assessment** comparing DeepU technology to conventional deep drilling

# THE PROJECT TEAM

Università degli Studi di Padova

Fraunhofer IAPT

Prevent $CO_2$

Geoserv

Consiglio Nazionale delle Ricerche
Institute of Geosciences and Earth Resources
igg

RED Renewable Energy Development

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