Comparison of one- and two-step seismic inversion for Lithology and Fluid prediction

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Two-step seismic LFP

Seismic inversion

Rock physics inversion

Seismic 5°, 20° and 30°

AI (g/ccm*m/s) 5000 7500 10000

Vp/Vs 1.4 2.1 2.4

LFP probability

0 0.5 1.0
Two-step seismic LFP

Seismic inversion

Rock physics inversion

Seismic 5°, 20° and 30°

5000 AI (g/ccm* m/s)

7500

10000

LFP probability

1.4

2.1

2.4

Vp/Vs

0

0.5

1.0

One-step seismic LFP
Bayesian seismic inversion

Bayes rule: \( p(f|d) \propto p(f) \times p(d|f) \)

Posterior \( \propto \) Prior \( \times \) Likelihood(data)
Why do we need the prior?

Energy spectrum

Energy

Frequency (Hz)
Why do we need the prior?

Energy spectrum

Energy

Frequency (Hz)
Why do we need the prior?

Energy spectrum

Seismic 5°, 15° and 25°
Why do we need the prior?

Energy spectrum

Seismic 5°, 15° and 25°
Why do we need the prior?

Energy spectrum

Frequency (Hz)
High-frequent information is also missing

Energy spectrum

Energy

Frequency (Hz)
High-frequent information is also missing

Energy spectrum

Seismic 5°, 15° and 25°
Two-step LFP inversion (PCube)

Buland et al., 2008, *Bayesian lithology and fluid prediction from seismic prestack data*
One-step LFP inversion (PCube+)
One-step LFP inversion (PCube+)
One-step LFP inversion (PCube+)
One-step LFP inversion (PCube+)
Synthetic case: Simple wedge

- Shale
- Oil-filled sand
- Gas-filled
Prior model

- Top sand: ± 25 ms
- OWC: ± 50 ms
- Bottom sand: ± 100 ms
Two-step inversion

One-step inversion

Prior
Two-step inversion

One-step inversion

Prior
Two-step inversion

One-step inversion

Prior
Inversion results for wedge

Answer

Two-step

One-step

Near

Mid

Far

NR
# Summary

<table>
<thead>
<tr>
<th>Two-step inversion</th>
<th>One-step inversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pointwise</td>
<td>Neighbourhood</td>
</tr>
<tr>
<td>No lithology or fluid ordering</td>
<td>Lithology and fluid ordering</td>
</tr>
<tr>
<td>Facies probability only</td>
<td>Zone and horizon probability</td>
</tr>
<tr>
<td>Smoother result</td>
<td>Can resolve details below tuning resolution</td>
</tr>
<tr>
<td>Less detailed background model</td>
<td>More detailed background model</td>
</tr>
<tr>
<td>Fast</td>
<td>Slower</td>
</tr>
</tbody>
</table>
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