Technical Report Profile DEKORP 1990-3B/MVE (West) (incl. Q21-Q24) - Reprocessing

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1. Introduction

This is the technical description of new DEKORP 1990-3B/MVE (West) 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 deep seismic reflection profile DEKORP 1990-3B/MVE (West) across the Rhenohercynian and Saxothuringian zone of the state of Hesse, Germany. GFZ Data Services. https://doi.org/10.5880/GFZ.DEKORP-3B_MVE_WEST.002

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2. General

The folders **DEK90-3B-WEST_RData** and **DEK90-3B-WEST-Q_RData** contain 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 westernmost 90 km of the 208 km long profile 3B/MVE (West), 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 eastwards by another 7 km (with decreasing CDP coverage) in order to avoid boundary effects during migration. As a particularity, also a set of 10 cross-profiles, each ca. 9.6 km in length and perpendicular to the main line, were surveyed along DEKORP 3B/MVE (West) to get information about possible cross-dips. Four of those short cross-lines (Q21-Q24) were reprocessed in 2D as well.

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:       2019-03-04
C 4 Project:    2D Seismic Reprocessing DEKORP, Line DEK90-3B
C 5 Content:    CRS Pre-Stack Depth Migration, Filtered and Scaled, Zerophase
C 6             CDP 2004-5874, Sampling Rate: 4m, Length: 45000m
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=500m 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
```

2.1. Folder structure DEK90-3B-WEST_RData and DEK90-3B-WEST-Q_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 **DEK90-3B-WEST_RData** and **DEK90-3A-WEST-Q_RData** parent folder all files contained in the subfolders are listed together with additional information for a full overview.

3. 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.

4. 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.

5. 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** a GoogleEarth-based map helps to localize naming and position of the individual seismic lines. Finally, the field parameters and geometry dimensions are compiled in ***Tables 1a, b*** and the general sequence of the reprocessing in ***Table 2***.

6. References

Barry, K. M., Cavers, D. A., & Kneale, C. W. (1975). Recommended Standards for Digital Tape Formats. Geophysics, 40(2), 344–352. https://doi.org/10.1190/1.1440530, https://seg.org/Portals/0/SEG/News and Resources/Technical Standards/seg_y_rev0.pdf

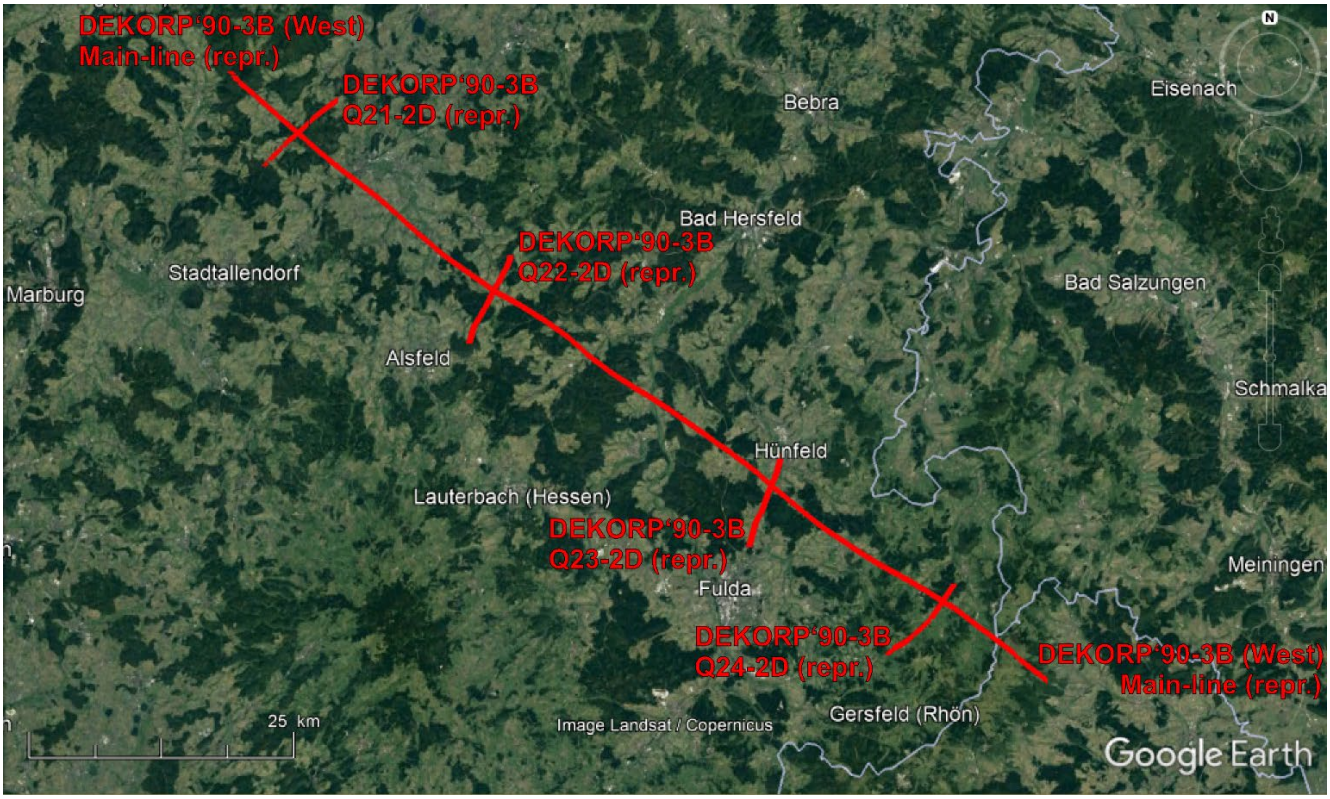
SEG Technical Standards Committee (2002) SEG Y rev 1 Data Exchange format. https://seg.org/Portals/0/SEG/News and Resources/Technical Standards/seg_y_rev1.pdf

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

Stiller M. & Thomas, R. (1989). Processing of reflection-seismic data in the DEKORP Processing Center, Clausthal. In: Emmermann, R. & Wohlenberg, J. (Eds). The German Continental Deep Drilling Program (KTB). Springer Press, pp 177-232. https://doi.org/10.1007/978-3-642-74588-1_9

Stiller, M.; Kaerger, L.; Agafonova, T.; Krawczyk, C.; Oncken, O.; Weber, M.; Former DEKORP Project Leaders; Former DEKORP Research Group; Former DEKORP Processing Centre (2021): Deep seismic reflection profile DEKORP 1990-3B/MVE (West) from the Kellerwald to the Bohemian Massif, West Germany. GFZ Data Services. https://doi.org/10.5880/GFZ.DEKORP-3B_MVE_WEST.001

