DAS-VSP data from the Feb. 2017 survey at the Groß Schönebeck site, Germany

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2. Citation

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3. Data description

This data publication contains vertical seismic profiling (VSP) data collected at the Groß Schönebeck site, Germany, from February 15-18, 2017. Energy excitation was performed with vibrator sources. Data was acquired in the two 4.3 km deep wells E GrSk3/90 and Gt GrSk4/05 (in the following referred to as GrSk3 and GrSk4) using hybrid wireline fiber-optic sensor cables and distributed acoustic sensing (DAS) technology. In total, data for 61 source positions (VP1-VP76) distributed in a spiral-shaped pattern with offsets between 180 m and 2000 m from the wellheads was collected. The data publication covers selected common source gathers for a zero-offset position and representative examples for three intermediate- and far-offset positions, in the form of full waveform data stored in SEG-Y format. Both uncorrelated raw data and data for different processing stages described in Henninges et al. (2021) are given. Moreover, the survey geometry data (well trajectories and source point coordinates), the pilot sweep data, records of a conventional three-component borehole geophone, and processing results for the VP10 zero-offset position (vertical one-way travel times, interval velocities, corridor stacks) are included. Further information on the survey design and data acquisition, the overall characteristics of the acquired data, and the zero-offset data processing and evaluation for the VP10 source position are described in Henninges et al. (2021).

4. File inventory and file naming convention

The processed data is organized in several subfolders which are included in the zip-file ***2021-001_Henninges-et-al_processed-data.zip***. The raw data (DAS data, raw vibroseis records, unstacked, uncorrelated) are provided as individual SEG-Y files in the separate folder ***2021-001_Henninges-et-al_raw-data.*** The following table contains an overview of the file inventory, and the contents of the individual folders is described in more detail in the following sections

Directory	Files or subfolders	Format	Content
\Geometry*	GrSk3_deviation-survey GrSk4_deviation-survey	.csv .csv	Trajectories of GrSk3 and GrSk4 wells
	Vibro-point-coordinates	.csv	Vibrator source point coordinates
\Sweeps*	Sweeps	.sgy	Pilot sweeps from VibPro encoder
\Common-source-gathers*	\prep (file names as per naming convention)	.sgy	DAS data, preprocessed
	\prep_decon (file names as per naming convention)	.sgy	DAS data, preprocessed and denoised
\Geophone-data*	(file names as per naming convention)	.sgy	Borehole geophone data, x-, y-, and z-component, raw and preprocessed
\Zero-Offset_VSP_results*	GrSk3_VP10_prep_decon_CS-depth	.sgy	DAS data, corridor stacks GrSk3, converted to depth
	GrSk4_VP10_prep_decon_CS-depth	.sgy	DAS data, corridor stacks GrSk4, converted to depth
	GrSk3_ZOVSP_TTvert-Vint	.csv	Vertical travel times and interval velocities GrSk3
	GrSk4_ZOVSP_TTvert-Vint	.csv	Vertical travel times and interval velocities GrSk4
2021-001_Henninges-et-al_raw-data	(file names as per naming convention)	.sgy	DAS data, raw vibroseis records (unstacked, uncorrelated)

* included in 2021-001_Henninges-et-al_processed-data.zip

The main content is seismic data stored in SEG-Y revision 1 format (SEG Technical Standards Committee 2002). Besides the binary header, the textual header (EBCDIC) contains valuable descriptive informations, e.g. the valid trace headers as specified by their byte start. The trace sample format is IEEE-32bit.

The following convention for naming of the SEG-Y files (.sgy) is used:

<Well>_<VP#>_<Special(optional)>_<Processing>.sgy

Key	Text	Description
Well	GrSk3 GrSk4	Abbreviated well name
VP#	VP10 VP25 VP66 VP76	Vibrator source point number
Special	slack	Cable slack test GrSk3, with 5, 11, and 20 m cable slack (all other data sets recorded with 1 m cable slack)
	GL	Gauge length tests, recorded with 10 and 20 m gauge length
	VSI	Borehole seismometer data, with x-, y-, and z-component, respectively
Processing	raw	Raw vibroseis records, unstacked and uncorrelated
	prep	Preprocessed data
	decon	Burg adaptive deconvolution (ringing noise suppression)
	CS-depth	Corridor stacks, converted to depth using vertical time-depth relationships

4.1.Folder \Geometry

- **Survey geometry data**

The following table contains wellhead coordinates, format UTM-WGS 84 (easting, northing, Zone 33), geographic (latitude, longitude), Gauß-Krüger / Bessel (easting, northing), and elevation (m above mean sea level) of the GrSk3 and GrSk4 wells.

Borehole	UTM-WGS 84 - Zone 33		Geographic Coordinates (WGS84)		Gauß-Krüger / Bessel		Eleva-tion
	Easting	Northing	Longitude	Latitude	Easting	Northing	m
E GrSk 3/90	405948.6	5862487.96	13.60162	52.90383	5406044.8	5864387.3	65.98
Gt GrSk 4/05	405944.6	5862461.17	13.60157	52.90359	5406040.8	5864360.5	65.96

- **Files GrSk3_deviation-survey.csv and GrSk4_deviation-survey.csv**

Well trajectories of GrSk3 and GrSk4 wells, measured after drilling of the individual well sections in year 1990/1991 and 2006/2007, respectively. For further information see Hurter (2002) and Moeck et al. (2007).

