

Acquisition of the GEUS2026-STORVORDE seismic survey

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1. Introduction

In 2026, the Geological Survey of Denmark and Greenland (GEUS) carried out a 2D reflection seismic survey around the village of Storvorde, east of Aalborg in northern Jutland, with the primary goal to characterise the subsurface prior to the drilling of a deep geothermal well. The seismic acquisition was funded by the Energy Technology Development and Demonstration Programme (EUDP) as part of the Heat4Ever project led by Green Therma.

The survey comprised 78.9 km seismic data from eight profiles (Figure 1), which were acquired during six weeks from February 28th to April 22nd, 2026 (Figure 2). The target depth was the sedimentary successions at 4–6 km depth in the Sorgenfrei–Tornquist Zone.

The technical design and acquisition were led by GEUS, with in-house seismic equipment, using one 16.5 tonnes vibroseis truck as source. The acquisition was carried out without any major deviations or challenges.

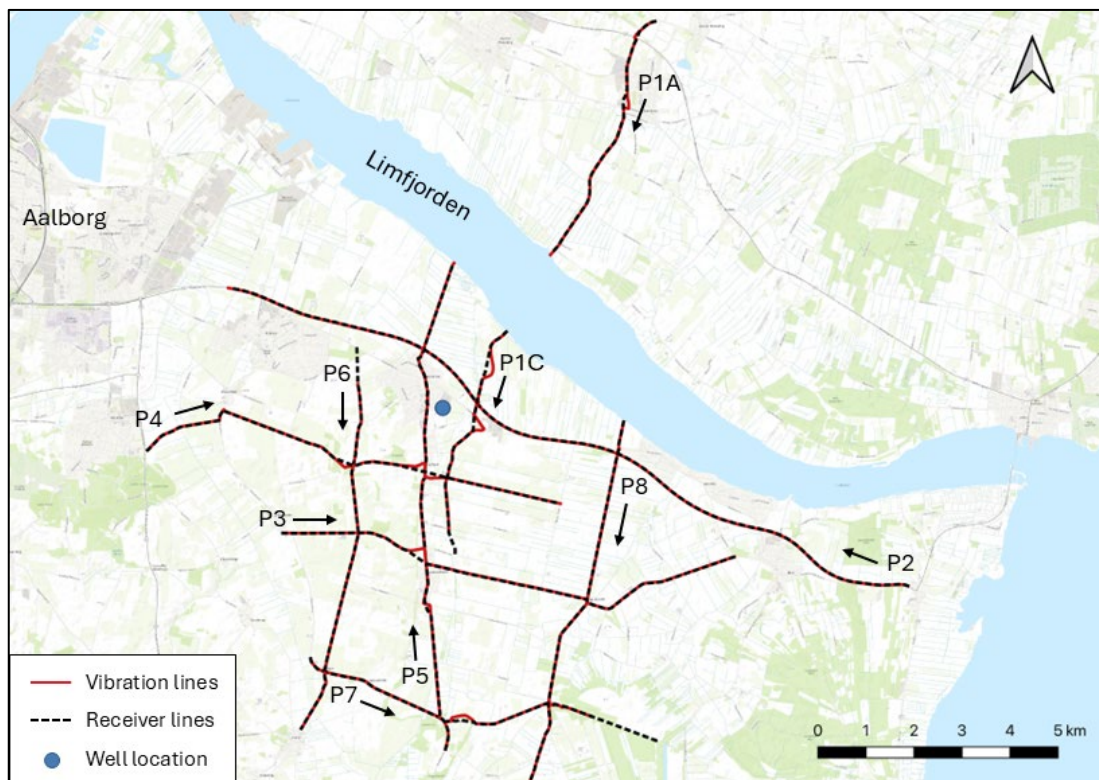


Figure 1. Survey design for the acquisition. A total of 78.9 km 2D seismic data was acquired along eight profiles (red/black hatched lines). The direction of the vibroseis truck movement is shown with the arrows. Profile names are abbreviated from P1A_GEUS2026-STORVORDE, etc. The planned well location in Storvorde is shown with the blue dot.



2. Operations

2.1 Crew

The field crew consisted of GEUS personnel with assistance from field assistants, who were all active students within geology, geoscience or geography at Copenhagen University, Aarhus University, and Aalborg University. A field person from the consultancy company COWI was in the field to coordinate permissions. Traffic safety was administered by the company Saferoad. A total of 17 permanent GEUS employees and 16 field assistants participated in the field operations, with a typical crew of four GEUS employees and four–six field assistants per day.

2.2 Health, safety and environment

Before the start of each field day, a ca. 20-minute safety briefing was held, to introduce the work of the day and flag any health, safety or environmental issues. All crew members stayed and dined at the hotel Scheelsminde in Aalborg.

Prior to the seismic acquisition, an environmental assessment was carried out and approved by the Danish Energy Agency. No major health, safety or environmental incidents occurred. No one was hurt in the field. Three seismic nodes were destroyed because they were hit by cars, corresponding to a loss of 0.25 % of the nodes. Minor damage to rental cars and sign trailers occurred. The vibroseis truck got stuck in soft ground at the end of P7 but was recovered without causing any damage to the truck or the environment.

