CRS-based minimum-aperture time migration – a 2D land data case study

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Overview

Principle of Kirchhoff migration

Common-Reflection-Surface stack

Real data example

- CRS stack results
- Velocity model building
- Practical aspects
- Aperture parameters
- Poststack time migration
- Prestack time migration

Conclusions

Acknowledgments

The principle of Kirchhoff migration

General properties:

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- integral solution of wave equation

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Time migration:

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- simplified model building
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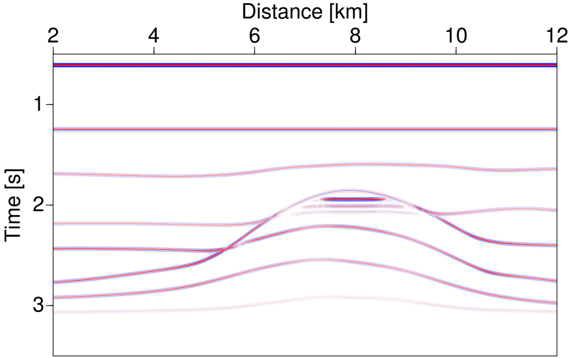
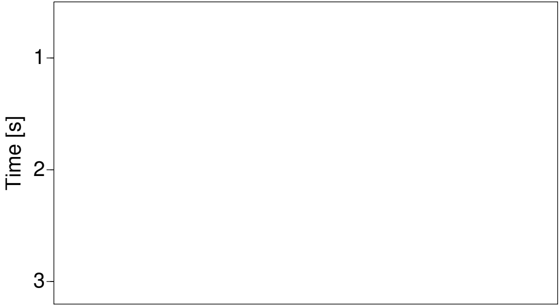
  ➥ well suited for amplitude analysis


Distance [km]
2
4
6
8
10
12
Time [s]
1
2
3


Time [s]
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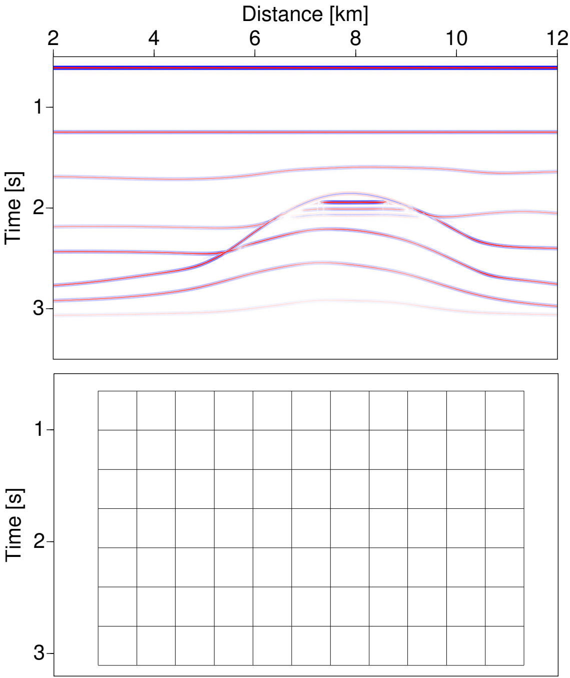
2
3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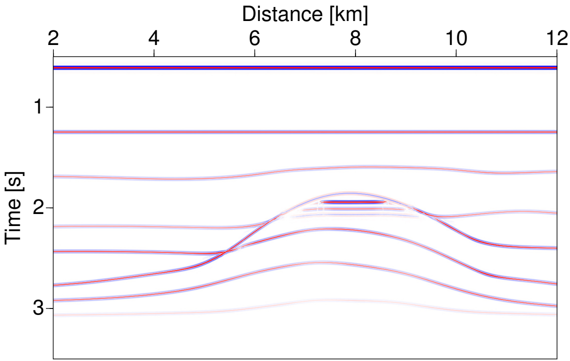

Distance [km]
2
4
6
8
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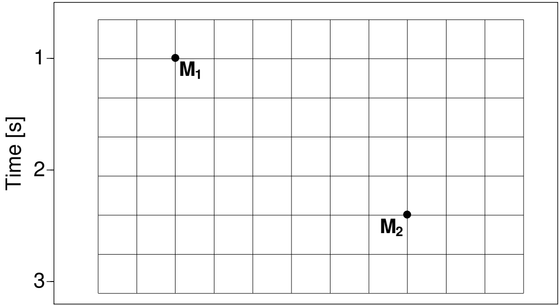
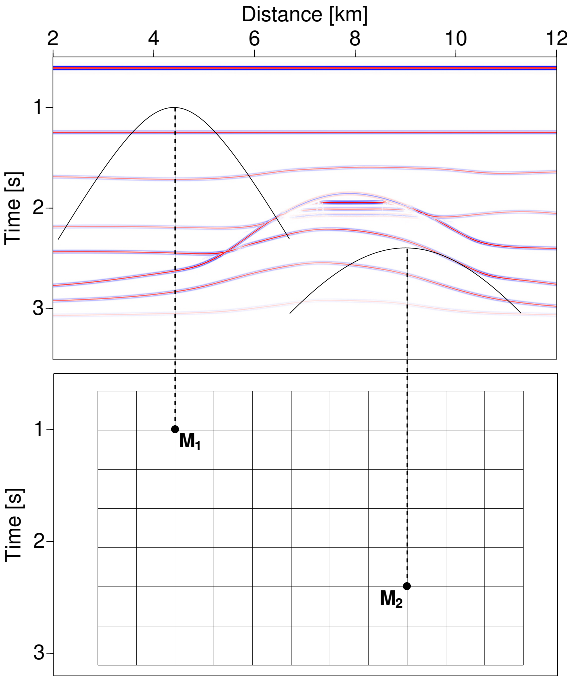


