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:
The principle of Kirchhoff migration

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- integral solution of wave equation
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- each point is considered as potential secondary source (diffractor)
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Time migration:
- analytic migration operator
- analytic migration weights
- simplified model building
- small model error sensitivity
  - well suited for amplitude analysis
Idea of minimum-aperture migration

Constructive contributions from tangency region only:
- Aperture attached to stationary point, depends on event dip.
- Width given by first projected Fresnel zone.
- Depends on event dip and curvature.

Conventional approach:
- Dip and curvature unknown.
- Aperture centered around operator apex.
- Size user given.
- Too small: loss of steep events.
- Too large: operator aliasing, noise.
- General: migration artifacts, degraded amplitudes.
Idea of minimum-aperture migration

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Common-Reflection-Surface stack

Common-Reflection-Surface stack extracts structural information from prestack data for each sample:

- Emergence angle of normal ray
- Radius of normal-incidence-point (NIP) wave
- Curvature of normal wave

All information required for:

- (time) migration velocity model building
- Determination of stationary points
- Estimation of projected Fresnel zone

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General workflow

1. Common Reflection Surface (CRS) stack
2. Kinematic wavefield (CRS) attributes
3. Automatic picking
4. Event–consistent smoothing
5. Determination of stationary point
6. Determination of projected Fresnel zone
7. Determination of CRP trajectory
8. Time migration velocity model
9. Minimum aperture time migration

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Kinematic wavefield (CRS) attributes

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Time migration

Minimum aperture time migration

Real data example

Acquisition parameters:
- 2D land data, 12 km fixed spread geometry
- 50 m shot/receiver spacing
- 2 ms sampling interval
- standard preprocessing
- amplitudes not preserved

Main purpose: Delineation of faults
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Main purpose:
Delineation of faults
Coherence section
Emergence angle section
NIP wave radius section
Normal wave curvature section
Unmigrated picks

CMP number

Time [s]

50 100 150 200 250 300 350 400
Unmigrated and migrated picks

![Graph showing unmigrated and migrated picks with time, CMP number, and velocity](image)
Migrated picks

CMP number

Time [s]

v [km/s]

1.8 2.0 2.2 2.4 2.6 2.8 3.0

0.5 1.0 1.5 2.0
Interpolated velocity model
Image gathers
Practical aspects
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- Preconditioning of CRS attributes
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  - event-consistent smoothing

Criteria for stationary points

- Dip estimation very stable
- Stable determination of stationary point
- Normal wave curvature less stable
  - In worst case: plane wave approximation
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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
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    - similar strategy as in input domain
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CRS-based ZO projected Fresnel zone
PostSTM section (CRS-based)
PreSTM section (CRS-based)
Conclusions

Minimum-aperture time migration
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- all required information available from CRS stack
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➤ all required information available from CRS stack
➤ simple model building
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- 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