7. Appendix A



GoogleEarth-based location map showing position and naming of the different reprocessed DEK'90-3B (West) lines, consisting of Main-line and Q21-2D to Q24-2D (red).

7.1. *Table 1a:* Field parameter summary and geometry dimensions (Main-Line)

General information	**Recorded**	August 1990
	by	Prakla-Seismos AG
	for	Geological Survey of Lower Saxony, Germany
	Area	Hesse
	Profile length / direction / azimuth	Reprocessed 96.75 km of total 207.65 km / NW – SE / -214.8404 °
	Total data amount	4.16 GB of total 14.25 GB
Recording	**Recording system**	Sercel SN 368 / MTC01
	Sample interval	4 ms
	No. of channels	320
	Field filter	Low-cut 12.0 Hz / 18 dB High-cut 88.8 Hz / 70 dB
	Noise reduction	Automatic noise-mute before correlation
	Correlation	with filtered sweep
	Recording format	SEG-D
	Sweep + listening time **Recording time**	20 s + 14 s = 34 s (uncorrelated) 14 s (correlated)
Receivers	**Geophone type**	SM 4 (10 Hz)
	Geophones per group	24
	Receiver array	In-line array
	Group spacing	50 m
	Spread length	16 km
	No. of geophone points	4555 (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	50 m
	Vertical stacking rate	6-fold
	Recording configuration	Symmetrical split-spread (8075 – 125 – VP – 125 – 8075 m)
	Source point spacing	100 m
	No. of source points	2200 (entire profile)
CDPs	**Coverage (theor. / real)**	80-fold / 71-fold
	CDP-spacing	25 m
	No. of CDPs	3871 (reprocessed part) of 8307 in total
	Final datum	500 m a.s.l.

Geometry dimensions DEKORP 1990-3B-WEST / Main-Line

	Record	**Location**	**X coordinate**	**Y coordinate**	**Longitude**	**Latitude**
			Gauss-Krueger (Bessel, Potsdam)		**Decimal degree (WGS84)**	
Source	1	1001	4290400.	5655195.	9.01277287	50.99373386
	(2200	5397	4472285.	5558515.	11.61064783	50.16216157 **)**
Receiver	1	1001	4290392.	5655219.	9.01264523	50.99394639
	(4555	5555	4479367.	5561994.	11.70956947	50.19372737 **)**
CDP	2004	1002	4290435.	5655177.	9.01328109	50.99358502
	5874	**2958**	4365974.	5595198.	10.11032036	50.47725923

7.2. Table 1b: Field parameter summary and geometry dimensions (Q-Lines 2D)

General information	**Recorded**	August 1990
	by	Geological Survey of Lower Saxony (recording, receivers), Prakla-Seismos AG (sources)
	for	Geological Survey of Lower Saxony, Germany
	Area	Hesse
	Line: profile length/direction/azimuth/ data amount (correlated)	**Q21-R_{2D}**: 9.44 km / SW – NE / -137.38040 ° / 13.67 MB **Q22-R_{2D}**: 9.28 km / SW – NE / -116.82622 ° / 13.67 MB **Q23-R_{2D}**: 9.36 km / S – W / -110.18385 ° / 13.67 MB **Q24-R_{2D}**: 9.36 km / SW – NE / -133.25681 ° / 13.67 MB
	Profile length in total / total data amount	37.44 km / 54.68 MB
	Q-line spacing	~25 km along main-line
Recording	**Recording system**	Texas Instrument DFS V
	Sample interval	4 ms
	No. of channels	120
	Field filter	High-cut 90 Hz / 70 dB Notch 50 Hz
	Recording format	SEG-B
	Sweep + listening time **Recording time**	20 s + 13.792 s = 33.792 s (uncorrelated) 14 s (correlated with filtered sweep)
Receivers (per Q-line set-up)	**Geophone type**	SM 4 B (10 Hz)
	Geophones per group	12
	Receiver array	In-line array
	Group spacing	80 m
	Spread length	9.52 km
	No. of geophone points	120
Sources (per Q-line set-up)	**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	50 m