1
2
3
Time [s]
M_1
M_2



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4
6
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1
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3
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3
M1
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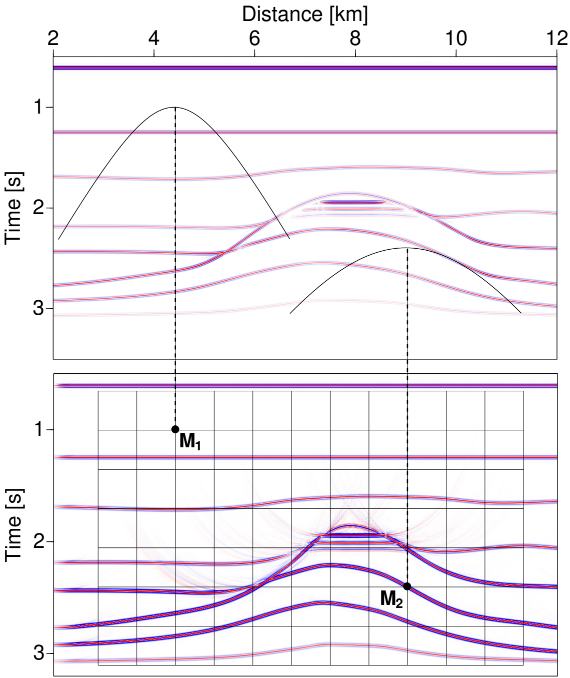

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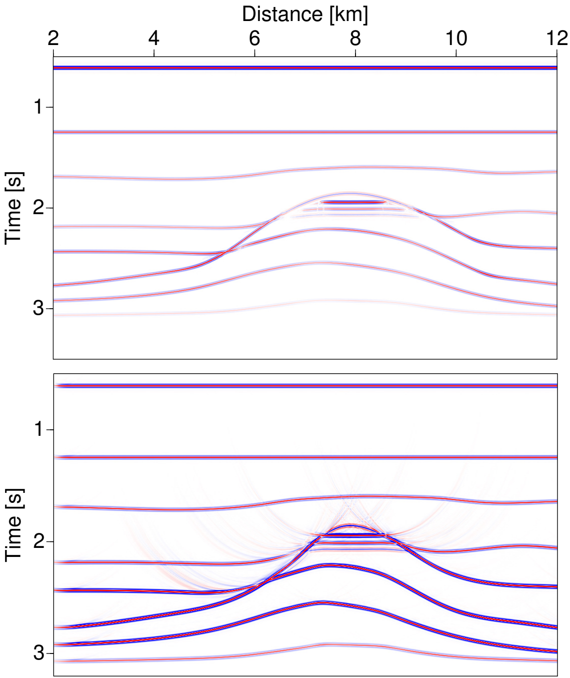
Distance [km]
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Idea of minimum-aperture migration

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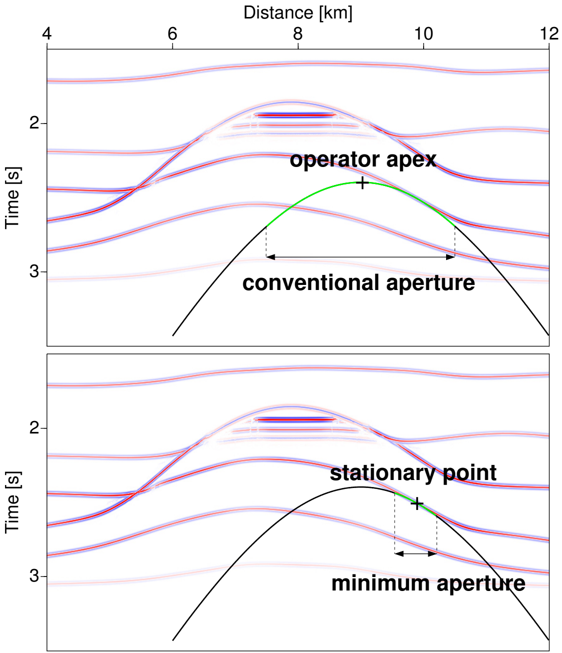
  - general: migration artifacts, degraded amplitudes


Distance [km]
4
6
8
10
12
Time [s]
2
3
operator apex
conventional aperture
Time [s]
2
3
stationary point
minimum aperture

