Proceedings World Geothermal Congress 2026, Calgary, Canada, June 8—11, 2026

Sustainable subsurface energy storage at Utrecht Science Park

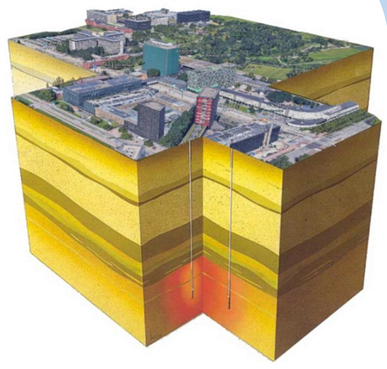
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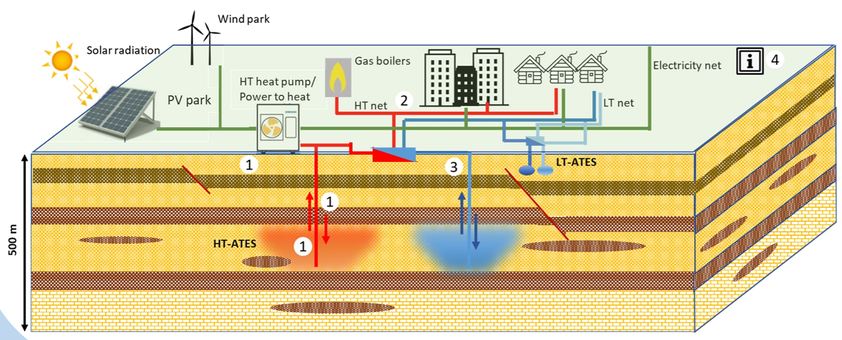
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INTRODUCTION

Utrecht University (The Netherlands) plans to reduce its carbon footprint by replacing fossil fuel heat sources with solar parks. The seasonal mismatch between solar power supply (summer) and heat demand (winter) can be resolved by converting solar power into heat and storing the heat at high temperatures in aquifers beneath Utrecht Science Park (USP).

The ACCEL-UTES project aims to demonstrate the feasibility of a sustainable solar-powered HT-ATES system to accelerate the energy transition.





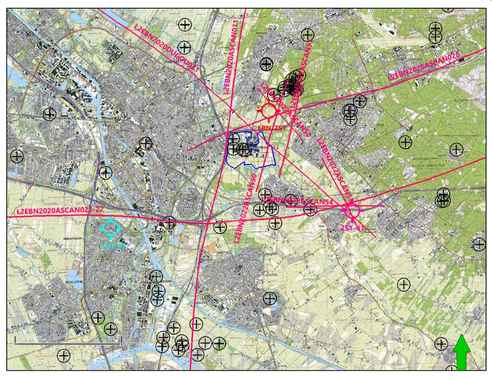
(*above*) Artistic view of the underground heat storage at Utrecht Science Park (USP)

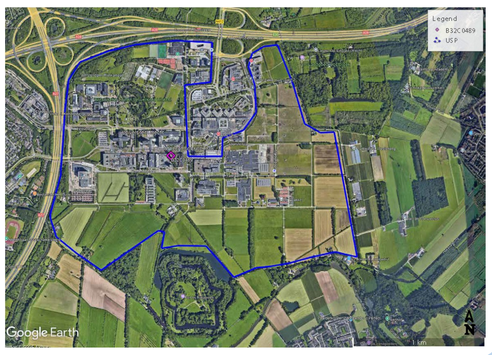
(*left*) Schematic overview of the HT-ATES system.

DATA AND METHODS

An important project component is to improve the existing USP geological model. The following methods have been employed:

1. Reprocessing of regional 2D seismic lines.
2. Stratigraphic reinterpretation of seismic lines.
3. Assembly, quality control, lithological categorisation and correlation of regional deep and shallow borehole data.
4. Construction of a 3D geological model.
5. Hydrogeological modelling of ATES-induced changes in aquifer pressure and temperature.