	Vertical stacking rate	5-fold
	Recording configuration	Few VPs within 9520 m fixed spread
	Source point spacing	~1200 m
	No. of source points	8
CDPs (per Q-line set-up)	**Coverage**	Fold 1-8
	CDP-spacing	40 m
	Line: no. of CDPs	**Q21-R_{2D}**: 237 **Q22-R_{2D}**: 233 **Q23-R_{2D}**: 235 **Q24-R_{2D}**: 235
	Final datum	500 m a.s.l.

Geometry dimensions DEKORP 1990-3B (West) / Q-2D

Q21-2D (R)

	Record	Location	X coordinate	Y coordinate	Longitude	Latitude
			Gauss-Krueger (Bessel, Potsdam)		Decimal degree (WGS84)	
Source	1195	102	3504301.	5642025.	9.06010882	50.91350248
	1202	220	3511235.	5648327.	9.15889721	50.97005794
Receiver	1	101	3504245.	5641968.	9.05931189	50.91299052
	120	220	3511235.	5648327.	9.15889721	50.97005794
CDP	203	101	3504271.	5641982.	9.05968175	50.91311617
	439	219	3511229.	5648330.	9.15881188	50.97008502

Q22-2D (R)

	Record	Location	X coordinate	Y coordinate	Longitude	Latitude
			Gauss-Krueger (Bessel, Potsdam)		Decimal degree (WGS84)	
Source	1381	102	3523917.0	5625420.0	9.33794489	50.76376207
	1388	220	3527757.0	5633790.0	9.39300201	50.83882924
Receiver	1	101	3523898.0	5625342.0	9.33767054	50.76306170
	120	220	3527772.0	5633788.0	9.39321480	50.83881054
CDP	203	101	3523913.5	5625393.5	9.33789356	50.76352400
	435	217	3527759.2	5633772.0	9.39303188	50.83866733

Q23-2D (R)

	Record	Location	X coordinate	Y coordinate	Longitude	Latitude
			Gauss-Krueger (Bessel, Potsdam)		Decimal degree (WGS84)	
Source	1564	101	3550586.9	5606447.6	9.71333837	50.59151468
	1571	220	3553560.2	5615295.7	9.75660088	50.67078289
Receiver	1	101	3550577.7	5606450.2	9.71321008	50.59153911
	120	220	3553550.1	5615298.3	9.75645825	50.67080710
CDP	202	101	3550582.5	5606449.5	9.71327721	50.59153258
	436	218	3553549.5	5615278.0	9.75644669	50.67062487

Q24-2D (R)

	Record	Location	X coordinate	Y coordinate	Longitude	Latitude
			Gauss-Krueger (Bessel, Potsdam)		Decimal degree (WGS84)	
Source	1707	101	3563764.0	5596416.0	9.89768806	50.50005709
	1714	220	3570021.0	5603203.0	9.98713807	50.56034673
Receiver	1	101	3563764.0	5596416.0	9.89768806	50.50005709
	120	220	3570021.0	5603203.0	9.98713807	50.56034673
CDP	202	101	3563763.8	5596416.0	9.89768524	50.50005711
	436	218	3570016.8	5603198.0	9.98707786	50.56030230

7.3. *Table 2:* Reprocessing sequence summary (Main-line, Q-Lines 2D)

Process	Parameter
Data Output 1	*Input data, raw FF-sorted gathers*
Geometry Extraction	CDP assignment (Main-Line & Q-Lines 2D: Crooked-Line)
Correlation noise suppression	Despiking on uncorrelated data plus subsequent Sweep Correlation (only Q-Lines 2D)
Minimum-Phase Transformation	Operator designed from sweep autocorrelation
Trace Editing	Initial Bad-Trace Elimination
Analytic Gain	Spherical Divergence Correction (T^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 (additional 16⅔ Notch-filter on Q-Lines 2D)
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 (500 m a.s.l.) and Zero-Phase Transformation Coverage: Main-Line ~80-fold, Q-Lines 2D max 8-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 (500 m a.s.l.) and Zero-Phase Transformation Coverage: Main-Line ~80-fold, Q-Lines 2D max 8-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 (500 m a.s.l.) and Zero-Phase Transformation Coverage: Main-Line ~80-fold, Q-Lines 2D max 8-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***