Common-Reflection-Surface stack

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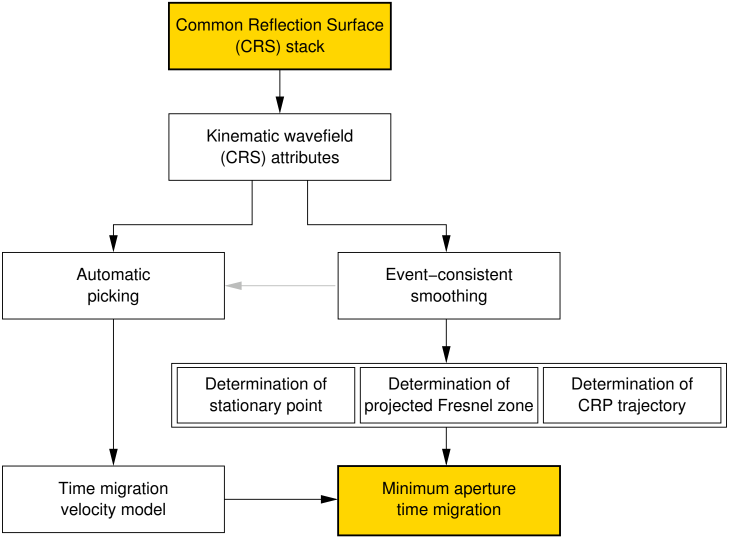
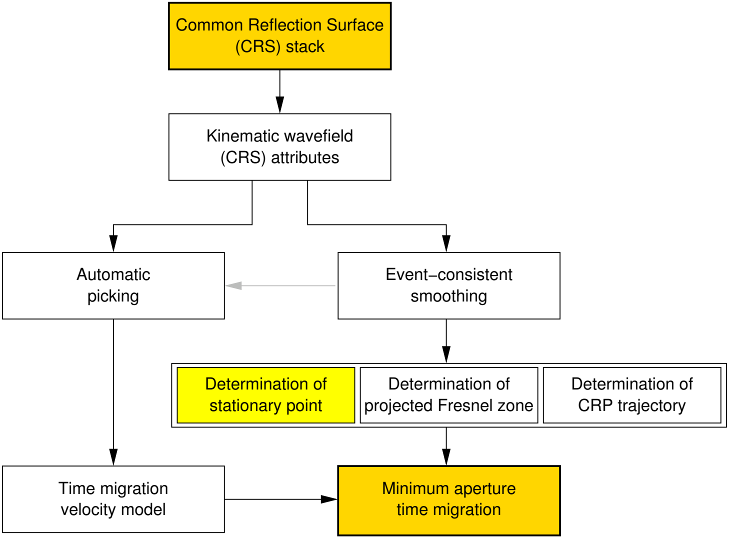
- estimation of projected Fresnel zone

General workflow



Spinner & Mann, 2006, J. Seis. Expl.

General workflow



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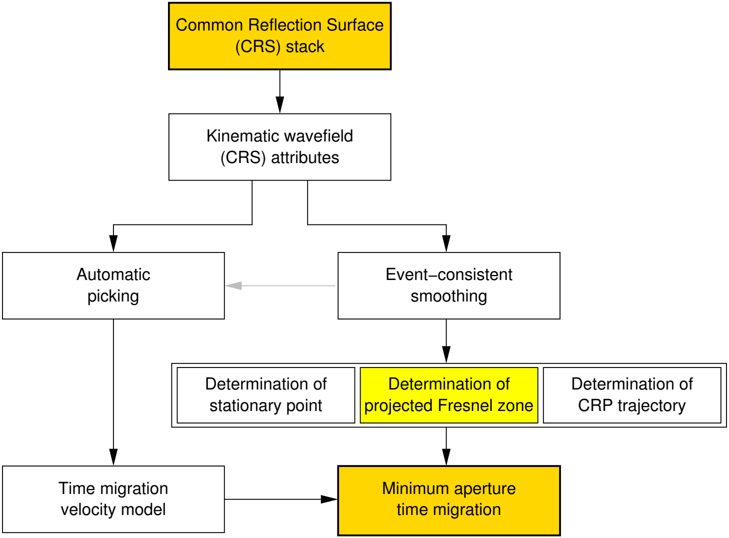

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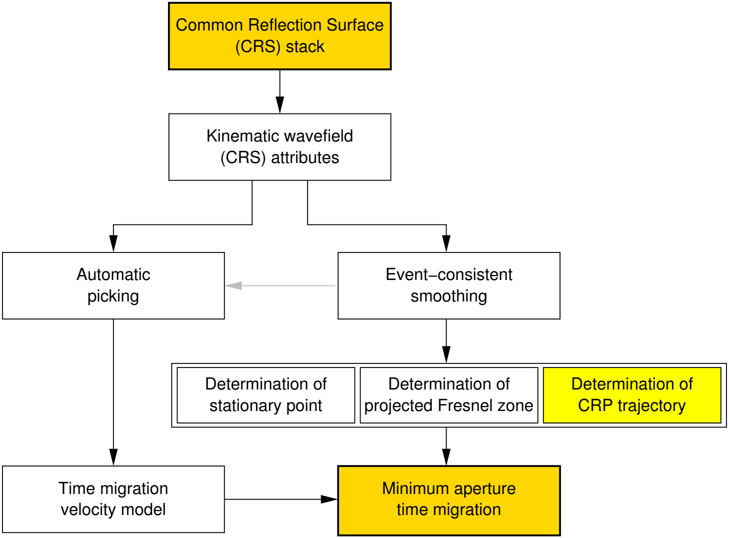

