Stenlille seismic test data set

In September 2024, GEUS acquired a relatively short, 5 km long 2D seismic data set at Stenlille, central Zealand, Denmark. The primary objective of the Stenlille data set was to test newly purchased land seismic equipment, including two vibroseis trucks and wireless nodes. This brief report describes the acquisition layout and processing of the seismic dataset.

Acquisition

The seismic data were acquired using a cross-spread configuration consising of two 2D seismic profiles along roads: Profile 1 (north-south) and Profile 2 (east-west) (Figure 1). A single 16.5-tonnes vibroseis truck was used as the seismic source, and 500 1-component Micro-Electro-Mechanical Systems (MEMS) receivers were used to record the signals. All receivers were active during recording. The receivers were placed with 10 meter intervals along the road sides, and vibrations were triggered at 20 meter intervals. Each vibration consisted of three repeated linear 18-second sweeps at 10-140 Hz.

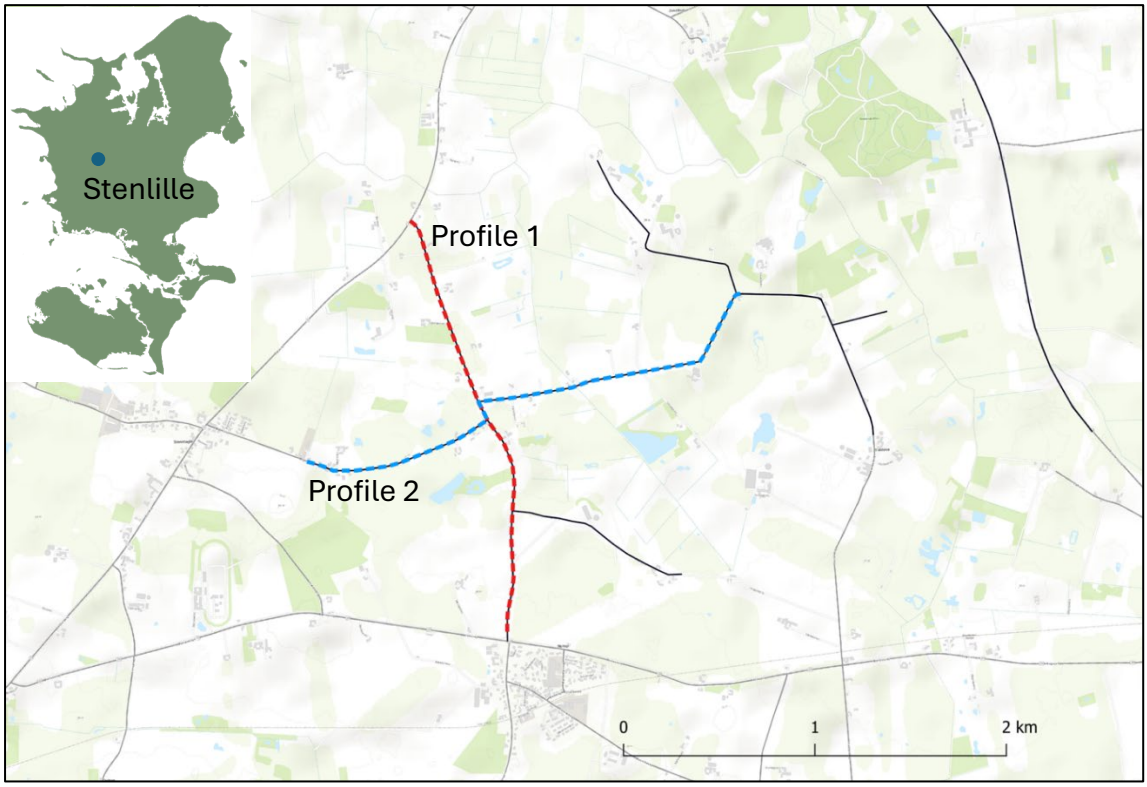

Figure 1: Cross-spread layout for the Stenlille test, where two profiles P1 and P2 (stippled red and blue) were acquired along the same profiles that were previously acquired by Uppsala University in 2023 (thin black lines) during the GEUS CCS2022-2024 project.



Figure 2: Picture of one of the GEUS' vibroseis trucks and a wireless node.

Processing

This report presents the processing results for Profile 1 (north-south). The processing input consisted of navigation-assigned raw shot gathers in SEG-Y format. The processing was carried out from geometry QC through pre-stack time migration (Table 1).

Results and comparison to earlier data set

The processing reveals the deepest key reflectors at about 2.2 seconds, with a sufficient signal-to-noise (S/N) ratio and resolution (Figure 3).

