Technical Report Profile DEKORP 1986-2N - Reprocessing

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1. Introduction

This is the technical description of new DEKORP 1986-2N seismic reflection data as reprocessed in 2019/20. It builds an addition to the data publication Stiller et al. (2021), which encompasses the first processing of the DEKORP Processing Centre carried out in 1991. The trace data come in SEGY format, the description of which can be found in the References, SEG Technical Standards: SEGY rev0 (1975); rev1 (2002).

When using the data please cite:

Homuth, Benjamin; Stiller, Manfred (2022): Reprocessed southern part of the deep seismic reflection profile DEKORP 1986-2N across the Rhenish Massif in the state of Hesse, Germany. GFZ Data Services. https://doi.org/10.5880/GFZ.DEKORP-2N.002

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3. Table of Contents

4. General

The folder **DEK86-2N_RData** contains all seismic data and corresponding metadata as well as additional information like e.g. high-resolution graphic representations of the reprocessing results from 2019/20. All data are based on the original field data and on the processing carried out in 1991 at the former DEKORP Processing Centre (DPC) at the Geophysical Institute of the Technical University Clausthal, Germany and have been reprocessed by DMT Petrologic GmbH & Co. KG, Hanover, Germany, supervised by the GFZ Potsdam, Germany (see the corresponding Reprocessing Report and the related FlowCharts coming with the metadata). It is recommended to have also a look at the data publication of the original processing from 1991 (Stiller et al. 2021) which contains a lot of additional information also with respect to the reprocessing results. Other DEKORP profiles can be found in Meissner & Bortfeld (1990) and a basic introduction to the processing of DEKORP data in Stiller & Thomas (1989).

The southernmost 68 km of the 219 km long profile 2N, i.e. the part located in the State of Hesse, were reprocessed on behalf of the Hessian Agency for Nature Conservation, Environment and Geology. The input data were extended northwards by another 12 km (with decreasing CDP coverage) in order to avoid boundary effects during migration.

All provided SEGY files are IEEE-32bitFP rev1 with proper binary header. Corresponding downloadable SEGY format descriptions in PDF can be found in the References, SEG Technical Standards: SEGY rev0 (1975); rev1 (2002). In the following, as an example, the EBCDIC header for the final pre-stack depth-migrated section is given, containing several useful information. This also supports an easy set-up for the SEGY input routine of any other software:

SEG-Y Reel Header

```
C 1 Client:     HLNUG, Wiesbaden, Germany
C 2 Contractor: DMT Petrologic GmbH & Co. KG, Hanover, Germany
C 3 Date:       2019-02-18
C 4 Project:    2D Seismic Reprocessing DEKORP, Line DEK86-2N
C 5 Content:    CRS Pre-Stack Depth Migration, Filtered and Scaled, Zerophase
C 6             CDP 2004-5993, Sampling Rate: 4m, Length: 40000m
C 7 Polarity:   Impedance Increase = Negative Value
C 8 Geodetic Reference: DHDN / 3-Degree Gauss-Kruger Zone 3 (EPSG: 31467)
C 9 Processing Sequence:
C10  1)  Data Input
C11  2)  Binning and Geometry Load
C12  3)  Minimum Phase Transformation of Vibroseis Data
C13  4)  Initial Trace Editing
C14  5)  Refraction Statics (Delivered by Client, SRD=400m AMSL)
C15  6)  Spherical Divergence Correction (T*VV)
C16  7)  1st Run Surface Consistent Amplitude Balancing
C17  8)  Surface Consistent Spiking Deconvolution (160ms, 1.0% Prewhitening, Two
C18      Gates)
C19  9)  Bandpass (6Hz-12Hz-48Hz-60Hz)
C20 10)  2nd Run Trace Editing and Surface Consistent Amplitude Balancing
C21 11)  Air Blast Attenuation (331m/s)
C22 12)  Residual Statics Computation, including Iterative Velocity Updates
C23 13)  Noisy Trace Editing (Despike by Standard Deviation) in Supergathers
C24 14)  Ground-Roll Suppression in Cone Window
C25 15)  CRS Processing
C26 16)  Transformation to Zero-Phase
C27 17)  Isotropic Kirchhoff Pre-Stack Depth Migration 50 Degree Operator
C28      with iterative Velocityfield Update
C29 18)  Residual Moveout Correction, Outer Trace Mute and Stacking
C30 19)  Poststack Noise Cleaning: Coherence Enhancement with
C31      F-K Amplitude Power and Time-Variant Scaling
C32 20)  SEG-Y Output
C33 Trace Header Byte Positioning: SEG-Standard SEGY Rev 1, May 2002
C34 Bin-Center X-Coord   181-184 4I      Bin-Center Y-Coord  185-188 4I
C35 Bin-Center X-Coord     73-76 4I      Bin-Center Y-Coord    77-80 4I
C36 Bin-Center X-Coord     81-84 4I      Bin-Center Y-Coord    85-88 4I
C37 CDP Bin Number         21-24 4I      CDP Bin Number      193-196 4I
C38 Bin-Center Elevation 233-236 4I      CDP Location Number 237-240 4I
C39 SEG Y REV1
C40 END EBCDIC
```