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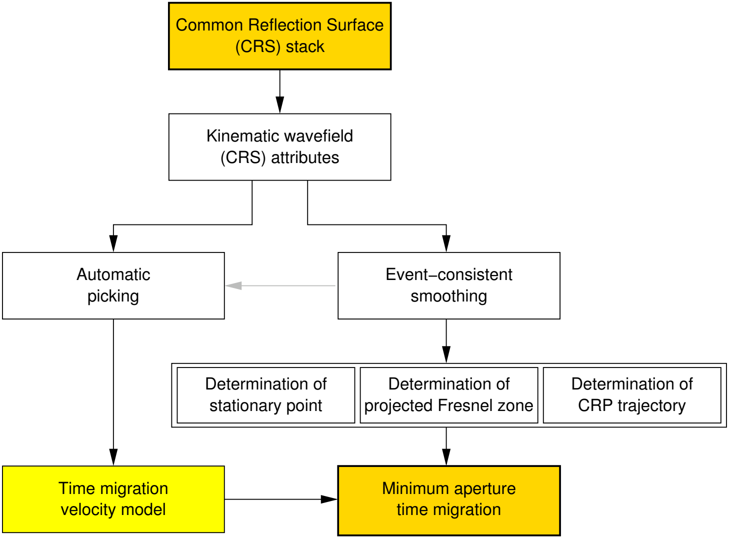

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Real data example

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Acquisition parameters:

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- 2D land data, 12 km fixed spread geometry

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Real data example

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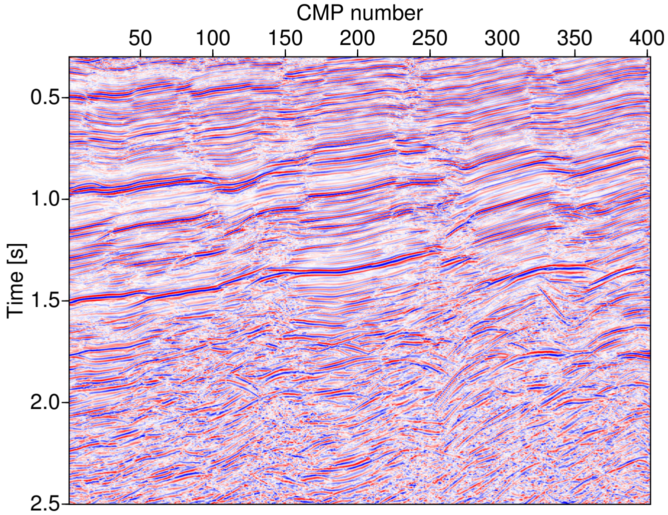
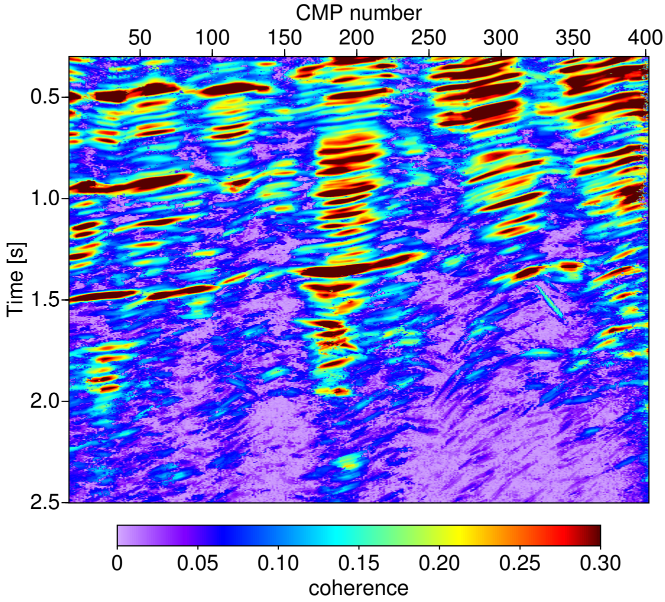
Main purpose:
Delineation of faults

