3D geothermal reservoir characterisation in Nevada, USA

case study
industrial applications

Challenge

To develop and assess an integrated technology for characterizing in three dimensions the mechanical properties of highly heterogeneous fractured rock systems of a geothermal reservoir.

Solution

The solution consisted of deployment of iDAS™ and ULTIMA™ DTS over 9 kilometers of fibre optic cable in a trenched seismic and temperature surface array and 400 meters of fibre optic cable resistant to high temperatures in a downhole array. iDAS and ULTIMA DTS were selected for their revolutionary seismic and extremely fine temperature measurement capabilities, respectively, and for their capacity to be deployed in the harsh conditions experienced in geothermal reservoirs. iDAS was combined with an active seismic source and numerous geophones to carry out a time-lapse seismic survey. Temperature measurements from the ULTIMA DTS were combined with pressure measurements from multiple observation wells. Data were collected during four time intervals each representative of distinct hydraulic conditions due to alterations in the flow field from manipulation in pumping and injection. Collecting time series data under varying hydraulic conditions allows the dataset to be utilized to characterize the hydraulics of the geothermal reservoir through analyses of the poroelastic response.

Results

Both the surface and downhole fiber optic cables installations were completed successfully in late winter 2016. iDAS and ULTIMA DTS data were recorded 24 hours/day over the entire 9400 m of cable for a period of 15 days directly following installation. Analysis of the active and passive seismic data, temperature data, and other data collected is ongoing.

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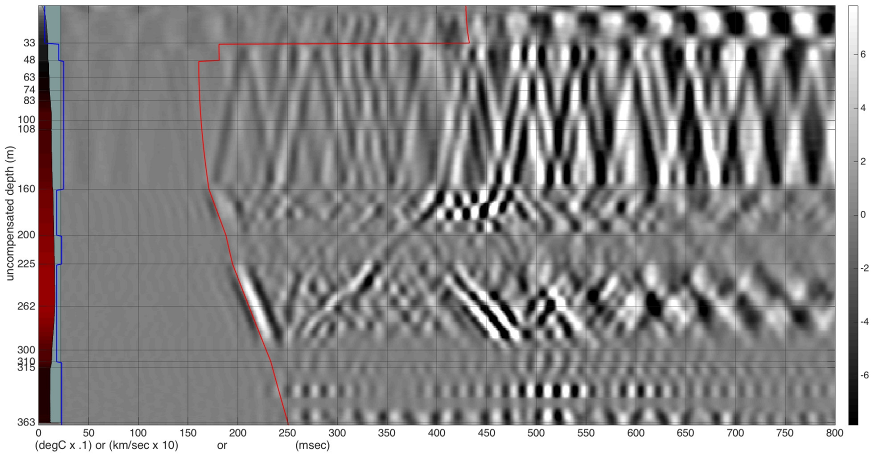
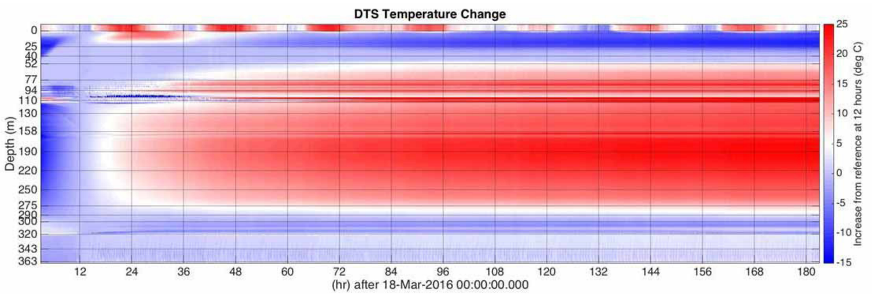
Discussion

A “natural laboratory” consisting of the reservoir underlying an active geothermal power plant located at Brady’s Hot Springs near Fernley, Nevada, USA was selected as an ideal site for testing the integrated approach and evaluating the method’s applicability for deployment at deeper EGS (Enhanced Geothermal Systems) fields.

The PoroTomo project includes a multidisciplinary team of scientists and engineers from both academia and industry focused on developing and accessing an integrated technology for characterization of EGS reservoirs. The geothermal specific technology developed as part of this project, as well as Silixa’s expertise developed from numerous installations worldwide in harsh environments can be deployed to provide insight into complex subsurface systems and processes. An improved understanding of fracture networks and their control of fluid flow and heat transport provides both reservoir engineers and plant operators with knowledge that can improve management of geothermal resources at both the well and reservoir scale.



ULTIMA DTS temperature profile and iDAS active source seismic data (offset VSP) from the downhole installation at Brady’s Hot Springs. The DTS temperature profile collected during a thermal recovery period indicates that the rock formation has cooled below 262 m due to power plant operations. iDAS active seismic data showcasing cable coupling and P and S wave signal. Temperature and seismic features show correlation as highlighted with blue and red on the plot.



ULTIMA DTS data is dominated by thermal recovery from cold water injection in the borehole during the cable installation process. The zone below 262 m has been cooled below the original thermal gradient due to production processes at the geothermal power plant.

Project partners:

The University of Wisconsin Madison
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ORMAT

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