For comparison, results from an recent state-of-the-art seismic dataset acquired along the same road and processed by an external party during GEUS' CCS2022-2024 project are also examined. The comparison (Figure 4) indicates that the current result:

1. Provides generally higher resolution, allowing improved distinction of thin geological strata.
2. Provides a better imaging of reflectors in the shallow interval down to approximately 800 milliseconds.
3. Removes artefacts likely related to out-of-plane diffractions at depths between 2000 and 2200 ms.

Overall, the data quality and processing results is of high quality and support further geological interpretation of the profile.

Table 1. Processing workflow applied in this work.

Processing step	Tool	Key parameter
Geometry QC		
Trace editing	Trace length	0-4000 m/s
	Resampling	Up-sampling to 1 ms
Preprocessing	Top mute	Using first-arrivals
	Bandpass filter	30-40-120-140 Hz
	Deconvolution	Operator length: 300 ms, prediction lag: 20 ms
	Bandpass filter	30-40-120-140 Hz
	Trace balancing	Full trace length
	Static correction	Tomostatics, replacement velocity: 1900 m/s
	Refraction residual static corr.	Min.-max. refractor offset: 0-800 m
	Velocity analysis I	Using constant velocity cube
Processing	Residual static corr. I	Stack power, max. shift: 10 ms
	Time-offset scaling	Power of time-offset: 1-0
	Surface consistent amp. corr.	Full offset
	Surface consistent decon.	Operator length: 160 ms, prediction lag: 20 ms
	Bandpass filter	30-40-70-80 Hz
	Velocity analysis II	Using constant velocity tube
	Residual static corr. II	Stack power, max. shift: 10 ms
	F-K filter	Top-bottom velocity: -3000-3000 m/s
	F-X dip filter	F-X operator length: 15 traces
Migration	Velocity analysis III	Using constant velocity cube
	Pre-stack time migration	Kichhoff, aperture: 500 m, frequenzy: 10-140 Hz, mute: 15 deg.
Post-migration processing	Trace balancing	Full trace length
	Post-stack deconvolution	Operator length: 160 ms, prediction lag: 20 ms
	Bandpass filet	Low-high cut: 30-80 Hz
	F-X decon	Low-high cut: 30-80 Hz