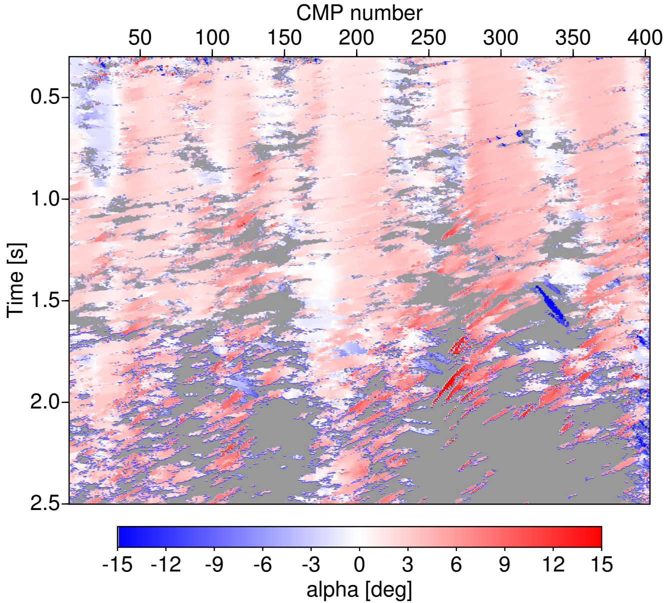
CRS-stacked section



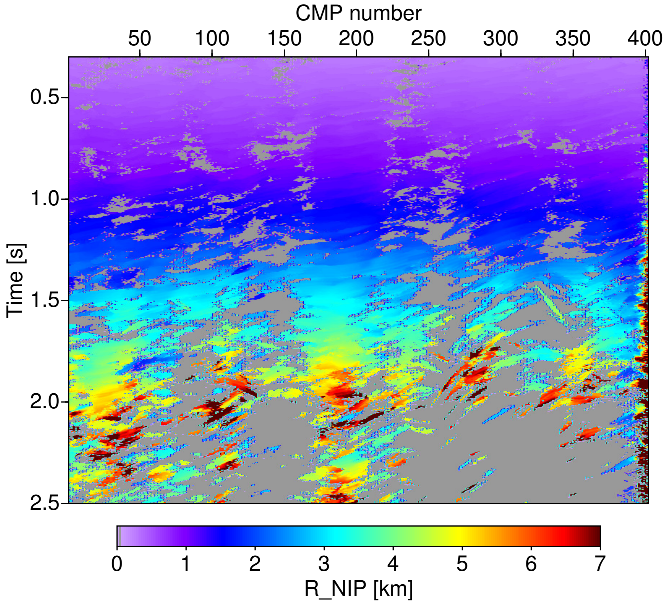
Coherence section



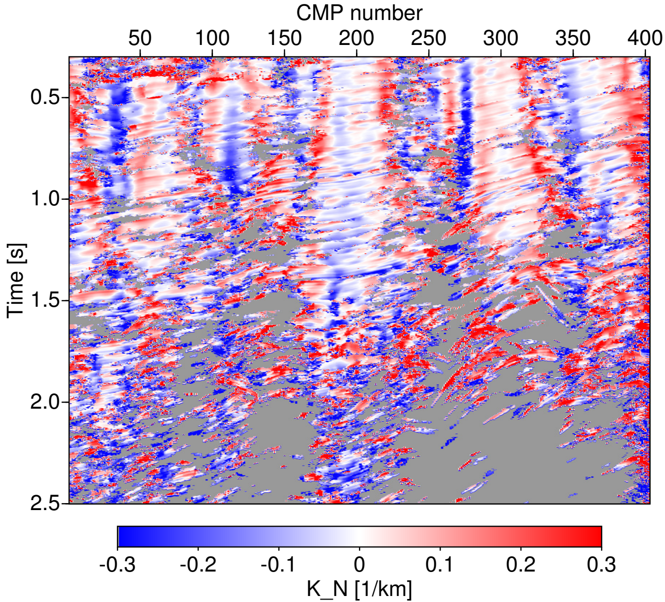
Emergence angle section



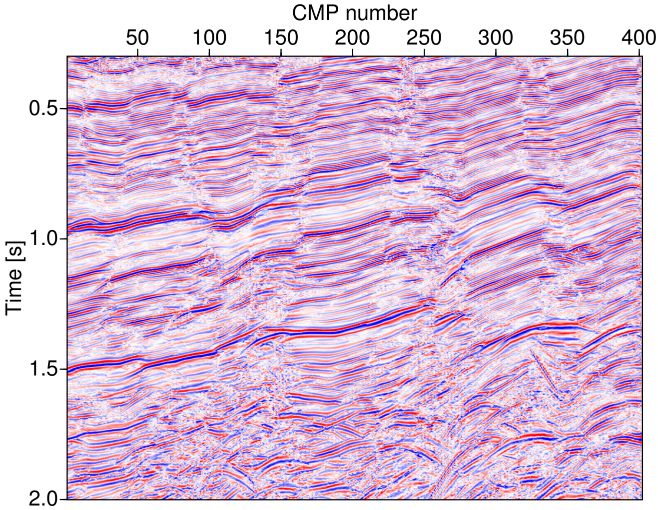
NIP wave radius section



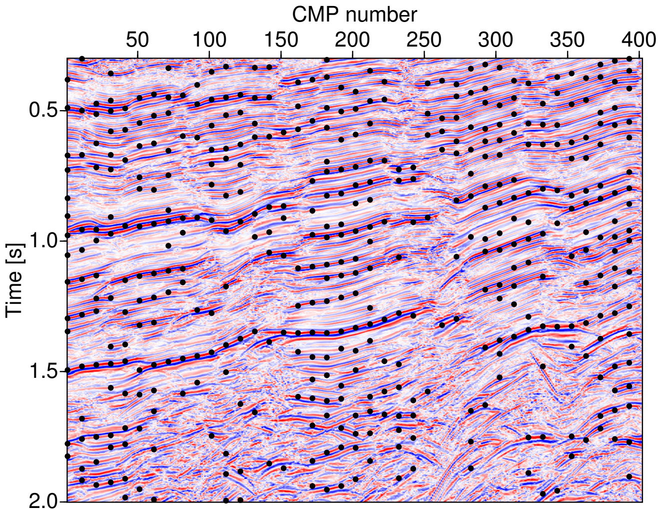
Normal wave curvature section



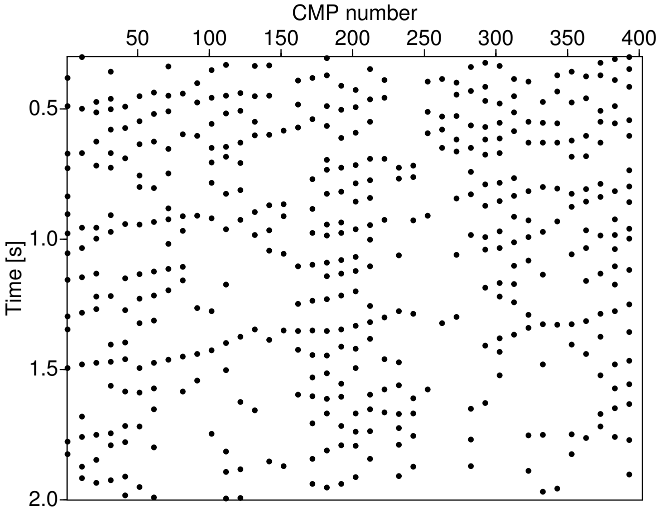
Stacked section



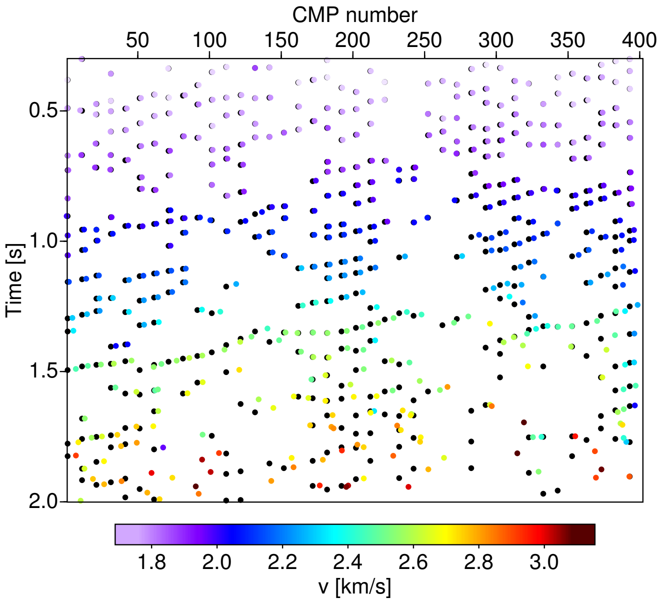