4.1. Folder structure DEK86-2N_Rdata

SeismicData	PreStack	ShotGathers_unmigrated	Raw
		CDPgathers_unmigrated	Preprocessed
		CRSgathers_unmigrated	Processed
		ImageGathers_migrated	PreStackTime
			PreStackDepth
	PostStack	CRSstacks_unmigrated	Raw
			Final
			RMSvelocities
		PostStack_time-migrated	Raw
			Final
			IntervalVelocities
		PreStack_time-migrated	Raw
			Final
			RMSvelocities
		PreStack_depth-migrated	Raw
			Final
			IntervalVelocities
	Inversion	Tomography	VelocityField_unmuted
			VelocityField_muted
			NodeCount

GraphicData	FinalStacks
	FinalMigrations
	SeismicAttributes
	Tomography

MetaData	Geometry	Sources
		Receivers
		CDPs
		Relation
		Misc
	SurveyData	FieldReport
		Maps
		Statics
		Misc
	Misc	

In a PDF document in the **DEK86-2N_RData** parent folder all files contained in the subfolders are listed together with additional information for a full overview.

5. Seismic Data

The seismic trace data comprise all reprocessed results that are most likely required for further evaluation. They are divided into **PreStack** and **PostStack** data. The reprocessed post-stack data are well suited for getting a structural overview or for reinterpretation of the profile. The reprocessed pre-stack data allow for an application of new stacking or migration methods on raw or pre-processed data.

In the SeismicData/**PreStack** folder there is a set of SGY files, containing the unstacked and unmigrated gathers at different processing stages: as **FF/Chan-sorted raw** data, as **CDP/offset-sorted pre-processed** data ready for application of dynamic corrections, and as **CDP/offset-sorted CRS-processed** data ready for stack and/or migration. The CRS processing (Common Reflection Surface) gives a significant improvement in comparison to the classical CDP processing with NMO (Common Depth Point with Normal MoveOut). In addition, there are also **CDP/offset-sorted image gathers,** either **pre-stack time-migrated** or **pre-stack depth-migrated** available.

The respective file names are self-explaining. All information that is necessary for recording geometry definition should be already present in the headers (source-/receiver-/CDP locations/coordinates/elevations/static corrections, shot/channel numbers, offsets etc.), so it should be easily possible to set up a matching database by extracting them accordingly. The PDF document in the parent folder lists all SGY files again together with additional information.

In the SeismicData/**PostStack** folder there are SGY files with the final results from the reprocessing carried out in 2019/20, they are arranged in subfolders according to the respective poststack processing stage, i.e. **unmigrated**, **post-stack time-migrated**, **pre-stack time-migrated** and **pre-stack depth-migrated**. Each version comes as **raw stack** (nearly true-amplitude), **final stack** (after additional semblance-based amplitude scaling for better readability) and together with the used **velocity model**.

A **Tomographic Inversion** has been conducted, based on the first-break picks of the raw data. This delivers a high-resolution image of the true interval-velocities versus depth down to 3-5 km below surface. The folder contains the derived **VelocityField (1) unmuted** and **(2) muted** to the reliable region, based on the corresponding **NodeCount** result. The tomographic velocities have also partly been used for the final migrations to obtain a better near-surface imaging.

The PDF document in the parent folder lists all SGY files again together with additional information.

