Microseism location by full-waveform triangulation

Jeff Godwin* and Paul Sava
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Colorado School of Mines
<table>
<thead>
<tr>
<th><strong>improve data</strong></th>
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<td>picking</td>
<td>imaging condition</td>
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</tbody>
</table>
Spatio-temporal coincidence
Receiver groups
13 Groups of 3 each
40 Groups of 1 each
Microseismic imaging conditions

- Product Imaging Condition (PIC)
- Semblance Imaging Condition (SIC)
# Product imaging condition

<table>
<thead>
<tr>
<th>Space-time</th>
<th>( R(x, t) = \prod_{i=0}^{N_g} W^i_R(x, t) )</th>
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<tr>
<td>Space-only</td>
<td>( M(x) = \sum_t R(x, t) )</td>
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$M(x), N_g = 3$
$M(x), N_g = 13$
$M(x), N_g = 40$
$M(x), N_g = 3$
Semblance imaging condition

\[ S(x, t) = \frac{\sum_{k=-m}^{m} \left[ \sum_{i=0}^{N_g} W_R^i(x, t+k) \right]^2}{\sum_{k=-m}^{m} \sum_{i=0}^{N_g} [W_R^i(x, t+k)]^2} \]

\[ m \] - temporal smoothing half-window width
**Semblance imaging condition**

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number of groups
spatial resolution
computational cost
sensitivity to noise
semblance potential
number of groups
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Velocity Analysis
wavefield gather

Incorrect
Future research
Future research

• hybrid imaging conditions
Future research

- hybrid imaging conditions
Future research

- hybrid imaging conditions
- S-waves
Future research

- hybrid imaging conditions
- S-waves
Future research

• hybrid imaging conditions

• S-waves

• automatic velocity inversion
Conclusions
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- spatio-temporal coincidence
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- spatio-temporal coincidence
- microseismic imaging conditions
Conclusions

- spatio-temporal coincidence
- microseismic imaging conditions
- product
Conclusions

• spatio-temporal coincidence
• microseismic imaging conditions
• product
• less expensive
Conclusions

- spatio-temporal coincidence
- microseismic imaging conditions
  - product
  - less expensive
- semblance
Conclusions

• spatio-temporal coincidence
• microseismic imaging conditions
• product
  • less expensive
• semblance
  • robust to noise
Acknowledgments

• Ran

• Ashley
Conclusions

• spatio-temporal coincidence
• microseismic imaging conditions
  • product
  • less expensive
• semblance
  • robust to noise