Stacked section with picks



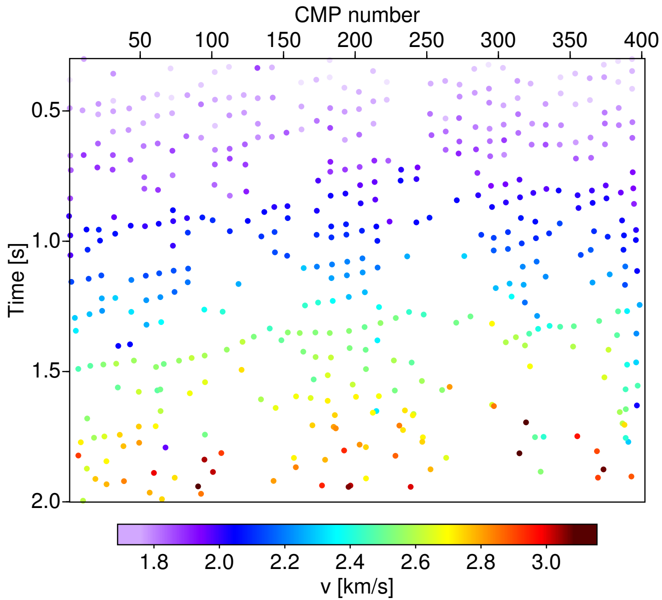
Unmigrated picks



Unmigrated and migrated picks



Migrated picks



Interpolated velocity model

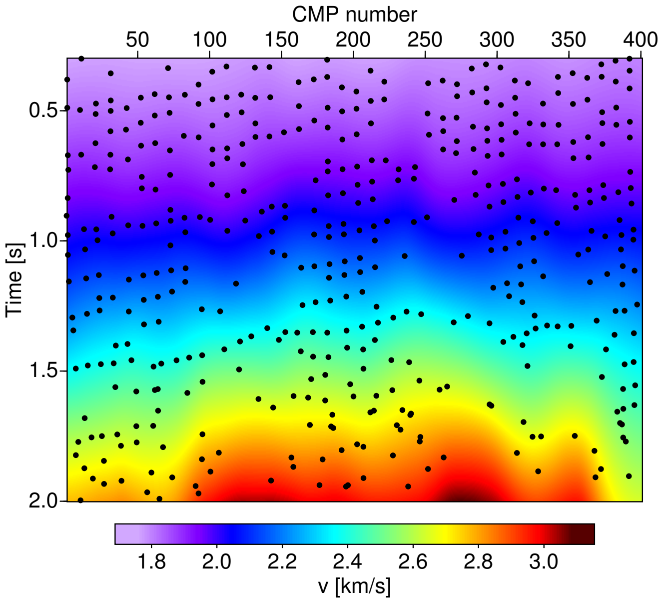
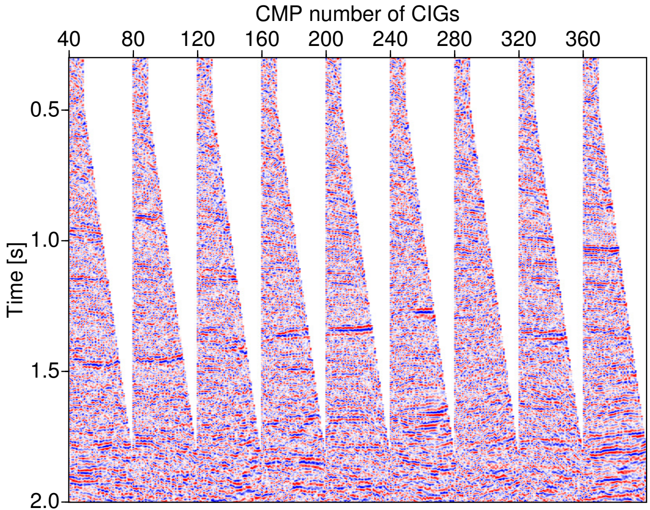


Image gathers



Practical aspects

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- Preconditioning of CRS attributes

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  - event-consistent smoothing