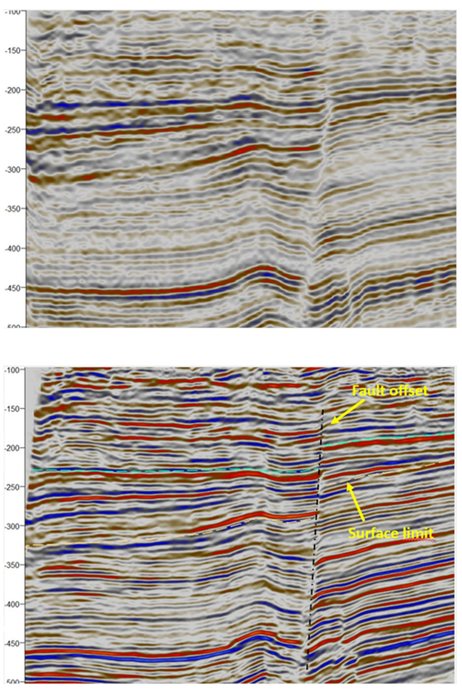




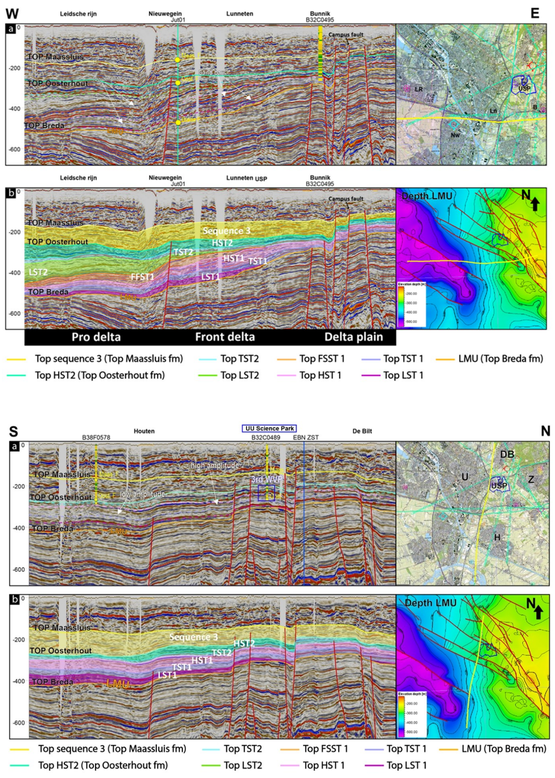
(*top*) Map of Utrecht city eastern region with location of reprocessed 2D seismic lines (red lines) and boreholes (circle symbols). Blue polygon is the USP border. (*bottom*) View of Utrecht Science Park (USP).

SEISMIC REPROCESSING AND REINTERPRETATION OF SEISMIC AND WELL DATA

Seismic line before (top) and after (bottom) reprocessing.

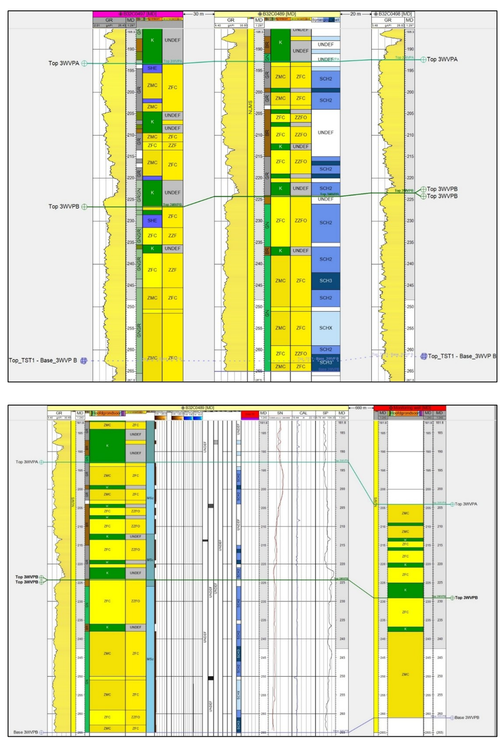


Regional stratigraphic interpretation of the Maassluis and Oosterhout aquifers.

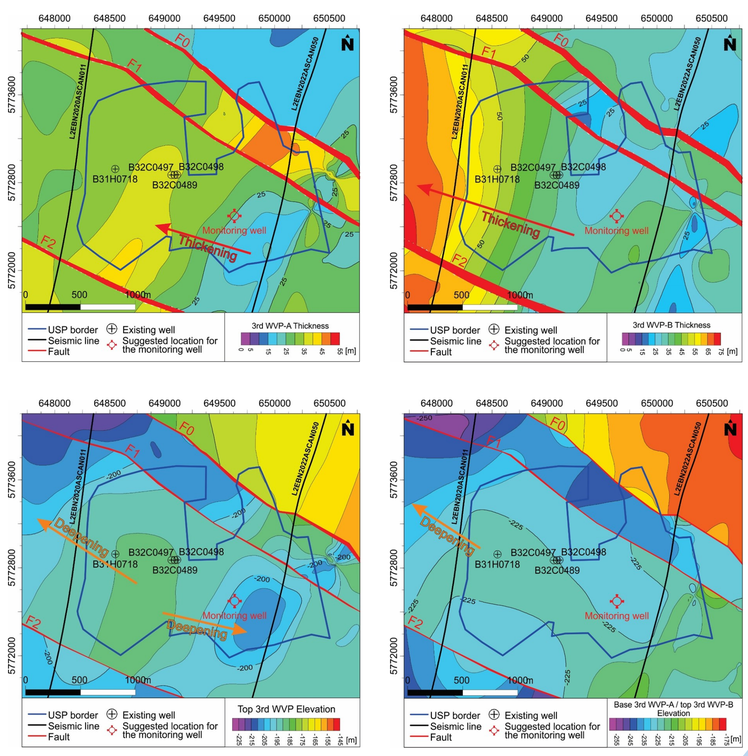


Well log correlations between:

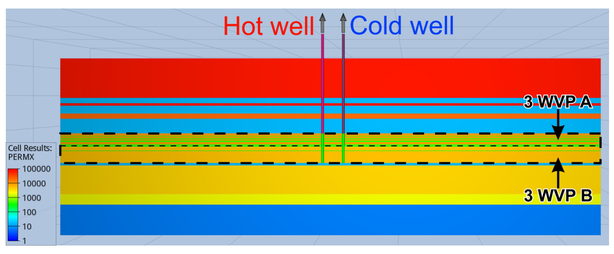
- top: 3 USP wells
- bottom: USP well and synthetic well at the location of a monitoring well.



