wide-azimuth angle gathers
for anisotropic wave-equation migration

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wide-azimuth angle gathers
wide-azimuth angle gathers

accurate wavefield imaging
wide-azimuth angle gathers

accurate wavefield imaging

efficient angle decomposition
accurate wavefield imaging

wavefield reconstruction

\[ \mathcal{L} [W_s(x, t)] = D_s(x_s, +t) \]
\[ \mathcal{L} [W_r(x, t)] = D_r(x_r, -t) \]
accurate wavefield imaging

wavefield reconstruction

\[ \mathcal{L} [W_s (x, t)] = D_s (x_s, +t) \]
\[ \mathcal{L} [W_r (x, t)] = D_r (x_r, -t) \]

conventional imaging condition

\[ R (x) = \sum_{\text{shots}} \sum_t W_s (x, t) W_r (x, t) \]
accurate wavefield imaging

wavefield reconstruction

\[ \mathcal{L} [W_s (x, t)] = D_s (x_s, +t) \]
\[ \mathcal{L} [W_r (x, t)] = D_r (x_r, -t) \]

extended imaging condition

\[ R (x, \lambda, \tau) = \sum_{\text{shots}} \sum_{t} W_s (x - \lambda, t - \tau) W_r (x + \lambda, t + \tau) \]
wavefield-domain decomposition

loop over shots{
    build $W_s(x, t), W_r(x, t)$

    decompose $W_s(x, t), W_r(x, t)$

    select main wave paths

    apply imaging condition
}

deimage-domain decomposition

loop over shots{
    build $W_s(x, t), W_r(x, t)$

    do nothing

    do nothing

    apply imaging condition

    decompose $R(x, \lambda, \tau)$
wavefield-domain decomposition

loop over shots{
  build $W_s(x, t), W_r(x, t)$
  decompose $W_s(x, t), W_r(x, t)$
  select main wave paths
  apply imaging condition
}

image-domain decomposition

loop over shots{
  build $W_s(x, t), W_r(x, t)$
  apply imaging condition
}

decompose $R(x, \lambda, \tau)$
efficient angle decomposition

1. use extended images
2.
3.
$R(x, \lambda, \tau)$

common-image gathers: wasteful, biased
$R(c, \lambda, \tau)$

common-image-point gathers: efficient, un-biased
high velocity
efficient angle decomposition

1. use extended images
2. use common-image-point gathers
3.
conventional IC interpretation
extended IC interpretation
extended IC interpretation
ISO: reflection geometry

\[ \theta_s = \theta \]

\[ \theta_r = \theta \]
TTI: reflection geometry

\[ \theta_s = \theta - \psi(\theta) \]

\[ \theta_r = \theta + \psi(\theta) \]
ISO: $\psi (\theta)$

$v_p = 3 \text{km/s}$
VTI: $\psi(\theta)$

$v_p = 3 km/s, \epsilon = +0.45, \delta = -0.29$
TTI: $\psi(\theta)$

$v_p = 3\text{km/s}, \epsilon = +0.45, \delta = -0.29, \theta_a = 35^\circ, \phi_a = 90^\circ$
anisotropic decomposition

\[ R(\lambda, \tau) \xrightarrow{\psi(\theta), v_s(\theta), v_r(\theta)} R(\phi, \theta) \]

\[(\hat{q} \cdot \lambda) \sin(2\theta) = [v_s \cos(\theta + \psi) + v_r \cos(\theta - \psi)] \tau\]
anisotropic decomposition

\[ R(\lambda, \tau) \xrightarrow{\psi(\theta), v_s(\theta), v_r(\theta)} R(\phi, \theta) \]

\[ (\hat{q} \cdot \lambda) \sin (2\theta) = [v_s \cos (\theta + \psi) + v_r \cos (\theta - \psi)] \tau \]

\[ (\hat{n} \cdot \lambda) = 0 \]
efficient angle decomposition

1. use extended images
2. use common-image-point gathers
3. use reflector geometry
examples
ISO: wavefield

\[ v_p = 3 \text{ km/s} \]
VTI: wavefield

\( v_p = 3 \text{ km/s}, \epsilon = +0.45, \delta = -0.29 \)
TTI: wavefield

\[ v_p = 3\text{km/s}, \epsilon = +0.45, \delta = -0.29, \theta_a = 35^\circ, \phi_a = 90^\circ \]
ISO: one shot
VTI: one shot
TTI: one shot
ISO: all shots
VTI: all shots
TTI: all shots
wide-azimuth angle gathers

- accurate wavefield imaging
- anisotropic RTM
- efficient angle decomposition
- extended CIPs
acknowledgments

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