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  - dip estimation very stable

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  - normal wave curvature less stable
    ➥ in worst case: plane wave approximation

Practical aspects

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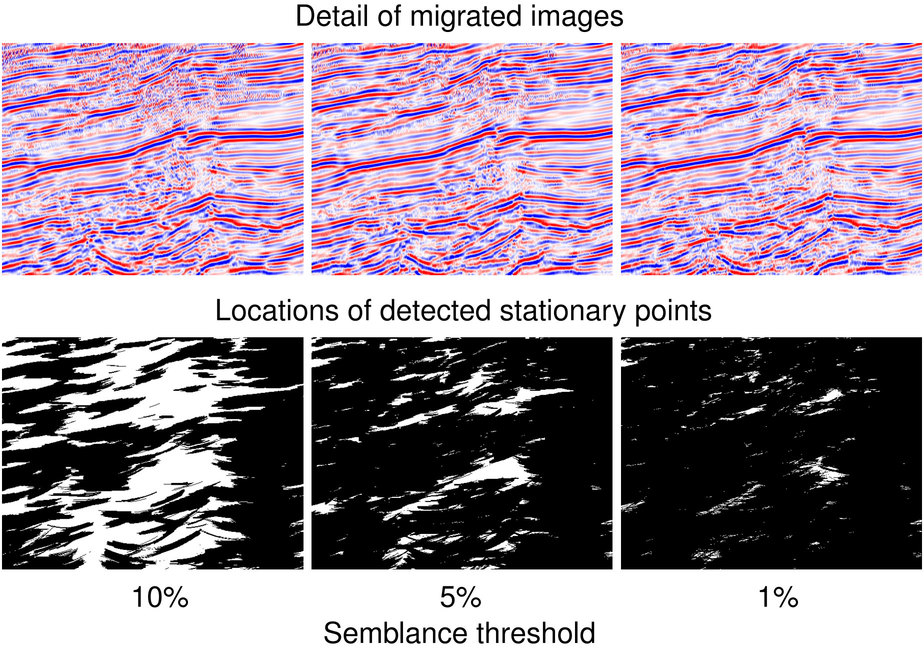
- Criteria for stationary points


Detail of migrated images
Locations of detected stationary points
10%
5%
1%
Semblance threshold

Practical aspects

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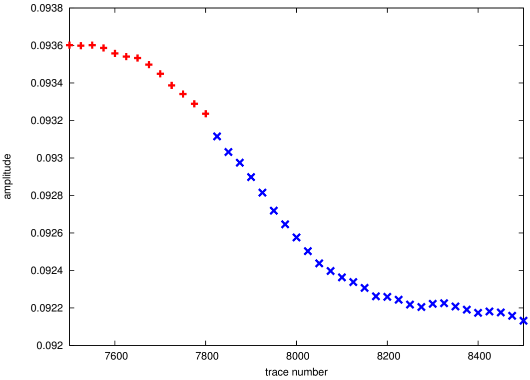

Aperture: minimum (red), conventional (blue)

Kienast, 2007

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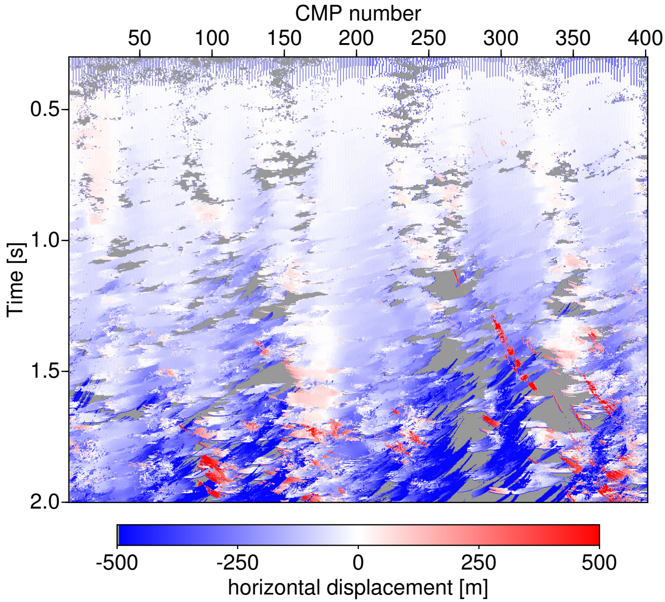
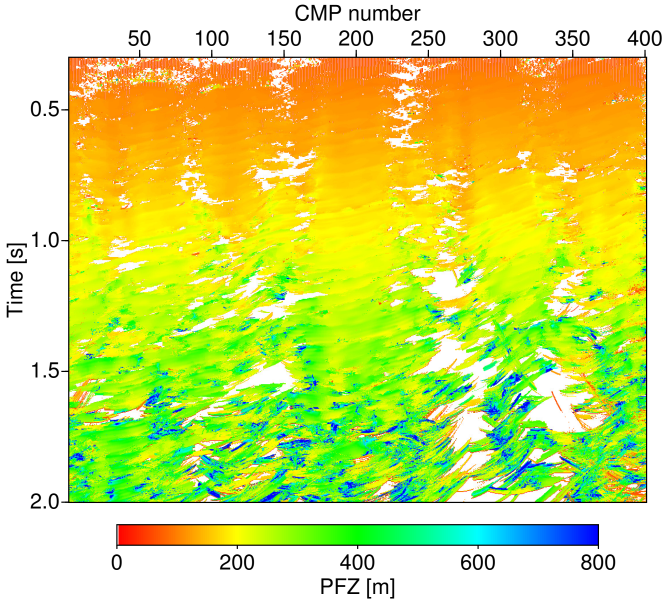
  - problem: stable recognition of such situations
  - not applied for the presented data