Column header	unit	Description
MD	m	Measured depth, relative to ground level
Incl	degree	Angle from vertical
Azim	degree	Well azimuth, angle relative to true north
TVD	m	True vertical depth, relative to ground level

- **Vibro-point-coordinates.csv**

Coordinates of the 61 Vibrator source points

Column header	unit	Description
VP#	-	Vibrator source point number
LocalEast	m	Easting, UTM-WGS 84 coordinate (Zone 33)
LocalNorth	m	Northing, UTM-WGS 84 coordinate (Zone 33)
Height [DHHN92]	m	Elevation, relative to mean sea level

4.2.File Sweeps.sgy

Pilot sweeps from VibPro encoder

Different sweeps have been used at individual source point locations. They are identified and referred to by a “sweep type” number, which is listed in the following, together with the sweep parameters. The pilot sweeps are required for correlation of the raw vibroseis records, and the sweep type applied for the individual records is listed in the textual header of the respective SEG-Y file.

Sweep Type	2	13	1
FFID	14	16	38
Sweep Start Frequency	10 Hz	10 Hz	10 Hz
Sweep End Frequency	112 Hz	96 Hz	88 Hz
Sweep Type	Linear up	Linear up	Linear up
Sweep Length	36 s	36 s	36 s
Taper Length	360 ms	360 ms	360 ms
Taper Type	Cosine	Cosine	Cosine

For further information on the vibrator sources see Henninges et al. (2021).

4.3.Folder \Common-source-gathers

DAS data acquired on hybrid wireline cables using two Schlumberger hDVS (Heterodyne Distributed Vibration Sensing) optical interrogator units.

Common-source-gathers for different processing stages are contained in individual sub-folders:

\prep	preprocessed (stack, correlate, time-derivative)
\prep_decon	preprocessed and denoised (Burg adaptive deconvolution)

The raw data (DAS data, raw vibroseis records, unstacked, uncorrelated) are provided as individual SEG-Y files in the separate folder ***2021-001_Henninges-et-al_raw-data.*** Further information on data acquisition and individual processing steps is contained in the textual headers of the SEG-Y files and in Henninges et al. (2021).

In the textual file headers and trace headers of the SEG-Y files the relevant source, recording, and processing parameters are listed. The following parameter names are used:

Parameter name	unit	Description
CHAN		Trace sequence number within filed record
DAY_YEAR		Day of year of data recording
FFID		Original field record number (raw data) Vibrator source point number (prep/decon data)
GL	m	Gauge length
hDVS		heterodyne distributed vibration sensing
HOUR_DAY		Hour of day (24-hour clock) of data recording
MD	m	Measured depth
MIN_HOUR		Minute of hour of data recording
NSAMPLES		Number of samples per trace
RCX	m	Receiver coordinate X
RCY	m	Receiver coordinate Y
SCX	m	Source coordinate X
SCY	m	Source coordinate Y
SEC_MIN		Second of minute of data recording
SL	m	Surface level (ground)
SMPL_INT	micro sec	Sample interval
Source ref elev	m	Source reference elevation
SRD	m	Seismic reference datum
TR_FOLD		Number of vertically summed traces
TRACENO		Trace sequence number within line
TVDSD	m	True vertical depth below seismic datum (mean sea level)
VP		Vibrator source point
Well ref elev	m	Well reference elevation
YEAR_REC		Year of data recording

4.4. Folder \Geophone-data

Check shots recorded with a three-component borehole geophone with acceleration characteristics (VSI Versatile Seismic Imager tool, Schlumberger) at measured depths of 1200 m, 2400 m, 3600 m, and 4207 m within the GrSk4 well, respectively. Data is stored as separate files with x-, y-, and z-component data, in raw and preprocessed format.

4.5. Folder \Zero-Offset_VSP_results

4.5.1. Corridor stacks GrSk3 and GrSk4

Corridor stacks for the VP10 zero-offset position. After pre-processing and noise suppression (Burg adaptive deconvolution) of the DAS data, seismic processing included wavefield separation, deterministic deconvolution, transformation to two-way travel time, and stacking over a 0.2 s time window after the first arrival. Travel times were converted to depth using model vertical travel times (see below).

4.5.2. Vertical travel times and interval velocities GrSk3 and GrSk4

Column header	Unit	Description
TVDSD	m	True vertical depth, relative to seismic datum (mean sea level)
MD	m	Measured depth, relative to ground level
TVD	m	True vertical depth, relative to ground level
Vint	m/s	Smooth interval velocity from VSP travel times corrected to vertical
OWTvert	s	One-way vertical travel times from seismic datum to receiver

No-data value: -999

One-way vertical travel times were calculated by ray tracing through a model calibrated with picked travel times. Acoustic interval velocity was calculated from picked VSP travel times corrected to vertical, using the method of smooth inversion after Lizarralde and Swift (1999), using 1.1 ms RMS transit time residuals. For further information on the zero-offset VSP processing applied see Henninges et al. (2021).

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