2.3 Communication with the public

Outreach to the local population was prioritized before and during the field operation with proactive and transparent communication. There were people stopping to talk to the field crew almost every day, and people were generally curious and positive to the operations and the end goal of establishing geothermal central heating in the area. The communication included two information meetings for the public prior to the acquisition, a visitor's day during acquisition, a project webpage with information about the progress of the acquisition and short posts on the activities, information flyers and small information signs placed with nodes in built-up areas.

3. Seismic acquisition parameters

A 16.5 tonnes UV2 vibroseis truck from INOVA Geophysical was used as seismic source (Figure 3). The receivers were wireless Sercel WiNG DFU nodes equipped with one-component micro-electromechanical systems (MEMS) sensors and GPS clocks for precise timing (Figure 4).

The data were acquired in a split-spread acquisition, where the seismic source moved along the array of active receivers. A total of 78.9 km seismic data on eight profiles (P1–P8) were acquired. The profile length was 7.5–16 km with 10 metre receiver spacing. The active spread was up to 12 km (1200 receivers). All profiles except one were acquired with all receivers active from start to end of acquisition. The 16 km long profile P2 was split into two profiles, so that the first half of the profile was acquired with active spread at 0–12 km, and the second half of the profiles were acquired with active nodes at 4–16 km.

All vibration points were on roads; however, the receiver arrays deviated from the roads in some places, to get more straight routes of the seismic profiles (see Figure 1). Each vibration point consisted of three linear sweeps at 10–140 Hz for 25 seconds, with 20 m distance between the vibration points (Table 1). During vibrations along segments where the receiver arrays follow roads, the mass of the vibroseis truck was placed as closely in line with the corresponding receiver as possible.

A planned deployment of ocean bottom seismometers across Limfjorden (connecting profile 1A and 1C, see Figure 1) was abandoned due to late season ice cover on the fjord.

Table 1. *Seismic acquisition parameters*

Parameter	Value
Source	One 16.5t Inova UV2 vibroseis truck
Receivers	1250 Sercel WiNG DFU nodes
Vibration point spacing	20 m
Receiver spacing	10 m
Sweep frequency	10–140 Hz
Sweep length (s)	25 seconds
Listen time (s)	5 seconds
Number of sweeps per vibration point	3
Vibrations per hour	25–30
Km per hour	ca. 0.5 km
Daily coverage	4–5 km/day
Minimum spread	ca. 8 km
Target depth	4–6 km
Receiver configuration	Sample rate: 2 ms; Filter type linear; Preamp gain: 0dB; Low cut value (1.25Hz)



Figure 3: One of GEUS' 16.5 tonnes UV2 vibroseis truck form INOVA Geophysical.



Figure 4: A Sercel WiNG DFU wireless node. The round yellow sign contains a short information to the public about the acquisition and a link to a project webpage.

4. Data management

The data were harvested as correlated data and as uncorrelated raw data in shot domain for each sweep. Listening time was 5 seconds.

Listening time was increased to 8 seconds during the harvesting of P3–P8, to account for a time shift of the vibration time breaks at profiles P3 and P4. This ensured that there was a total of at least 5 seconds listening time after each vibration.

The data were processed by Realtimeseismic under close quality control by GEUS personnel. GEUS was responsible for depth conversion, seismic ties to nearby wells, and the interpretation of the data.

5. First look at the data

The first results of the interpretation of profiles P1 and P2 show sufficient good images of the subsurface to confirm GEUS' regional geological model: As expected, the P1 profile shows the transition from the southern edge of the Skagerrak–Kattegat Platform (north of Limfjorden) and southwards into the deeper sedimentary basin of the Sorgenfrei–Tornquist Zone (STZ) (Figure 5). Both profiles show, as expected, the deep basin in the STZ and that the Top pre-Zechstein basement seems to occur at more than 5 km depth (>2.9 sec. TWT) near the planned well location at Storvorde, just south of Limfjorden in Figure 5. The well target (TD) is planned in the Skagerrak Formation, likely composed of sandstones and some mudstones and with the formation top deeper than 4 km (>2.3 sec. TWT) read on P1, which is located c. 600 m from the projected well position. As expected, also significant faulting is interpreted in the two profiles close to the planned well position (not show in Figure 5). If faults are also present where the well actually is drilled, this may cause some technical challenges.