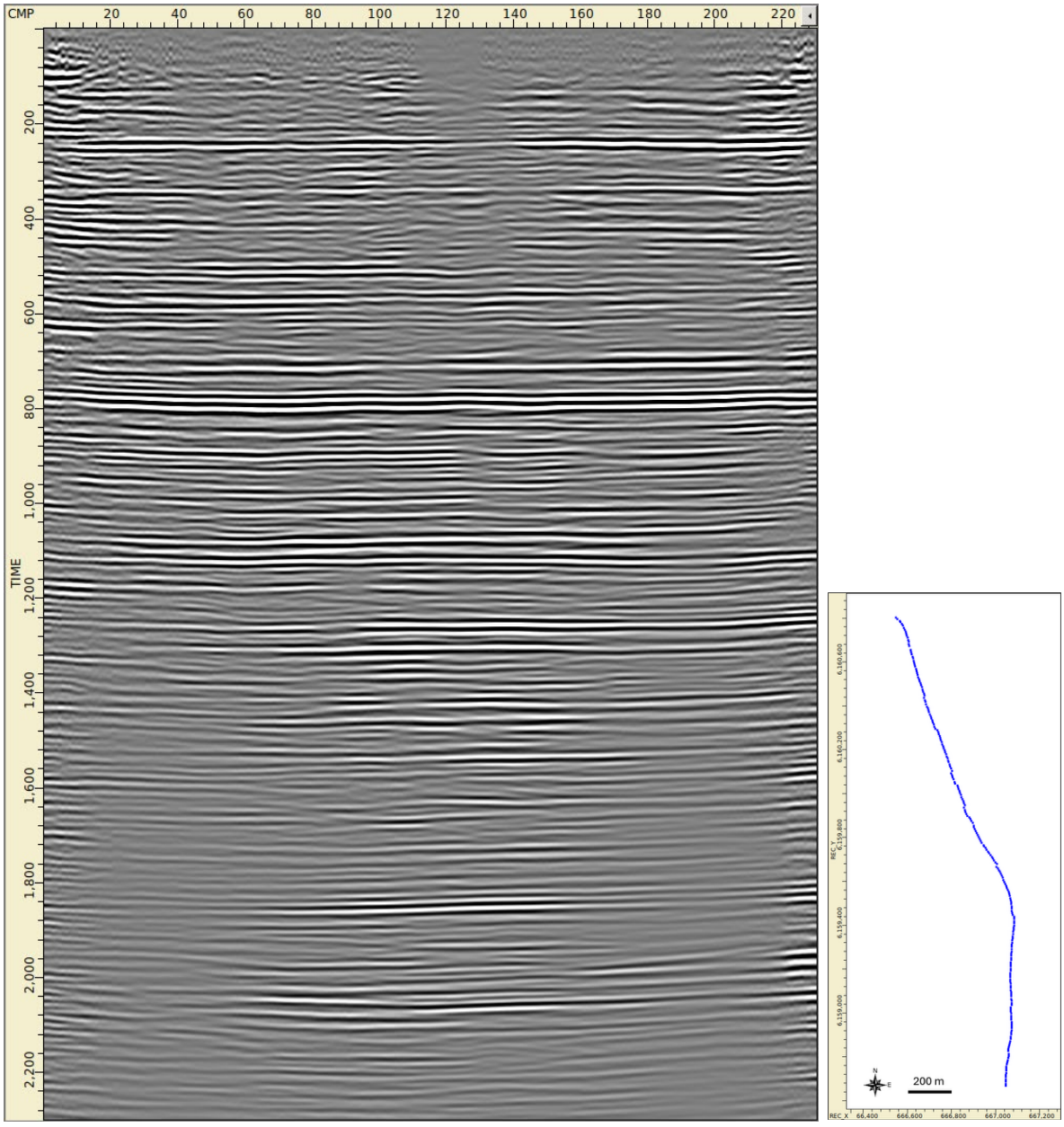

Figure 3. Pre-stack time migration (PSTM) profile obtained in this work.

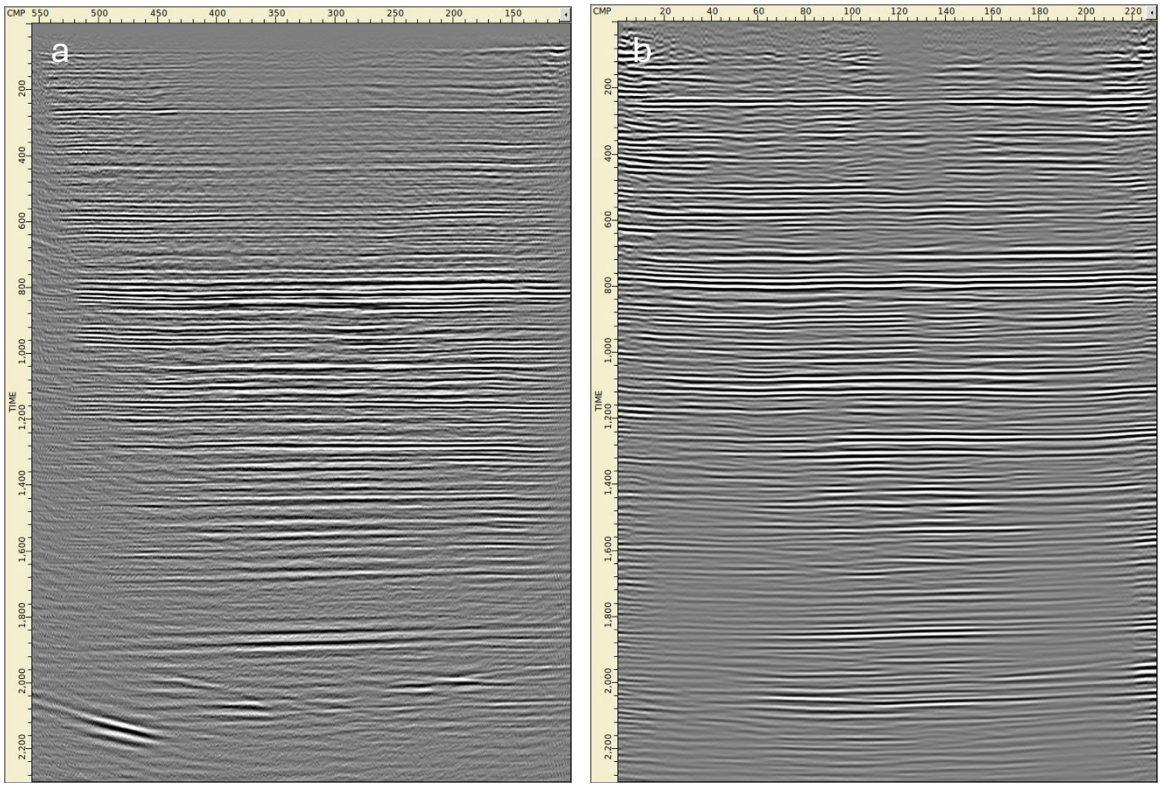

Figure 4. Comparison between a) result of external processing: post-stack time migration profile from GEUS' CCS2022–2024 project, and b) pre-stack time migration (PSTM) profile from the current work. The comparison shows that the current result images an increased number of coherent reflectors down to approximately 800 ms, resolves thinner geologic strata, and removes dipping reflector artefacts between 2000 and 2200 ms.