Passive wavefield imaging using the energy norm

Daniel Rocha\textsuperscript{1}, Paul Sava\textsuperscript{1} and Jeffrey Shragge\textsuperscript{2}

Center for Wave Phenomena, Colorado School of Mines\textsuperscript{1}
University of Western Australia\textsuperscript{2}
Wavefield-based passive imaging

anisotropic elastic

– displacement

– wave modes
wave modes

energy
Autocorrelation imaging condition

\[ I(x) = \sum_{t} W(x, t) W(x, t) \]
Autocorrelation imaging condition

\[ l_{PP}(x) = \sum_t P(x, t) P(x, t) \]

\[ l_{SS}(x) = \sum_t S(x, t) \cdot S(x, t) \]
$P \ast P = PP$
$S \ast S = SS$
Crosscorrelation imaging condition

\[ I_{PS}(x) = \sum_{t} P(x, t)S(x, t) \]
$P \ast S = PS$
Autocorrelation imaging condition

\[ I_{UUU}(x) = \sum_{t} U(x, t) \cdot U(x, t) \]
Energy imaging condition

\[ l_{EN}(x) = \sum_{t} \left[ \rho \dot{U} \cdot \ddot{U} - (\zeta \nabla U) : \nabla U \right] \]
Energy imaging condition

\[ I_{EN}(x) = \sum_{t} \left[ \rho \dot{U} \cdot \dot{U} - (c \nabla U) : \nabla U \right] \]

- kinetic
- potential
Imaging conditions

conventional: \( I(x) \)

extended: \( I(x, \lambda, \tau) \)
PS

1. low
   \[
   \frac{V_P}{V_S}
   \]

2. correct
   \[
   \frac{V_P}{V_S}
   \]

3. high
   \[
   \frac{V_P}{V_S}
   \]
\[
\frac{V_P}{V_S}
\]

*low*

*correct*

*high*
Conclusions

Elastic imaging condition for passive data

- improves focusing at the source
- requires no wave-mode decomposition
- handles arbitrary anisotropy