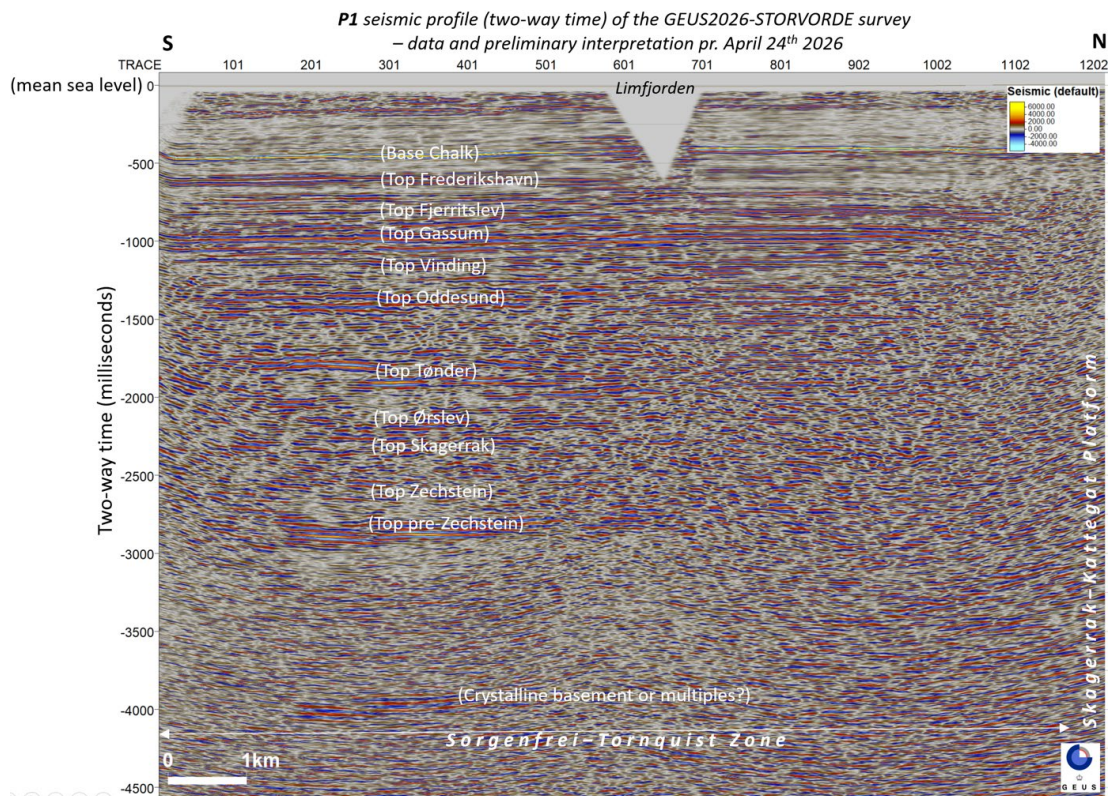


Figure 5: The P1 seismic profile of the GEUS2026-STORVORDE survey in two-way time (milliseconds) from south (left) to north (right) across the Sorgenfrei-Tornquist Zone. Preliminary interpretation (pr. April 2026) with levels of seismic stratigraphic horizons is also shown. The location of the planned well is just south of Limfjorden. The planned well TD (target depth) is below the Top Skagerrak (below c. 2300 ms TWT or c. 4 km). The profile is processed down to 5 sec TWT). For location of the profile see Figure 1.

6. Deliverables

6.1 Seismic data

The deliverables include the following folders with correlated data and raw uncorrelated data:

P1_GEUS2026-STORVORDE_Correlated-data
P1_GEUS2026-STORVORDE_RAW
P2A_GEUS2026-STORVORDE_Correlated-data
P2A_GEUS2026-STORVORDE_RAW
P2B_GEUS2026-STORVORDE_Correlated-data
P2B_GEUS2026-STORVORDE_RAW
P3_GEUS2026-STORVORDE_Correlated-data
P3_GEUS2026-STORVORDE_RAW
P4_GEUS2026-STORVORDE_Correlated-data
P4_GEUS2026-STORVORDE_RAW
P5_GEUS2026-STORVORDE_Correlated-data
P5_GEUS2026-STORVORDE_RAW
P6_GEUS2026-STORVORDE_Correlated-data
P6_GEUS2026-STORVORDE_RAW
P7_GEUS2026-STORVORDE_Correlated-data
P7_GEUS2026-STORVORDE_RAW
P8_GEUS2026-STORVORDE_Correlated-data
P8_GEUS2026-STORVORDE_RAW

6.2 Auxiliary data

The auxiliary data includes the following:

Curated metadata – vibration point information; the excel files show correlation between vibration points (Shot ID) and sweeps (Sweep ID), coordinates of each vibration point, output force and other metadata.

Daily progress report – information on progress, crew, weather etc.

Navigation – GPS coordinates of receivers ('rec') and vibration points ('VP') as csv, kml, and shapefile. Note that the GPS coordinate files for vibration points are only available for P1A and P3-P8; the coordinates of vibration points of P1C and P2 were not measured separately but can be found in the curated vibroseis metadata.

Observer's log – original observers log with correlation of vibration points and sweeps for P3-P8; note that there are some errors in the observer's log, which were corrected in the curated metadata files.

Pilot sweep – synthetic pilot sweep (linear increase 10–140 Hz, 25 seconds).

Vibroseis metadata – metadata output from Inova UV2 vibroseis truck, one file for each day of vibration.