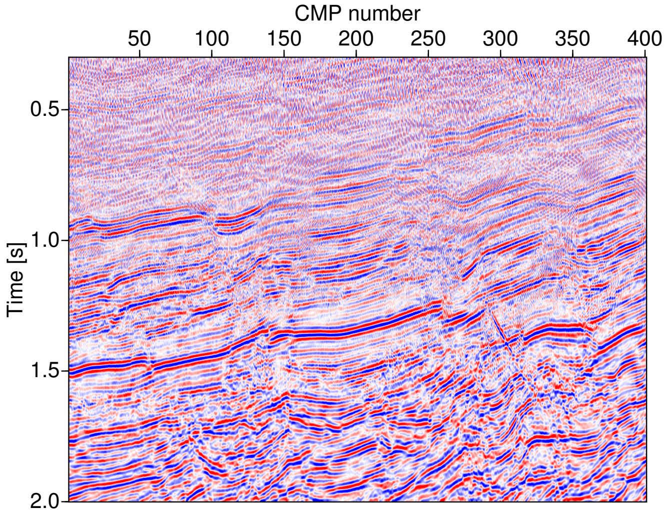
CRS-based stationary points



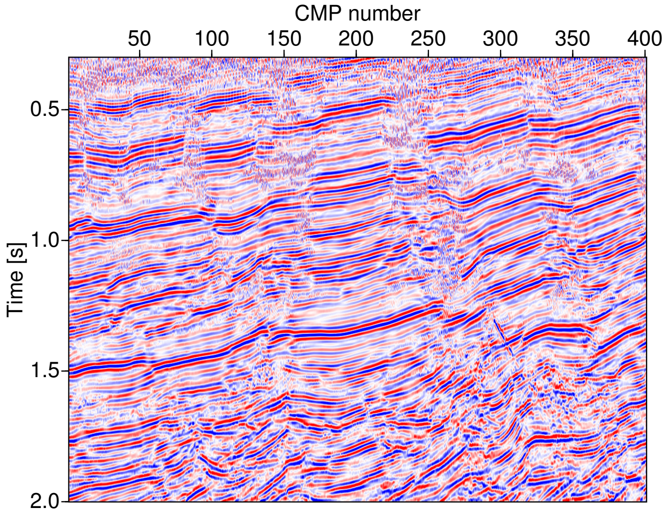
CRS-based ZO projected Fresnel zone



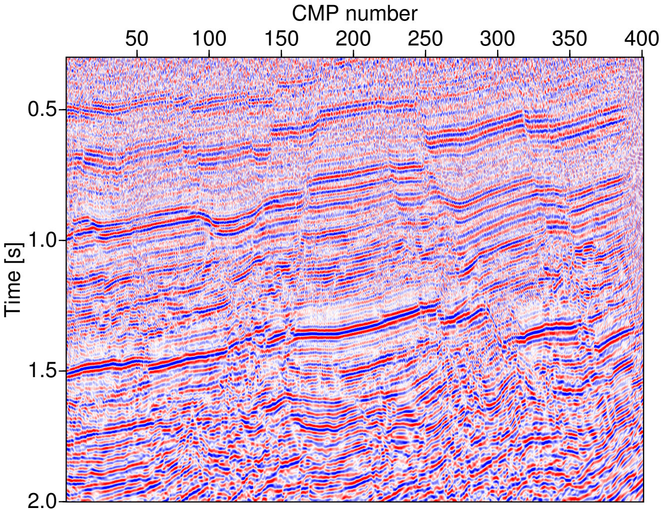
PostSTM section (conventional)



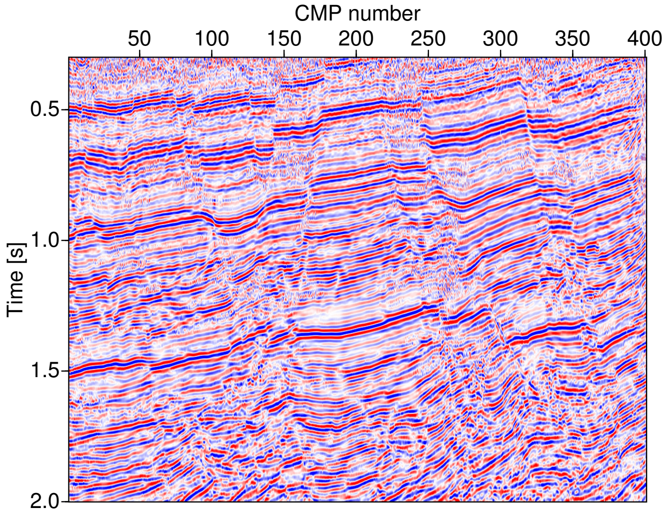
PostSTM section (CRS-based)



PreSTM section (conventional)



PreSTM section (CRS-based)



Conclusions

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Minimum-aperture time migration

- all required information available from CRS stack
- simple model building
- reduced noise level
- less artifacts
- no operator aliasing
- clearer delineation of faults

Acknowledgments

This work was kindly supported by the sponsors of the Wave Inversion Technology (WIT) Consortium, Hamburg, Germany