6. Graphic Data

The folder **GraphicData** contains graphic representations of the reprocessing results. The sections have been converted from SEGY to color-coded high-resolution PDF which can be displayed or plotted with common software that is able to handle images with 25 000 pixels and more. The images come with top label (showing profile-km and CDP) and with a basic side label (showing profile name and processing version).

The **GraphicData** folder structure is analogous to the **SeismicData** folder. It contains in the subfolders **FinalStacks**, **FinalMigrations** and **Tomography** the respective reprocessed results, sometimes in different versions. There is no graphic representation of unstacked data.

The file names correspond to the seismic data versions and should be therefore self-explaining. The PDF document in the parent folder lists all PDF files again together with additional information.

7. Metadata

In the folder **MetaData** there is accompanying information to the seismic data. The subfolder **SurveyData** contains scans of the original (PRAKLA) field report including appendices as well as the original location maps and the original evaluation of field static corrections. The scans might be overlapping and have not been merged together as they are slightly distorted by the optical scanning procedure from blueprints. Unfortunately, everything is in German language, but they are hopefully of help nevertheless.

In the subfolder **Geometry** there are ASCII tables with all source-/receiver-/CDP-location/-coordinates/-elevation, spread and static information, just in case, that for one or the other file something, e.g. the CDP coordinates, might be missing in the trace headers and have to be externally imported. The tables for **Receivers**, **Sources**, **CDP**s, the **Relation** describing the actually active spread and **Misc** (like additional particulars like static corrections if not included in the other files) are self-explaining by the first comment line in each file. The coordinates are given in the rectangular Gauß-Krüger system (Bessel ellipsoid), the used abbreviations are LOCN (geophone location), SPON (shotpoint order number), SLOC (source location), NSPON (nearest SPON to CDP), NLOC (nearest LOCN to CDP) and VEL (either weathering layer velocity or main refractor velocity in m/s). For import into maps or GIS the CDP line is additionally given in geographic coordinates (Longitude, Latitude, WGS84) in ASCII and kml format. The PDF document in the parent folder lists all Metadata files again together with additional information.

In **Appendix A** the field parameters and geometry dimensions are compiled in ***Table 1*** and the general sequence of the reprocessing in ***Table 2***.

8. References

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9. Appendix A

9.1. *Table 1:* Field parameter summary and geometry dimensions

General information	**Recorded**	August – October 1986
	by	Prakla-Seismos AG
	for	Geological Survey of Lower Saxony, Germany
	Area	Hesse
	Profile length / direction / azimuth	Reprocessed 79.78 km of total 219.02 km / SE – NW / -65.4903 °
	Total data amount	6.61 GB of total 14.25 GB
Recording	**Recording system**	Sercel SN 368 / MTC01
	Sample interval	4 ms
	No. of channels	400
	Field filter	Low-cut 12.0 Hz / 18 dB High-cut 88.8 Hz / 72 dB
	Noise reduction	Automatic noise-mute before correlation
	Correlation	with filtered sweep
	Recording format	SEG-D
	Sweep + listening time **Recording time**	20 s + 12 s = 32 s (uncorrelated) 12 s (correlated)
Receivers	**Geophone type**	SM 4 (10 Hz)
	Geophones per group	24
	Receiver array	In-line array
	Group spacing	40 m
	Spread length	16 km
	No. of geophone points	4676 (entire profile)
Sources	**Source type**	Vibroseis (p-waves)
	No. of vibrators	5*VVEA (each 19.4 tons, 125 kN peak-force)
	Sweep length / range	20 s / 12 – 48 Hz
	Pattern length	48 m
	Vertical stacking rate	5-fold
	Recording configuration	Aymmetrical split-spread (4060 – 100 – VP – 100 – 12060 m)
	Source point spacing	40 m
	No. of source points	3809 (entire profile)
CDPs	**Coverage (theor. / real)**	200-fold / 137-fold
	CDP-spacing	20 m
	No. of CDPs	3990 (reprocessed part) of 10952 in total
	Final datum	400 m a.s.l.

