Multicomponent imaging with Distributed Acoustic Sensing

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Multicomponent Imaging
with
Distributed Acoustic Sensing
6 components

$\varepsilon_{xx}$  $\varepsilon_{xy}$  $\varepsilon_{xz}$

$\varepsilon_{yy}$  $\varepsilon_{yz}$  $\varepsilon_{zz}$

$z$ (km)

0.2  0.4
equation of motion

\[ \rho \ddot{u} - \nabla \cdot \sigma = f \]

stress-strain relation

\[ -\sigma + c : \varepsilon = h \]

\( u = \) displacement

\( \sigma = \) stress tensor

\( \rho = \) density

\( c = \) stiffness tensor
equation of motion

\[ \rho \ddot{u} - \nabla \cdot \sigma = f \]

stress-strain relation

\[ -\sigma + \mathbf{c} : \varepsilon = h \]

\( f = \) volume force density

\( h = \) deformation density
\[ \mathbf{V} = - \oint_{\partial \Omega} ds \ u \ast \mathbf{G}^f \]

\[ \mathbf{G}^f = \text{propagator with } f \text{ source} \]
\[ V = - \oint_{\partial \Omega} ds \left[ \sigma \ast G^f + u \ast G^h \right] \cdot n \]  

(Ravasi and Curtis, 2013)

\( G^f = \) propagator with \( f \) source
\( G^h = \) propagator with \( h \) source
example
- explosive source
- multicomponent receivers
Marmousi II example
pressure sources
multicomponent receivers
\[ l_E = \sum_{e,t} \left[ \rho \dot{U} \cdot \dot{V} + (\mathbf{c} \nabla U) : \nabla V \right] \]

(Rocha et al., 2017)

\[ U = \text{source wavefield} \quad \mathbf{c} = \text{stiffness tensor} \]
\[ V = \text{receiver wavefield} \quad \rho = \text{density} \]
\( f, h \)
\( f, h \)
extrapolation from the water layer
- pressure sources
- multicomponent receivers
f: streamer
take home message

**MIDAS** improves elastic seismic imaging
Matteo Ravasi, Statoil

Daniel Rocha
MIDAS