Report of Transnational Access Projects

(Note: the information here will be publicly disclosed in the Geo-INQUIRE website, do not include sensitive information)

Project ID: C1_TA1-44-1_2

Principal investigator: Thomas Fechner (Geotomographie GmbH, Germany)

Project team (if applicable): -

Project title: Increasing the geotechnical information from DAS data by using conventional seismic sources (P-, SH- and SV-waves)

Project acronym: ConvDAS

Hosting installation: SINTEF test-site in Svelvik (Norway)

Hosting team: Michael Jordan (SINTEF, Norway)

Period of access: 12.-17.10.2024

Report of activities:
The project evaluated the benefits of using conventional sources and the two types of DAS cables (linear and HWC) together to characterise the subsurface and associated processes in a cross-hole experiment. At the test-site two SV-wave seismic cross-hole surveys were carried out using a high resolution SV-wave source and the installed DAS receiver system.

The study presents a novel approach to perform high-resolution S-wave crosswell tomography by combining Distributed Acoustic Sensing (DAS) with a borehole-coupled SV-wave source. Linear DAS fibers, which exhibit optimal sensitivity to vertically polarized shear waves, were used to acquire dense seismic datasets with significantly improved spatial resolution compared to conventional geophones. The SV-wave source (BIS-SV) provides efficient signal generation and coupling, allowing accurate traveltime picking and stable tomographic inversion results.

The field experiments conducted at the ECCSEL Svelvik CO_2 Field Lab demonstrated that DAS-based S-wave tomography can be performed with acquisition times of 3-4 minutes per shot depth and a twofold increase in spatial resolution compared to conventional methods. In contrast to P-wave tomography, S-wave results revealed distinct subsurface structures and allowed direct derivation of dynamic shear stiffness, a key parameter in geotechnical engineering. A low correlation (R^2 = 0.196) between P- and S-wave traveltimes confirmed that both methods provide complementary insights into subsurface properties.

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In addition, the DAS system eliminated the need for water-filled boreholes and mechanical geophone coupling, providing significant cost and logistical advantages. DAS seismic tomography adds significant value by providing continuous, high-resolution, cost-effective subsurface monitoring with minimal field effort, making it a transformative tool for modern geotechnical and environmental applications.

Project outcomes:

One paper was published under https://doi.org/10.1190/tle-2025-1012

Data are available to researcher upon request (email: tfechner@geotomographie.de).