Attenuation tomography in 2D TI media

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Example of attenuation anisotropy

Zhu et al (2007)
**TI velocity and attenuation parameters**

<table>
<thead>
<tr>
<th>Velocity</th>
<th>Attenuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{P0}$</td>
<td>$A_{P0}$</td>
</tr>
<tr>
<td>$V_{S0}$</td>
<td>$A_{S0}$</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>$\varepsilon_Q$</td>
</tr>
<tr>
<td>$\delta$</td>
<td>$\delta_Q$</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>$\gamma_Q$</td>
</tr>
</tbody>
</table>

\[
A_P(\theta) = A_{P0} \left( 1 + \delta_Q \sin^2 \theta \cos^2 \theta + \varepsilon_Q \sin^4 \theta \right)
\]

$\theta$ — angle with symmetry axis

*Zhu & Tsvankin (2006)*
Piecewise-factorized VTI model

\[ V_{P0}(x,z) = V_{P0}(0,0) + k_x x + k_z z \]

\[ \delta \]

\[ \varepsilon \]

\[ Q_{P0}(x,z) = Q_{P0}(0,0) + j_x x + j_z z \]

\[ \delta_Q \]
Kirchhoff modeling + Gaussian-beam summation
Migration velocity analysis

For each factorized block:

\[ V_{\text{nmo}} = V_{P0} \sqrt{1 + 2\delta} \]

\[ k_z = k_x \sqrt{1 + 2\delta} \]

\[ \eta = \frac{\varepsilon - \delta}{1 + 2\delta} \]

\[ k_x \]

\[ V_{P0} \]

\[ k_z \]

\[ \varepsilon \]

\[ \delta \]

Sarkar & Tsvankin (2004)
$A_P(\theta) = A_{P0} \left( 1 + \delta_Q \sin^2 \theta \cos^2 \theta + \varepsilon_Q \sin^4 \theta \right)$
Linearized inversion

\[ m = \left[ Q_{P0}(0,0), j_X, j_Z, \varepsilon_Q, \delta_Q \right] \]

quasi-Newton: \( m^{(j+1)} = m^{(j)} - \alpha H^{-1} g^{(j)} \)
Summary

- factorized VTI for velocity and attenuation
- Kirchhoff + Gaussian-beam modeling
- migration velocity analysis
- attenuation layer stripping
- linearized inversion for $A_{P0}(x,z)$, $\varepsilon_Q$, $\delta_Q$
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