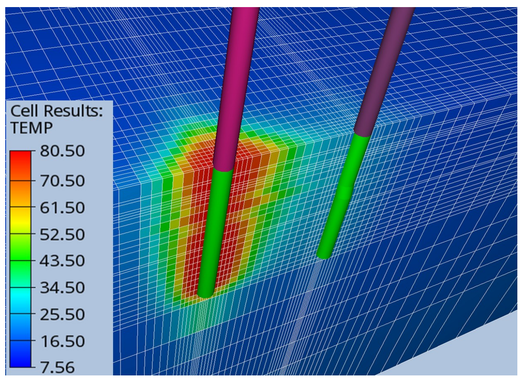
Constructed maps of the thickness (*top*) and depth-to-top (*bottom*) of the WVP3-A (*left*) and WVP3-B (*right*) aquifers.



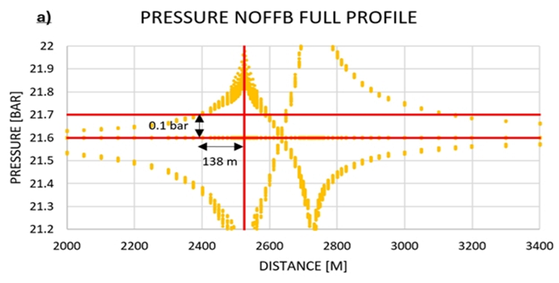
HYDROGEOLOGICAL MODELLING

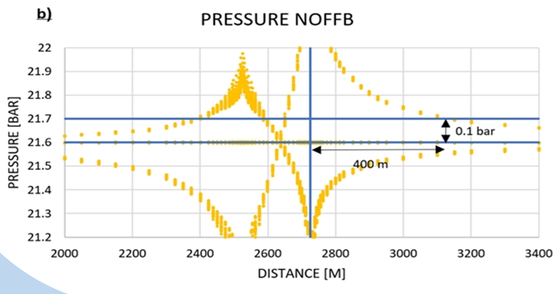


ROSIM layer-cake reservoir model for flow simulations. Wells are located 200m apart. Target aquifers are layers WVP3-A and WVP3-B. Colours: x-permeability.
(Source ROSIM: https://www.nlog.nl/en/tools)



Predicted magnitude and spatial extent of the temperature change in the aquifer around the hot and cold well during a seasonal charging cycle.





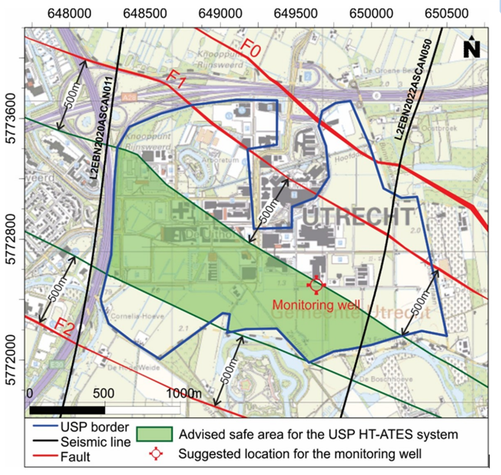
Calculated variation in aquifer pressure during a full production scenario (8 months injection, 4 months production, for 5 years).

Horizontal red and blue lines indicate at which distance from the hot well (top) and cold well (bottom) well the difference between induced and ambient aquifer pressure (21.6 bar) has dropped below the assumed safety limit of 0.1 bar.

CONCLUSIONS AND DISCUSSION

1. Advanced reprocessing significantly improved seismic resolution at shallow depths, enabling more refined stratigraphic models/modelling.
2. Integration and joint interpretation of seismic and borehole data resulted in an improved 3D geological model, enabling new trends in depth and thickness of the target aquifers to be identified.
3. Hydrogeological modelling helped identify the USP area with the lowest geological risks for exploitation.

- Geological uncertainties remain due to a lack of 3D and in-situ data. These will be reduced by a future monitoring well.
- The feasibility of a sustainable HT-ATES system will ultimately depend on the business case, which will take into account not only geological but also technical, economic, financial and social aspects.
- The results of this demonstration project will be useful for decision-making regarding the development of similar sustainable geo-batteries.



(*above*) Proposed location for a monitoring well in the green area (assessed as having low geological exploitation risks) and near an existing heating network. Blue polygon: USP border. Black lines: 2D seismic lines. Red lines: traces of deep faults.

Acknowledgements

This research is conducted within the Acceleration of Underground Thermal Energy Storage (ACCEL-UTES) project, funded by the Netherlands Enterprise Agency RVO (DEI124009), the Utrecht University Real Estate Division, the Utrecht University Department of Earth Sciences, and TNO-Geological Survey Netherlands.

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