Geometry dimensions DEKORP 1986-2N

	Record	**Location**	**X coordinate**	**Y coordinate**	**Longitude**	**Latitude**
			Gauss-Krueger (Bessel, Potsdam)		**Decimal degree (WGS84)**	
Source	1	1001	3471476.	5572854.	8.59868866	50.29101426
	(7518	6605	3385051.	5767536.	7.32403779	52.02972015)
Receiver	1	1001	3471486.	5572837.	8.59883027	50.29086192

	(4676	6675	3381905.	5772123.	7.27663560	52.07026562 **)**
CDP	2004	1002	3471461.	5572880.	8.59847621	50.29124727
	5993	**2996**	3437702.	5644468.	8.11277314	50.93211281

9.2. *Table 2:* Reprocessing sequence summary

Process	Parameter
Data Output 1	*Input data, raw FF-sorted gathers*
Geometry Extraction	CDP assignment (Crooked-Line)
Minimum-Phase Transformation	Operator designed from sweep autocorrelation
Trace Editing	Initial Bad-Trace Elimination
Analytic Gain	Spherical Divergence Correction ($T*v^2$)
First-Break Muting	Offset-dependent
Amplitude Balancing	Surface-consistent, 1st run
Deconvolution	Surface-consistent spiking (160 ms operator length, 1 % prewhitening, two gates)
Bandpass Filtering	6/12 – 48/60 Hz
Air-Blast Attenuation	Constant fan 333 m/s
Amplitude Balancing	Surface-consistent, 2nd run with additional bad-trace elimination
Static Correction	to Floating Datum (smoothed receiver elevation)
Velocity Analysis	1st pass, integrated method
Residual Static Correction	Surface-Consistent, including Iterative Velocity Updates
Velocity Analysis	2nd pass, integrated method
Noisy Trace Editing	Despiking by Standard Deviation in Supergathers
Ground-Roll Suppression	Cone Window
Data Output 2	*Preprocessed CDP-sorted gathers*
CRS-Processing	Common Reflection Surface method
Data Output 3	*CRS-processed CDP-sorted gathers*
Post-NMO/CRS Muting	Exclude refraction residuals
CDP Stacking	with shift to Final Datum (400 m a.s.l.) and Zero-Phase Transformation Coverage: ~137-fold
Coherency Enhancement	Dip attenuation, f-k Filtering, f-x Deconvolution, bandpass Filtering
Data Output 4 a, b, c	*CRS Stack (raw) and semblance-scaled for dynamic compression (final) + velocities*
Migration	Post-Stack Steep-Dip Finite-Differences Method ***Input is the CRS Stack***
Data Output 5 a, b,c	*Post-Stack Time-Migration (raw) and semblance-scaled for dynamic compression (final) + velocities*

Migration	Pre-Stack Curved-Ray Kirchhoff Time-Migration (with iterative Velocity Field Update) ***Input are the unstacked CRS gathers***
Post-Migration Muting	Exclude noise residuals
Output 6	*Pre-Stack Time-Migrated CDP-sorted image gathers*
CDP Stacking	with shift to Final Datum (400 m a.s.l.) and Zero-Phase Transformation Coverage: ~137-fold
Coherency Enhancement	Dip attenuation, f-k Filtering, f-x Deconvolution, Bandpass Filtering
Output 7 a, b, c	*Pre-Stack Time-Migration (raw) and semblance-scaled for dynamic compression (final) + velocities*

Depth-Model Building	Start model: First-Break Tomo vels + PreSTM vels + GFZ crustal vels ***Input are the unstacked CRS gathers after Zero-Phase Transformation***
Migration	Pre-Stack Isotropic Kirchhoff Depth-Migration (with iterative Velocity Field Update)
Post-Migration Processing	Residual Moveout Correction and Outer Trace Muting
Output 8	*Pre-Stack Depth-Migrated CDP-sorted image gathers*
CDP Stacking	with shift to Final Datum (400 m a.s.l.) and Zero-Phase Transformation Coverage: ~137-fold
Coherency Enhancement	Dip attenuation, f-k Filtering, f-x Deconvolution, Bandpass filtering (application in time domain)
Output 9 a, b, c	*Pre-Stack Depth-Migration (raw) and semblance-scaled for dynamic compression (final) + velocities*

Output 10 a, b c	*Tomographic Inversion (unmuted, muted, ray-count)* ***Input are the first-break picks of the raw unstacked data***