

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 SEG Y format, the description of which can be found in the References, SEG Technical Standards: SEG Y rev0 (1975); rev1 (2002).

When using the data please cite:

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3. 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 SEG Y files are IEEE-32bitFP rev1 with proper binary header. Corresponding downloadable SEG Y format descriptions in PDF can be found in the References, SEG Technical Standards: SEG Y 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 SEG Y 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 SEG-Y 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

3.1. 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.

4. 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.

5. 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.

6. 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**, **CDPs**, 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**.

7. References

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SEG Technical Standards Committee (2002) SEG Y rev 1 Data Exchange format. https://seg.org/Portals/0/SEG/News and Resources/Technical Standards/seg_y_rev1.pdf

Meissner, R. & Bortfield, R.K. (Eds.) (1990). DEKORP-Atlas – Results of Deutsches Kontinentales Reflexionsseismisches Programm. Springer Press. <https://doi.org/10.1007/978-3-642-75662-7>

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Stiller, Manfred; Kaerger, Lauretta; Agafonova, Tatiana; Krawczyk, Charlotte; Oncken, Onno; Weber, Michael; Former DEKORP Project Leaders; Former DEKORP Research Group; Former DEKORP Processing Centre (2021): Deep seismic reflection profile DEKORP 1986-2N across the eastern Rhenish Massif and the Muensterland Basin, Northwest Germany. GFZ Data Services. <https://doi.org/10.5880/GFZ.DEKORP-2N.001>

8. Appendix A

8.1. 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 |

8.2. Table 2: Reprocessing sequence summary

| Process | Parameter |
|------------------------------|---|
| Data Output 1 | <i>Input data, raw FF-sorted gathers</i> |
| 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 ($T \cdot v^2$) |
| First-Break Muting | Offset-dependent |
| Amplitude Balancing | Surface-consistent, 1 st 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, 2 nd run with additional bad-trace elimination |
| Static Correction | to Floating Datum (smoothed receiver elevation) |
| Velocity Analysis | 1 st pass, integrated method |
| Residual Static Correction | Surface-Consistent, including Iterative Velocity Updates |
| Velocity Analysis | 2 nd pass, integrated method |
| Noisy Trace Editing | Despiking by Standard Deviation in Supergathers |
| Ground-Roll Suppression | Cone Window |
| Data Output 2 | <i>Preprocessed CDP-sorted gathers</i> |
| CRS-Processing | Common Reflection Surface method |
| Data Output 3 | <i>CRS-processed CDP-sorted gathers</i> |
| 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 | <i>CRS Stack (raw) and semblance-scaled for dynamic compression (final) + velocities</i> |
| Migration | Post-Stack Steep-Dip Finite-Differences Method Input is the CRS Stack |
| Data Output 5 a, b, c | <i>Post-Stack Time-Migration (raw) and semblance-scaled for dynamic compression (final) + velocities</i> |
| 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 | <i>Pre-Stack Time-Migrated CDP-sorted image gathers</i> |
| 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 | <i>Pre-Stack Time-Migration (raw) and semblance-scaled for dynamic compression (final) + velocities</i> |
| 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 | <i>Pre-Stack Depth-Migrated CDP-sorted image gathers</i> |
| 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 | <i>Pre-Stack Depth-Migration (raw) and semblance-scaled for dynamic compression (final) + velocities</i> |
| Output 10 a, b, c | <i>Tomographic Inversion (unmuted, muted, ray-count)</i> Input are the first-break picks of the raw unstacked data |